Increasing awareness of urban cultural heritage using digital technologies

Increasing awareness of urban cultural heritage using digital technologies: empirical design and analysis of a new multi-media web platform

PROEFSCHRIFT

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geboren te Shandong, China

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Benshuo Wang

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Chapter 1 Introduction

1.1 Background and motivation

As defined by UNESCO World Heritage Center (2005): “cultural heritage (CH) is the legacy of physical artefacts and intangible attributes of a group or society that are inherited from the past generation, maintained in the present and bestowed for the benefit of future generations.” Sustainability of cultural heritage involves protecting and conserving tangible heritage and disseminating the knowledge on heritage from generation to generation (Sadowski, 2017; Srivastava, 2018; Tweed and Sutherland, 2007; Yilmaz and Gamil, 2018). Cultural heritage, especially urban cultural heritage, is the physical representation of a community identity that demands to be disseminated to other people and generations (Riganti and Nijkamp, 2004). Preserving urban cultural heritage is vital because the values behind it are inestimable and irreplaceable (Jokiletho, 2002). Van Zanten (2004) states that cultural heritage is only sustainable if people understand, enjoy and recreate them. Therefore, it is important that cultural heritage, tangible or intangible, is accepted and recognized by the society for its continuity (Mourato and Mazzanti, 2002: 51). The missions of preserving cultural heritage expand from restoring and maintaining the tangible heritage (Zukin, 2012) to keeping the intangible spirit of society (Vecco, 2010). Therefore, raising awareness of cultural heritage is the first step to its sustainability. However, internal and external barriers prevent the public’s awareness of cultural heritage, such as the funding limitation, social discrimination, poor physical access, and insufficient knowledge of cultural heritage (Jigyasu, 2016; Fatorić and Seekamp,

2017; Van der Borg & Russo, 2005; Wang et al, 2018). Among them, lack of knowledge of cultural heritage is an essential factor that causes misunderstanding or loss of cultural heritage values within the society (Chen et al., 2018). Thus, providing information of cultural heritage can pass knowledge to the public, raise their awareness of cultural heritage and prevent the loss of cultural heritage values (Calvo-Iglesias et al., 2006).

Cultural heritage is the link between the past and our future, and media (i.e., text, images, maps) are one of the sources that can carry the information from the past to the future (Giaccardi, 2012), in addition to people's experiences and stories. In the past, it was difficult for the public to have immediate access to information on cultural heritage (Ashworth, 2011; Kaddu, 2015). The information on cultural heritage was mainly received from others, such as learning it via oral stories. Moreover, some heritage areas are difficult to physically access, such as the Terra-Cotta Warriors and Mogao Caves in China, which results in less visibility and information on these places. The limited information on a cultural heritage might cause an incomplete understanding of the heritage and its values on-site, and might cause even more challenges for people who cannot visit the cultural heritage on-site (Dragoni et al., 2017; Monod et al., 2006). Recently, the emergence and widespread use of the World Wide Web presents an opportunity to enhance access to detailed information on cultural heritage (Garau and Ilardi, 2014). In that respect, digital technologies, multi-media and the internet have enabling roles for enhancing cultural heritage experiences. With such technologies, cultural heritage places can be experienced, even

before the physical visit starts, and people's understanding and awareness of cultural heritage can be shaped by providing content-related information (Ciasullo et al., 2016).

1.2 The state-of-art

Cultural heritage is commonly divided into two main parts: tangible and intangible cultural heritage (Swensen et al., 2013). Tangible cultural heritage is related to the physical architecture, such as the buildings; it constitutes the cornerstone of activities and projects (La Frenierre, 2008; Tweed & Sutherland, 2007; Vecco, 2010). Historical buildings, public space, and landscapes are the main constituent parts of tangible cultural heritage (Hołuj, 2017; Milan, 2017). Intangible cultural heritage, in contrast, is a practice, representation, expression, knowledge, or skill which is part of a place's cultural heritage, such as the traditions and significant events (Bakar et al., 2014; Garduño Freeman, 2010; Pietrobruno, n.d.; Selmanović et al., 2020). Therefore, significant events, significant persons and local lifestyle are the main parts of intangible cultural heritage. However, cultural heritages are naturally prone to damage due to their age and environmental conditions (Wilson et al., 2017). Also, unexpected disasters can lead to the destruction of cultural heritage, such as the fire of Notre Dame Catehdral in France in 2019. With the destroyed tangible cultural heritage, the values conveyed to cultural heritage also disappear. Therefore, keeping and passing on the values and knowledge to the next generation is important. To preserve cultural heritage, increasing the public's awareness is a major task.

In the past, for transferring the information on history, memories and narrated stories, mostly static sources such as written documents and oral information was used. Recently, especially due to the rise of world wide web technologies, the public can access more information through different media. 2D map is the most commonly used media in providing spatial information; it can represent the geographic information of a place (Jenny and Hurni, 2011). However, it lacks information from the third dimension (Lucas, 2012; Morello and Ratti, 2009) which eases people's understanding of a place. Therefore, 3D models started to be used in displaying cultural heritage recently (Kurakula and Kuffer, 2008). To attract visitors to heritage areas, some advanced technologies, such as Virtual Reality, are also used to represent cultural heritage. It allows users to immerse into the virtual environment to view, for instance, the destroyed ancient architectures (Ch'ng et al., 2019; Tost and Economou, 2009). Photo is another commonly used media to represent cultural heritage. Through photos of the object across a timeline, visitors can get to know the history and compare the changes between the past and the present. However, users cannot get a full understanding of a cultural heritage object through just single media (Garduño Freeman, 2010). The text has always been the primary choice to record the history, so we can learn about the historical content by reading. However, the text is usually subjective, and transferring the writers' perception and knowledge (Rubegni et al., 2010). Videos have been playing a more critical role in passing information to the public, because they are visually attractive and can convey information quickly (Dimoulas et al., 2014; Selmanović et al., 2020; Toyama et al., 2009). Yet, the information in a video can't easily be summarized and therefore it is important that the story to be conveyed is well-structured in a video (Toyama et

al., 2009). To acquire information more comprehensively, due to the above listed shortcomings, single and traditional media alone probably cannot satisfy users' needs.

Information Communication Technology (ICT) enabled platforms potentially can broaden the way to acquire information on cultural heritage (Panagiotopoulou et al., 2018). Therefore, new web platforms and technologies have the potential to enable raising awareness of cultural heritage by providing multimodal ways to produce, transmit, and communicate the cultural heritage information (Zhu et al., 2001). In recent years, an increasing number of applied studies have emerged on web-based platforms aimed at raising the awareness of cultural heritage, such as Portal of Culture of Latin America and the Caribbean, the Digital Culture Center, and the CIP (CDMX Heritage Information Center). These web-based platforms are concentrated on delivering information especially on the intangible part of cultural heritage, such as the local customs and events while ignoring information on the tangible component and its relevant spatial content. In addition, these studies did not take into account more recent media types, such as 3D models and Virtual Reality (VR).

There are also several platforms using more recent media types, such as KnossosAR, ARmuseum and TripAdvisor AR (Galatis, P et al., 2016; Yovcheva, et tal., 2012). These platforms intend to be used when users visit a cultural heritage place on-site, and allow the user to use the advanced media to receive complementary descriptions of

the ancient tangible cultural heritage under concern. These platforms help users to get a better understanding of the cultural heritage, but they need users to hold the pad or phone while visiting the place on-site and compare the real objects with the artefact models. In addition, some researches focus on the relationship between cultural heritage and ICT design, especially to increase people's awareness of cultural heritage (i.e.; Bødker et al., 2003; Halabi et al., 2015; Kamppuri et al., 2006; Leidner and Kayworth, 2006). For example, a platform, called PLUGGY, a Pluggable Social Platform for Heritage Awareness and Participation, intends to motivate citizens to know more about the cultural heritage, and encourage them to broadcast and preserve the cultural heritages (Lim et al., 2018). Other researches have emphasized other functions ICT platforms can offer in relation to cultural heritage. For example, ICT platforms can teach students the history and educate them on preserving cultural heritage (Haus, 2016; Ott andc Pozzi, 2008). Also, specific ICT, such as AR/VR used in museums, can entertain and inspire children, while supporting their learning during the recreational time (Machidon et al., 2018).

1.3 Research gap and objectives

1.3.1 Research problem

As the review above indicates, dedicated ICT platforms for cultural heritage accommodate increasingly multi-media information and additional functionalities in order to provide users with engaging and enriched experiences of cultural heritage sites, before and during their visits. There are, however, two main shortcomings that need attention.

First, even though, there are many different existing media platforms to broadcast local cultural heritage, these platforms generally do not achieve fully the expected impact (De Asís López-Fuentes andc Ibañez-Ramírez 2018). The main reason may be that creators don't consider explicitly users' preferences regarding cultural heritage content and media types offered before developing the platform. Most of the developers were cultural heritage experts, and they decided on the cultural heritage contents and the functions of the platform based on assumptions rather than based on information about users' preferences (Koukopoulos et al., 2017). This results in professional platforms that can benefit cultural heritage experts, but that are not necessarily aligned to needs of visitors of cultural heritage sites (Koukopoulos et al., 2017). Overall, existing platforms usually aim to broadcast the cultural heritage or to offer artefacts models to virtually recreate the destroyed heritages. Given the limited attention users preferences on type of information provided and type of media used, existing platforms may not utilize fully the potential of ICT to increase awareness of cultural heritage. Therefore, how to increase awareness of cultural heritage more effectively by taking into account the potential users' needs is the main research question addressed in this thesis.

Second, there is limited research on whether the dedicated multi-media ICT platforms of cultural heritage areas, even when they would be well adapted to users preferences and needs, are able to significantly increase users' knowledge and awareness of cultural heritage compared to existing general purpose media and tools such as the internet search engines. Currently, the testing of existing

dedicated multi-media ICT platforms is performed only based on small sizes of user groups or testing is not carried out at all. Therefore, it is difficult to evaluate the extent to which they fulfill their intended purposes (i.e. increasing awareness, increasing knowledge and interest).

1.3.2 Research objectives

To fill these research gaps, the objective of this thesis is to design and test a dedicated Multi Media Platform prototype and analyze the effectiveness of such a platform to enhance experiences and increase the public's awareness of cultural heritage. To achieve this objective, the following questions are addressed (see Figure 1.1).

(1) What are users' preferences regarding content, functionalities, and media types provided by a dedicated cultural heritage (web-based) multi-media platform?

(2) How can a web-based multi-media platform adapted to users preferences be designed?

(3) How are different functionalities offered by a well-designed multi-media web-platform related to experiences of users and increase of their awareness of cultural heritage, and to what extent and how is this influenced by person characteristics of the user?

(4) To what extent can a properly designed dedicated multi-media web platform enhance experiences of users and increase potential users' awareness of cultural heritage?

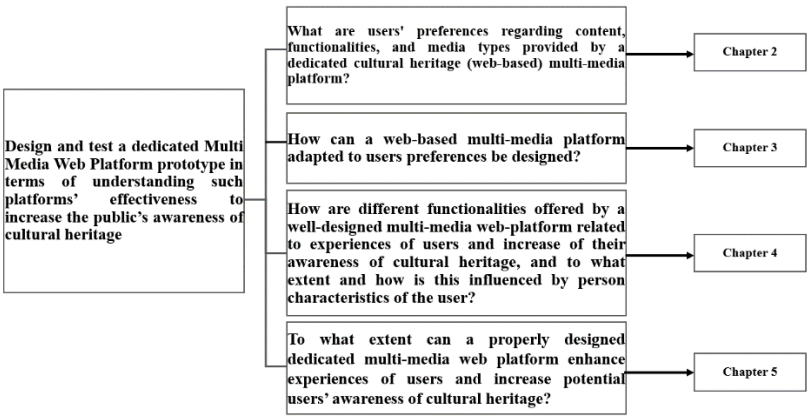

Figure 1.1 Objectives of this research project

1.3.3 Research approach

This research aims to analyze, design and evaluate a multi media platform in light of its potential to increase people's awareness of cultural heritage. For this research purpose, a specific cultural heritage site - the former factory campus of Philips in Eindhoven, Strijp-S - was selected as a case and a new multi media platform is designed and implemented as a prototype system. To address the research questions data wrere collected on users preferences and evaluations of a mulit-media platform in two surveys. The first survey was conducted to collect data on users' preferences regarding the content and media types of a platform. A stated choice experiment was part of the questionnaire that provided stated choice data to analyze users' preferences in the framework of a discrete choice model. The survey included a large sample of individuals from the Netherlands and China. Based on the information about preferences a new multi media platform was then designed using UML and

developed using PHP language. A second survey involving a national sample from the Netherlands was subsequently conducted to test the effectiveness of the system. This was done by measuring respondents' awareness of Strijp-S before and after using the dedicated multi media platform. To create a control group, a random subsample used the Google search engine instead of the new platform. The data was analyzed using a structural equation model (SEM). Furthermore, the comparison between the two groups allowed us to measure the performance of the new platform.

1.4 Case study: Strijp-S, Eindhoven

Strijp-S is a neighbourhood in the district Strijp of Eindhoven, the Netherlands and the former industrial campus of Philips electronics company. The buildings in the area were built and served with industrial purposes (i.e. factory, offices) to company Philips. In 1916, Anton Philips built the first glass factory in Strijp-S to produce light bulbs. At Strijp-S, Philips invented and produced many electronic devices such as radios, CDs and televisions. Majority of the employees were from the city of Eindhoven. The innovative and productive culture of Eindhoven stemmed from the Philips campus in the Strijp-S area. In the 1990s, the Philips company moved out of Eindhoven, and in the year 2000 deliberations and plannings about the repurposing of Strijp-S has started. In 2002, the land was sold to Park Strijp Beheer B.V. which is a public-private partnership between the city of Eindhoven and VolkerWessels, a Dutch contractor. Today, thousands of new citizens and new small high-tech companies occupy the renovated industrial buildings and make use

of the repurposed spaces after the departure of Philips from the area. As a result, Strijp-S is gradually developing towards the new center of Eindhoven (Arts et al., 2005; Dane et al., 2019; de Zwart, 2007; Luttikhuis, 2006).

(a) The past of Strijp-S

https://www.wikiwand.com/en/Strijp-S

(b) The present of Strijp-S

https://www.volkerwessels.com/en/news/strijp-s-awarded-prestigious-neprom-prize-for-site-development

Figure 1.2 An overview of the Strijp-S area

Strijp-S is a representative industrial cultural heritage in the Netherlands; it is a landmark of Eindhoven and contains extensive history of the factory and development of Eindhoven city. For example, it underwent bomb explosions during the WW Ⅱ and is famous for its glassmaking and lightbulbs. The factory's architecture and physical changes through time are well-documented, so that rich tangible information is available. In addition, the Philips Museum is an archive of Strijp-S which contains a wealth of intangible information about Philips and Strijp-S. The availability of rich tangible and intangible information, the historical importance for the city and landmark status make Strijp-S a suitable case for this research.

1.5 Thesis outline

This thesis is organized in several chapters (represented in Figure 1.3) which are based mostly on papers that have been published or submitted for publication in journals.

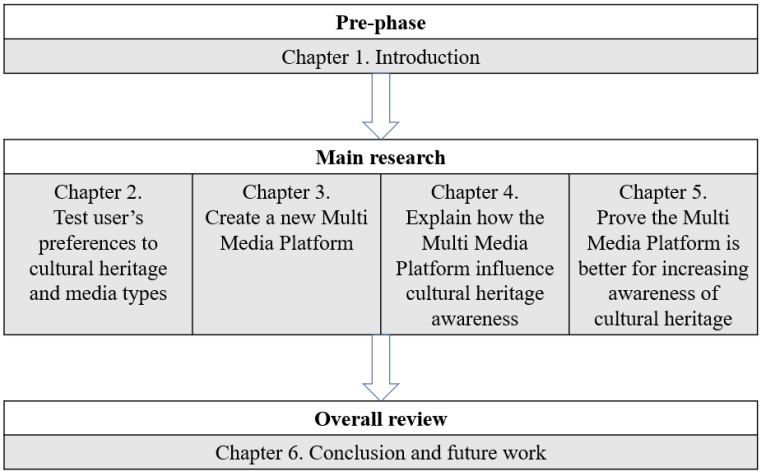

Figure 1.3 Outline of the dissertation

Chapter 2 describes the design and application of a stated choice experiment to measure users preferences regarding content and media types offered by a multi-media platform. The stated choice experiment is administered through an on-line survey. The choice data obtained are analyzed using a mixed logit model and discussed in this chapter. The results are used for the following chapter where a multi-media platform prototype development is described.

Chapter 3 describes the design and development of a new Multi Media Platform prototype based on the preference measurement

results described in Chapter 2. The technical design is specified using Unified Modeling Language (UML). The new platform uses the map as the entrance to all the information, and it includes both tangible and intangible cultural heritage content. All information is stored in a MySQL database, and displayed using multiple media types. The prototype system is used later for testing the usefulness of the different functionalities and analyzing the impacts on experiences and awareness of cultural heritage.

Chapter 4 presents the study conducted to test the relationships between the usefulness of the functions and content offered by the system and the impact of the system on users' experiences and awareness of cultural heritage. The study is based on data collected in the second survey where respondents are asked to indicate their awareness of Strijp-S before and after using the Multi Media Platform prototype or Google search engine (benchmark). In this chapter only the data of the Multi Media Platform group are used. Using Structural Equation Modeling, the relationships are analyzed between the functions of the Multi Media Platform prototype, the perceived helpfulness of the system, the experience of cultural heritage, the awareness of cultural heritage and person characteristics. The results indicate which characteristics of the Multi Media Platform prototype are important for and in what way they are able to increase awareness of cultural heritage and differences between groups of users regarding these aspects.

Chapter 5 uses the data of the same survey including in addition the data of the control group which used the google search engine. Bivariate analyses are used to analyze the extent to which the dedicated Multi Media Platform prototype is better able to increase awareness of cultural heritage compared to a comprehensive general purpose search engine such as Google.

Chapter 6 summarizes the main conclusions regarding the stated research questions across the chapters and discusses the contributions, limitations and suggested problems for future research. The contributions of this thesis are discussed from both scientific and societal perspectives. As for the societal contribution, it will be discussed how the new Multi Media Platform prototype can be used as a base to support the new platform developments and what benefits they can offer to government and cultural heritage institutes to broadcast cultural heritage and increase its awareness.

Chapter 2 Identifying Users' Preferences for a New Multi Media Platform via a Stated Choice Experiment

This chapter is based on:

Wang, B., de Vries, B., & Dane, G. (2021). Preferences for a multimedia web platform to increase awareness of cultural heritage: A stated choice experiment. Journal of Heritage Management, 6(2), 188-208.

2.1 Introduction

For creating and developing a multimedia platform to disseminate information on cultural heritage, several authors (Cucchiara et al., 2011; Desouza and Bhagwatwar, 2012; Tomor et al., 2019; Young et al., 2020) mentioned that users together with the developers should be involved from the beginning to the (co)creation process in order to identify the functions and boundaries of the platforms. However, most of the current cultural heritage platforms (i.e., KnossosAR) (Kasapakis et al., 2016) were developed with a focus on their technological framework or architecture to achieve the aimed functionality without much consideration of users' preferences. For example, some applications focus on testing one specific medium, such as augmented reality (CorFuAR) or voice (Voices of Oakland), for conveying cultural heritage information (Kourouthanassis et al., 2015; Suh et al., 2011). The developers of project SNOPS invited the

users to understand users' emotions and satisfaction after using the prototype (Amato et al., 2012). Some studies (i.e., Cultural Entertainment System) collected data about users' expected adoption and perception of newly developed cultural heritage application prototypes (García-Crespo et al., 2016; Ho and Siu, 2012). These studies include few and homogenous samples for the observations (i.e., students), which are usually not representative of the potential users. In addition to this, in most of the aforementioned research works, only basic statistics were used to measure people's observed or expected attitude focusing on a specific communication medium. However, this cannot capture the trade-off of people's preferences towards different communication media as can be provided by state-of-the-art multimedia platforms.

This chapter investigates the preferences of people for a variety of media to represent the content of cultural heritage, based on a hypothetical multimedia web platform. Multimedia web platforms can increase public's awareness of cutltural heritage by making relevant information accessible to a large public. Mobile devices are now a part of our lives and changing how we retrieve and perceive the information. Moreover, technology users' behaviour also changes constantly. For instance, users dedicate short time to a topic and prefer short text and videos (Rizvic et al., 2017). However, the existing multimedia web platforms for cultural heritage are not used regularly or they are abandoned by the public after the test phases. Taking into account technology users' changing behaviour and providing them information in a way that they can proceed are important for the usability and sustainability of such platforms (Dane

et al., 2020). Usually, the preferences of the users on the multimedia platform for cultural heritage are not taken into account in the design phase. Therefore, taking into account people's preferences regarding their choice of multimedia representation of different cultural heritage types and contents can increase users' engagement with the platform and therefore raise their awareness of cultural heritage. This would also enable relevant information on cultural heritage to reach to a wider public and increase their awareness of cultural heritage. Within this context, this chapter aims to explore the most valued media representations for different cultural heritage types (i.e., buildings, sites, events, lifestyles) and other additional interactive functionalities (i.e., timeline feature, experience upload) by users that can be presented on a multimedia web platform for cultural heritage, before it is designed and implemented.

To analyse people's preferences for different media and functions, we conducted a survey that included a stated choice experiment. A stated choice experiment survey was sent to a panel of respondents. Respondents firstly filled out their socio-demographic information (e.g., gender, age, etc.). Next, attribute levels of the different combinations for cultural heritage type, possible media representations and platform functionalities were varied, and respondents were asked to choose one of the two given options or none of them. Using a mixed logit model, this chapter estimates the preferences of people for different combinations. The results can give directions to the development of new multimedia platforms for raising people's awareness of cultural heritage.

2.2 Related work

Cultural awareness mainly focuses on immaterial heritage, including the language, customs, traditions, spiritual beliefs, folklore and rules of behaviour in a society, without forgetting the influence of past events on that society (Mortara et al., 2014). The awareness generally is essential for cities because a city can only further develop by building on its own culture and heritage (Hassan and Rahman, 2015; Tweed and Sutherland, 2007). To increase the public's awareness, more information about cultural heritage should be provided to the public. Creating awareness is a decisive subject to make the general public understand the pressing need for knowledge acquisition, promotion and dissemination of cultural heritage (Shimray, 2019). In these regards, the multiple media platforms have the potential to broadcast not only the physical settings but also the historical stories to the public. The different media can offer an immersive, realistic way to learn the architectural, artistic or natural values of a site, and offer the users a motivation to understand cultural heritage. This section discusses the existing literature concerned with the main concepts of this chapter. First, studies related to the content of cultural heritage in terms of its physical and non-physical nature are reviewed. The second part of the literature review focuses on the influence of media on disseminating information for cultural heritage.

2.2.1 The content of cultural heritage

The content of cultural heritage in the built environment can be divided into two parts: spatial and historical content. Spatial content is related to the physical or tangible cultural heritage, such as

historical landscape and buildings. Historical content is related to non-physical or intangible cultural heritage, such as events and significant people in history. As Janowicz (2009) argued, spatial information could be used to structure geographic knowledge and to display first impression of heritage easily. It provides an opportunity to confirm or contradict the established historiography judgments concerning heritage development (Bushmakina et al., 2017). Historical buildings, public spaces and landscapes with their spatial content represent the architectural history of its time and also the history of its usage. In time, one heritage could have different versions of names, often changes in size, style, use and functions (Alani et al., 2000), and these changes are visible to the public through the spatial existence of a heritage. Today, some of them are protected, while some are reused for other functions. In addition to historical buildings, historical public spaces and landscapes are essential elements for the cultural heritage of a city (Hołuj, 2017; Milan, 2017). In cities with a long and interesting history, these spaces contain tangible cultural heritage, and the citizens connect their personal meaning and feelings with this spatial information (Hołuj, 2017; Zawilińska and Szpara, 2016). Heritage places are crucial in terms of transferring cultural identity and history to new generations (Misiriisoy and Günçe, 2016). Comprehending the changes allows people to see the difference from past to present, and encourages them to find out the reasons for the changes and methods to preserve cultural heritage in the future (Wascher, 2005).

Besides spatial content, historical content also occupies a vital position in cultural heritage information. The historical content of a

cultural heritage reflects and identifies the community's history, cultural and social identity and social values (Wendland, 2006). The historical knowledge of cultural heritage is considered as one of the main assets of a city (Assem and El-sayed, 2016; Ismagilova et al., 2015). Historical content is an important part of life and literature, and without it, memories, stories and characters have less meaning. A strong understanding of the historical content behind a cultural heritage can give us a better understanding of and appreciation for the heritage. It also provides the local population to be proud of the unique heritage and gives opportunities to share it with tourists (Ismagilova, et al., 2015). Therefore, it was clear that the value of the knowledge deemed important to the public (Brown et al., 2010; Rajapakse, 2017; Vasavada and Kour, 2016).

2.2.2 The media on cultural heritage

The visitors of historical places need informational support before their visits begin (Barile et al., 2014). Normally, when visitors plan to travel, they gather information from their families and friends (Richards, 2011). Recently, especially due to the rise of world wide web technologies, the visitors can access more information through different media, such as text, images and videos. With these media, visitors are better informed and they arrive at the destination owning more knowledge and skills compared to the past, and with higher expectations (Surugiu and Surugiu, 2015b; Xue et al., 2019). To acquire information more comprehensively, single and traditional media cannot satisfy users' needs. Lange-Faria and Elliot (2012) concluded that 3D virtual technologies, which can increase attention

and experience of cultural heritage, could influence the attitudes and perceptions of visitors toward a heritage. Moreover, the traditional media such as text and photos lack the dimension of participation with the visitors. The visitors would like to not only gather information through media, but also would like to generate their own cultural products (Månsson, 2011). Visitors desire to introduce their own experience with cultural heritage and share with others (Buhalis and Law, 2008). These personal experiences could deliver the public's preference and attitude to one heritage, which can help the government enrich cultural database and heritage content (Khoshkam et al., 2016).

A most commonly used medium of acquiring spatial content is a 2D map. Besides displaying the location, transportation routes, and points of interest (POI) to the tourists, (Jenny and Hurni, 2011) maps are a potential source of information for historical studies. Maps contain heterogeneous landscape information, which is represented as graphic signs and texts (Vuorela et al., 2002). Moreover, the historical map is also popularly used in cultural heritage. For instance, it shows which parts of a heritage changed in the time and how they changed (Bitelli et al., 2014; Cano Viktorsson, 2015; Panagiotopoulou et al., 2018; Swensen and Jerpåsen, 2008; Tucci et al., 2010). Although maps are common and useful, they rely on two-dimensional top-down views and lack information from the third dimension (Lucas, 2012; Morello and Ratti, 2009). Images are also used in spatial information presentation, usually linked to 2D maps with points of interests, because images allow the public easily to acquire the appearance of objects (Hammer et al., 2018). When

comparing the historical image with reality, people can observe the significant changes from past to present. However, sometimes images or paintings are ambiguous and unclear (Garduño Freeman, 2010). Koramaz and Gulersoy (2011) argue that efficiency of visualisation techniques is important for the perception of spatial content. Therefore, next to 2D maps, it is important to add images and 3D models for displaying spatial information. A particular advantage of the use of these 3D models is that they provide information on vertical variations in building heights (Kurakula and Kuffer, 2008). A 3D model can be used to restore, monitor, research, communicate and represent a realistic cultural heritage (Dimoulas et al., 2014; Kolivand et al., 2018; Núñez Andrés and Buill Pozuelo, 2009). From this, the visitors could derive more spatial information, and thereby obtain a better and comprehensive understanding of cultural heritage. This technique allows the possibility to make accurate representations of objects, surfaces and structures, replicating not only their morphology, but also their texture and colour.

Historical content is captured and distributed through different media. In the past, the text was the primary choice to disseminate the content of history. Recently, large amounts of texts about cultural heritage are available online, which allows people to find the information source that fit his/her needs (Picchi and Sassolini, n.d.). Photos can pass visual information directly to people in a limited time and at a low cost. It also provides a creative and multi-sensory alternative to conventional text-based approaches for conveying historical knowledge (Matteucci, 2013). Video can contain even more content

than text and still images. With the popularity of smartphones and high-speed internet, video is beginning to play a more critical role in passing knowledge about cultural heritage to the public. In some countries, media platforms like YouTube are used to protect and broadcast the intangible cultural heritage by the government (Pietrobruno, 2009).

The existent social media platforms, such as YouTube, Facebook and Flickr, support visitors to browse and share information about their interesting experiences of cultural heritage (Surugiu and Surugiu, 2015a; Van Dijck, 2010). However, these platforms do not specifically concentrate on the cultural heritage field (Terras, 2011). Most of the information in these media is composed of the public instead of the government or experts. Also, they mainly focus on historical content and ignore spatial content. It weakens their authority and expertise, which cannot convince the public to choose them as a priority media platform.

2.3 Description of Hypothetical Platform

This section discusses the components of the hypothetical multimedia web platform, and also illustrates the different attributes of the platform. The multimedia web platform is researched in three aspects: spatial content, historical content, and functionalities of the platform.

The spatial content in the hypothetical multimedia web platform is composed of specific buildings, public space and heritage landscape. These contents are essential for a heritage site and cover the majority of spatial information about it. In this platform, we select the 2D maps, images and 3D models to display the spatial content. Each of the spatial content includes eight different media combinations, which are single media (2D maps, images and 3D models) and media group (2D maps & images, 2D maps & 3D models, images & 3D models, 2D maps & images & 3D models and nothing). Table 1 describes an example of specific buildings.

The historical content includes significant events (i.e. wars), historical significant persons (i.e. King), architectures (i.e. The Great Wall), and citizens' lifestyle (i.e. customs) in the hypothetical platform. In this platform, text, images and video are selected to display the historical information. Similarly, as spatial content, each of the historical content contains eight different kinds of media combinations. There are single media (text, images and video) and media group (text & image, text & video, image & video, text & image & video and nothing). Table 2.1 also lists one example of significant events.

According to the literature, multimedia web platform can also provide three functions: timeline, VR representation and personal experience sharing. Virtual Reality, as advanced technology has been maturely used in city planning (Evans et al., 2006), which also has potential in the cultural heritage field (Mah et al., 2019; Yano et al.,

2007). Based on the blueprint scanning from the images and other recorded information, VR can be used to reconstruct the tangible cultural heritage completely. With this technology, people can visit tangible heritage in the virtual space, but also can be immersed in the virtual environment, increasing the sense of identity. Today people are used to receive information on cultural heritage from official institutions run by the government, but sharing own experience and memories can enhance the impression to cultural heritage. It can also break the distance that often exists between public and the official institution, but also complements content between them (Gaitan and Historian, 2014; Giaccardi, 2012). It can also raise people's awareness of cultural heritage in their cities and stimulate that they take ownership and pride in the development of their respective cities (da Costa Liberato et al., 2018; Djabarouti, 2020).

Time is a fundamental dimension for making sense of digitised cultural heritage collections, and timeline visualisation can support analysis, exploration and presentation of these datasets (Vane, 2019). Through the timeline, the users can find the difference and evolution between past and the present immediately. In this section, a short example of attributes and levels description for the hypothetical multimedia platform can be seen in Table 2.1. The full table can be found in the Appendix.

Table 2.1 Example of a description of attributes and levels

Attribute	Level	Description
Information on Specific Buildings	1	Specific buildings are displayed by 2D map
	2	Specific buildings are displayed by the 3D model
	3	Specific buildings are displayed by Images
	4	Specific buildings are displayed by 2D map and 3D model
	5	Specific buildings are displayed by 2D map and Images
	6	Specific buildings are displayed by Images and 3D model
	7	Specific buildings are displayed by 2D map, Images, and 3D model
	8	No information on specific buildings
Information on Historical Events	1	Events are displayed by Text
	2	Events are displayed by Photo
	3	Events are displayed by Video
	4	Events are displayed by Text and Photo
	5	Events are displayed by Text and Video
	6	Events are displayed by Photo and Video
	7	Events are displayed by Text, Photo, and Video
	8	No information on Events
Timeline	1	Timeline to switch between previous and current use of the area
	2	No Timeline
Virtual Reality	1	Support Virtual Reality
	2	Not support Virtual Reality

Table 2.1 Continued

Attribute	Level	Description
Upload their own experience	1	Upload their own experience to the platform
	2	Not upload their own experience to the platform

2.4 Experiment Design and Data Collection

2.4.1 Stated Choice Experimental Design

Stated choice experiments are used to measure individuals' preferences through their choices among various options in a given hypothetical situation. In this experiment, individuals were asked to select their most preferred alternative from several choices in each situation.

The application of stated choice experiments involves the creation of an experimental design that combines attribute levels (see Appendix) in a specific choice set. For spatial content, specific buildings, public space and heritage site/landscape are considered as attributes, while for historical content, significant events, persons, architectures and community lifestyle are selected as attributes. These attributes have eight different media combinations. The functions part includes three attributes: timeline, Virtual Reality, and uploading experience, which have two levels.

In this chapter, the seven attributes with eight levels, and three attributes with two levels result in $8^7 \times 2^3$ different profiles in a full factorial experimental design that involves all possible combinations of attribute levels. To reduce the profile number, an orthogonal fractional factorial experiment design involving a subset of 64 attribute profiles is selected. Choice sets are created by randomly combining these 64 attribute profiles, thereby creating choice sets of two unlabeled alternatives. The "None of both" option is added to each choice set to allow for the possibility that both alternatives fall below some choice threshold. To reduce the respondent's burden, the 64 choice sets are organised into four blocks of sixteen sets of choice alternatives. Each respondent receives a selected block randomly. At each choice set, the respondents are required to choose the multimedia platform profile they like the best for acquiring information about cultural heritage, or to indicate they do not like any given option by choosing the "none of both" option. An example of a choice set for the hypothetical platform is shown in Table 2.2.

Table 2.2 An example of a stated choice

		Platform A	Platform B
Spatial content	Specific building	Images	None
	Public space	Images	2D map + Images
	Heritage site	None	Images + 3D model
	Functionality	No Timeline	Timeline to switch between previous and current use of the area

Table 2.2 Continued

		Platform A	Platform B
		Not support Virtual Reality	Support Virtual Reality
Historical context	Significant event	Text	Photo + Video
	Significant person	Photo	Text + Photo
	Significant architecture	None	None
	Community lifestyle	Photo + Video	Text + Photo
	Functionality	Upload own experience	Not upload own experience
Your choice		[ ]	[ ]

2.4.2 Data collection

The questionnaire consisted of two parts. The first part included questions about the socio-demographic variables, which are gender, age, education level, income level, living situation, and how many times a cultural heritage was visited before. The second part of the questionnaire included the sixteen stated choice sets about the hypothetical multimedia platform. Before asking respondents to complete these 16 tasks, an example choice set and an explanation of all attributes and their levels were presented.

The questionnaire was issued from August to October 2019. The hypothetical multimedia web platform was requested to test general visitors' preferences to media types and cultural heritage content. To avoid respondents from a specific place (Yu, 1995), the survey was issued in China and the Netherlands. In the Netherlands, we collected

data via the Limesurvey system, which is an online survey. The respondents were recruited via a company named PanelClix, which had an available paid panel in the Netherlands. Our online survey was sent to the respondents from the Netherlands in October 2019. In China, the questionnaire was sent by social media—Wechat in August 2019. For statistically data collection, a sample resembling the overall Dutch and Chinese population in terms of age, gender and occupation were required. A total of 630 respondents completed the questionnaire. Among the respondents, there were 399 from China and 231 from the Netherlands.

2.4.3 Sample characteristics

The distributions of respondents on socio-demographic characteristics are shown in Table 2.3. It showed that the number of females was slightly higher than males. As for the age, young people (18-34) and middle age (35-49) were over-represented with 40.5% and 34.0% respectively. The respondents who had vocational education constitute half of the sample, people who had a bachelor's and higher educational degrees were 21.9% of the sample. Around 43% of the respondents had a gross annual income between 20,001 and 40,000 euros, while 10.8% had a higher income. Regardless of the people who would rather not say their income, about 35% had relatively low income (below 20,000 euros/year). Half of the respondents were married and living with child(ren). The percentage of single without children, family without children, and living with others (not family) were similar, 15.7%, 16.7%, and 17.6% respectively. 16.4% of respondents never visited a local heritage in

their own city, while only 8.4% never visited other cities' cultural heritage. The Chinese respondents made up the majority of the sample, which is 63.3%, the rest of them were Dutch respondents.

Table 2.3 Distribution of socio-demographic information

Variable	Categories	Number	Percentage
Gender	Male	338	53.6
	Female	292	46.4
Age	18-34	255	40.5
	35-49	214	33.0
	50+	161	25.5
Education level	Low education (below secondary education)	177	28.1
	Middle education (Vocational education)	315	50.0
	High education (undergraduate and more)	138	21.9
Yearly net income	Low income (below € 20.000)	221	35.1
	Middle income (€ 20.001-40.000)	276	43.8
	High income (more than € 40.000)	68	10.8
	I'd rather not say	65	10.3
Household situation	Single without children	99	15.7
	Family with children	315	50.0
	Family without children	105	16.7
	Living with others (not family)	111	17.6
Visit local heritage site	0	103	16.4
	1+	527	83.7
Visit other heritage	0	53	8.4
	1+	577	91.6

Table 2.3 Continued

Variable	Categories	Number	Percentage
Nationality	China	399	63.3
	The Netherlands	231	36.7

2.5 Analysis and Results

2.5.1 Analysis Method

The mixed logit model is applied in this chapter because it overcomes three primary limitations of standard multinomial logit by allowing for random taste variation, unrestricted substitution patterns, and correlation in unobserved factors (Train, 2003). The alternatives in the logit model include two visualisations and the "none" option. The utility of alternative i for respondent n in choice situation t can be written as:

$$U_{int} = \alpha_0 + (\beta'^{A} + \eta'^{A}_{n})X^{A}_{it} + (\beta'^{M} + \eta'^{M}_{n})X^{M}_{it} + \beta'^{Z}X^{Z}_{n} + \varepsilon_{itn}$$

where U_{int} is the utility of alternative i for individual n in choice situation t, X^{A}_{it} is an (A×1) vector of the attributes of alternative i in choice situation t, which includes spatial content and historical content. The (1 × A) vector β'^{A} contains the associated parameters. X^{M}_{it} is a (M × 1) vector that describes the function of the platform in choice situation t. (1 × M) vector β'^{M} is the parameters for the attributes of chosen functions. X^{Z}_{n} is a (Z × 1) vector of socio-demographic attributes of individual n. The (1 × Z) vector β'^{Z} are the parameters for the socio-demographic variables. α_0 is the alternative-specific constant (related to the null alternative). ε_{itn} is a random term that is IID (independent and identically distributed) distributed

across choice alternatives. η'^{A}_{n} and η'^{M}_{n} are random terms with zero mean whose distribution over individuals and alternatives depends in general on underlying parameters and observed data relating to alternative i and individual n.

2.5.2 Results

A mixed logit model is applied in this study. Some of the parameters are added to the estimation model as random parameters, following a certain probability distribution, these random parameter distributions are assumed to be continuous over the sampled population (Hensher, Rose, and Greene, 2015). This is done in order to explain the taste variation in the sample amongst the parameters. In this study, the chosen random parameters are specific buildings (2D map & 3D model, 2D map & images, images & 3D model and 2D map & images & 3D model), public space (3D model), heritage landscape (images), significant person (text & video), significant architecture (text & photo & video), lifestyle (text & video) and uploading experience. The alternatives in the logit model include two visualisation options and the "none" option. The estimation is carried out by using maximum simulated likelihood procedures in NLOGIT econometric software, with 1000 Halton draws for the simulation (Greene, 2009). According to the estimation, ρ^2 is found to be 0.157, which shows a decent model fit (Hensher, Rose and Greene, 2015).

As shown in Table 2.4, when specific buildings are visualised by all media combinations, respondents are more willing to use the

proposed multimedia web platform. Only a 2D map is the least preferred type of representation for the description of buildings. For the public space, respondents tend to prefer the combination of the images & 3D models or all of the media types for the description of public space in order to use the proposed web platform. The results also illustrate that respondents tend not to prefer to use the proposed web platform if the visualisation of heritage landscape included only 2D maps. The type of visualisation people prefer is the combination of images & 3D models or all of the media types. These results describe that only 2D maps could not attract respondents' interest. This might be because it is two-dimensional and cannot show the 3D spatial information adequately. Also, the information on the map is monotonous and simple, which cannot leave respondents a strong impression. However, when 2D maps are combined with images and 3D models, respondents are more willing to use the proposed web platform. The combination of media has more visual power than maps, therefore, they can strengthen the heritage impression.

Table 2.4 Estimated parameters of mixed logit modes

Attribute	Levels	Mixed Logit		
		Coeff. (St.dev.)	Standard Error	p-value
Specific building	2D map	-0.251***	0.520	0.000
	3D model	0.077	0.472	0.101
	Images	0.038	0.492	0.438
	2D map and 3D model	0.027 (0.388***)	0.08	0.581
	2D map and Images	0.118*** (0.286***)	0.097	0.091

Table 2.4 Continued

Attribute	Levels	Mixed Logit		
		Coeff. (St.dev.)	Standard Error	p-value
	Images and 3D model	0.103** (0.534***)	0.069	0.572
	All of them	0.254*** (0.439***)	0.073	0.000
Public space	2D map	-0.259***	0.05	0.000
	3D model	-0.032 (0.186*)	0.108	0.520
	Images	0.058	0.048	0.231
	2D map and 3D model	0.063	0.050	0.208
	2D map and Images	0.197***	0.046	0.000
	Images and 3D model	0.209***	0.044	0.000
	All of them	0.266***	0.045	0.000
Heritage landscape	2D map	-0.181***	0.051	0.000
	3D model	0.112***	0.051	0.028
	Images	0.030 (0.140)	0.145	0.545
	2D map and 3D model	-0.036	0.048	0.451
	2D map and Images	-0.062	0.047	0.182
	Images and 3D model	0.156***	0.048	0.001
	All of them	0.203***	0.045	0.000

Table 2.4 Continued

Attribute	Levels	Mixed Logit		
		Coeff. (St.dev.)	Standard Error	p-value
Significant events	Text	-0.079*	0.051	0.122
	Photo	0.007	0.048	0.884
	Video	0.049	0.047	0.300
	Text and Photo	-0.069	0.049	0.163
	Text and Video	0.088**	0.045	0.049
	Photo and Video	0.054	0.045	0.231
	All of them	-0.002	0.048	0.970
Significant persons	Text	-0.118**	0.046	0.010
	Photo	0.169***	0.057	0.002
	Video	-0.054	0.052	0.295
	Text and Photo	0.036	0.052	0.481
	Text and Video	0.002 (0.136)	0.127	0.956
	Photo and Video	0.022	0.05	0.655
	All of them	0.093**	0.044	0.035
Significant architecture	Text	-0.240***	0.05	0.000
	Photo	0.074**	0.047	0.115
	Video	-0.005	0.044	0.915
	Text and Photo	-0.138***	0.053	0.009
	Text and Video	0.115**	0.048	0.016
	Photo and Video	-0.031	0.045	0.493
	All of them	0.229*** (0.184*)	0.101	0.000

Table 2.4 Continued

Attribute	Levels	Mixed Logit		
		Coeff. (St.dev.)	Standard Error	p-value
Community lifestyle	Text	-0.044	0.049	0.370
	Photo	0.077	0.049	0.116
	Video	0.066	0.055	0.232
	Text and Photo	0.071	0.046	0.122
	Text and Video	-0.101** (0.015)	0.192	0.039
	Photo and Video	-0.015	0.047	0.750
	All of them	0.117**	0.046	0.011
Timeline	Yes	0.116**	0.018	0.000
	No	-0.116	NA	
Support Virtual Reality	Yes	0.060***	0.021	0.004
	No	-0.06	NA	
Upload Experience	Yes	0.062** (0.493***)	0.026	0.018
	No	-0.062	NA	
Gender	Male	0.007	0.03	0.807
	Female	-0.007	NA	
Age	Young (18-34)	0.727***	0.048	0.000
	Middle (35-49)	-0.370***	0.045	0.000
	Old (>50)	-0.370	NA	
Education level	Low	-0.161***	0.049	0.001
	Middle	0.327***	0.038	0.000
	High	-0.16673	NA	
Income	Low	-0.518	0.043	
	Middle	0.479***	0.044	0.000
	High	0.03832	NA	0.383

Table 2.4 Continued

Attribute	Levels	Mixed Logit		
		Coeff. **(St.dev.)**	Standard Error	p-value
Living situation	Single without child	-0.069	NA	
	Family with child	-0.380***	0.059	0.000
	Family without child	-0.325***	0.058	0.000
	With others (not family)	0.774***	0.05	0.000
Visit local heritage	Visit 0 time	-0.241	0.05	
	Visit 1+ time	0.241	NA	0.000
Visit other heritage	Visit 0 time	-0.948	0.048	
	Visit 1+ time	0.948	NA	0.000

***, **, *: Significance at 1%, 5%,10% level.

Table 2.4 also lists the estimated results for the historical content of the multi-media platform. In order to use the proposed web platform, respondents tend not to prefer single text visualisation for significant events. The respondents tend to prefer text & video representation for the significant events. As for the visualisation of significant persons, respondents do not show interest in text and video, while they are attracted via only photo representation or combination of text, photo and video representation. The results for the visualisation of significant architecture illustrate that the respondents preferred to see

photos, combination of text and videos or combination of text, photos and videos to acquire information. For the community lifestyle people prefer a combination of text, photo and videos. These results demonstrate that text representation is preferred when it is combined with photos and videos for visualising cultural heritage historical content. Respondents do not embrace text probably because they consider it a tedious medium, losing patience after reading a few lines (Fairclough et al., 2008).

The estimated results for the functionality of the platform are also shown in Table 2.4. All the functions have a positive effect on the proposed web platform, which means that respondents prefer to use these functions on one platform. Virtual Reality shows the highest positive estimate, which indicate respondents' preference for advanced technology to understand cultural heritage.

For the spatial content buildings attribute, the levels of 2D maps & images and 2D maps & images & 3D models are significant both in the mean value and the standard deviation of the parameter. These results suggest that the attributes significantly affect people's willingness to use this visualisation combination to acquire spatial information. The mean parameter value of uploading-experience level is found to be significant. This result indicates that although on average this attribute does not play an important role in explaining individuals' choices regarding the function, the taste for this attribute varies significantly across individuals.

For the socio-demographic variables, the results show that the preference for the multimedia web platform decreases with increasing age. Probably, young people have more curiosity and interest in using different and advanced technologies (Livingstone and Helsper, 2007). The education level also has a significant impact on preferences. Having low and high education levels has a negative impact on the hypothetical web platform, while the middle education level shows a positive interest. In addition, middle-income people prefer to use the platform to understand cultural heritage. Moreover, people who visit cultural heritage before (both locally and in other cities) are more interested in the platform compared to people who did not visit cltural heritage before. This is probably because they know what kind of information they prefer to find and which media they like to use.

2.6 Conclusions

Disseminating information on cultural heritage content enables protecting the cultural wealth of society that is vital to strengthen its identity (de Asís López-Fuentes and Ibañez-Ramírez, 2018). Learning about cultural heritage and passing on the information is essential for cultural heritage preservation and sustainability (Psomadaki et al., 2019). Therefore, in this chapter, people's preferences for a multiple media web platform to broadcast cultural heritage knowledge to increase publics' awareness is conceptualised.

The main aim of this chapter was to provide more insights on people's preferences for different media types and combinations of a hypothetical multimedia platform. To that end, a stated choice experiment is designed and administered in both China and The Netherlands. A mixed logit model is estimated to analyse the influence of the different media attributes of the platform and its functionality. The results indicate that people prefer multiple media rather than a single medium, both in spatial and historical contexts, as expected. Secondly, the visualisation of cultural heritage information has a significant positive effect on people's perception of the platform. Still and static media, such as 2D map and text attract less attention than dynamic media, like 3D model and video.

In general, the results indicate that people are less interested in acquiring cultural heritage information only through 2D maps. The map can show a heritage location and visitation route, which is necessary but alone cannot satisfy people's needs for acquiring information on cultural heritage. The platform developer should link maps to different media as much as possible. For the specific building content, people are attracted if the combination contains3D model, which means the developer could build the platform based on the 2D maps and 3D models. The 3D model has a negative impact on people's preference for the platform in the case of public space heritage. An explanation might be that respondents find that a 3D model is not necessary to display the geographic information for public space (e.g. parking plot); what they only need to know is the location, route and appearance, so a map and images are satisfactory. The 3D model and images show a positive impact on the heritage

landscape, probably, because they allow people to comprehend the site better. The developer could link more image and 3D model resource to the heritage site/landscape.

For the historical content, text can be considered as an effective and traditional media to learn about cultural heritage, but people tend not to prefer only text to access this information. Therefore, a short and clear introduction could be a start, following with other vivid and dynamic media. For significant events, besides text, the platform should also use video resources, because it can capture important events clearly and vividly. People are more willing to see photo to understand a significant historical person, as probably they want to know what he/she looked like. The platform could put the photo in an obvious position, following with a brief introduction. The architecture contains much professional information, and a single media can not satisfy people's needs. The result shows respondents are interested in the visualisation of text and video, probably because the video can describe the information in a more detailed and comprehensive way. As for the community lifestyle, the developer could link more text & photo resources, and add some video as well to display the intangible heritage. Also, the cultural heritage platform should support Virtual Reality because respondents embrace this advanced visualisation technology. Moreover, respondents show interest in sharing their personal experiences with others, which can aid in extending cultural heritage knowledge dynamically. Therefore, social media applications, like Instagram, Facebook and Flicker could be embedded in the platform (Chen, Parkins and Sherren, 2018; Tieskens et al., 2018).

Appendix

Table A.1 Description of attributes and levels

Attribute	Level	Description
Information on Specific Buildings	1	Specific buildings are displayed by 2D map
	2	Specific buildings are displayed by the 3D model
	3	Specific buildings are displayed by Images
	4	Specific buildings are displayed by 2D map and 3D model
	5	Specific buildings are displayed by 2D map and Images
	6	Specific buildings are displayed by Images and 3D model
	7	Specific buildings are displayed by 2D map, Images, and 3D model
	8	No information on specific buildings
Information on Public Space	1	Public Space is displayed by 2D map
	2	Public Space is displayed by the 3D model
	3	Public Space is displayed by Images
	4	Public Space is displayed by 2D map and 3D model
	5	Public Space is displayed by 2D map and Images
	6	Public Space is displayed by Images and 3D model
	7	Public Space is displayed by 2D map, Images, and 3D model
	8	No information on Public Space

Table A.1 Continued

Attribute	Level	Description
Information on Heritage Site	1	Heritage sites are displayed by 2D map
	2	Heritage sites are displayed by the 3D model
	3	Heritage sites are displayed by Images
	4	Heritage sites are displayed by 2D map and 3D model
	5	Heritage sites are displayed by 2D map and Images
	6	Heritage sites are displayed by Images and 3D model
	7	Heritage sites are displayed by 2D map, Images, and 3D model
	8	No information on Heritage sites
Information on Historical Events	1	Events are displayed by Text
	2	Events are displayed by Photo
	3	Events are displayed by Video
	4	Events are displayed by Text and Photo
	5	Events are displayed by Text and Video
	6	Events are displayed by Photo and Video
	7	Events are displayed by Text, Photo, and Video
	8	No information Events
Information on Historical Persons	1	Persons are displayed by Text
	2	Persons are displayed by Photo

Table A.1 Continued

Attribute	Level	Description
	3	Persons are displayed by Video
	4	Persons are displayed by Text and Photo
	5	Persons are displayed by Text and Video
	6	Persons are displayed by Photo and Video
	7	Persons are displayed by Text, Photo, and Video
	8	No information Persons
Information on Architectures	1	Architectures are displayed by Text
	2	Architectures are displayed by Photo
	3	Architectures are displayed by Video
	4	Architectures are displayed by Text and Photo
	5	Architectures are displayed by Text and Video
	6	Architectures are displayed by Photo and Video
	7	Architectures are displayed by Text, Photo, and Video
	8	No information Architectures
Information on Lifestyles	1	Lifestyles are displayed by Text
	2	Lifestyles are displayed by Photo

Table A.1 Continued

Attribute	Level	Description
	3	Lifestyles are displayed by Video
	4	Lifestyles are displayed by Text and Photo
	5	Lifestyles are displayed by Text and Video
	6	Lifestyles are displayed by Photo and Video
Information on Lifestyles	7	Lifestyles are displayed by Text, Photo, and Video
	8	No information Lifestyles
Timeline	1	Timeline to switch between previous and current use of the area
	2	No Timeline
Virtual Reality	1	Support Virtual Reality
	2	Not support Virtual Reality
Upload their own experience	1	Upload their own experience to the platform
	2	Not upload their own experience to the platform

Chapter 3 System Architecture Design of the Multi Media Platform to increase awareness of Cultural Heritage

3.1 Introduction

There exist many different media resources to describe and record cultural heritage artefacts, but most of the resources are traditional and vague (i.e., posters on the cultural heritage field), or lack effective processes of digitalization (i.e., oral information) (Cunha et al., 2019; Rossato et al., 2021; Seifert et al., 2017). Limited information on a cultural heritage object makes that is hard for people to comprehend the heritage on-site and understand its values, and this holds even more for people who cannot visit the cultural heritage site (Dragoni et al., 2017; Monod et al., 2006). Therefore, there is a need of the public for facilities to access and better understand the tangible and intangible aspects of cultural heritage Information Communication Technology (ICT) offers wide accessibility, and it not only allows the user to acquire information about each object as a single, isolated element, but also to view it as part of a broader context, which can help him or her to better understand the whole history of cultural heritage (Di Giulio et al., 2021; Ott & Pozzi, 2008).

This Chapter proposes a newly developed Multi Media Platform for increasing people's awareness of a cultural heritage. The design of the new platform is based on a previous study in Chapter 2 on people's preferences. The results of that study indicate that users prefer to acquire more information through multiple media types. In

addition, users prefer to use more vivid media and advanced technologies to access information. Also, users are interested in using the functionalities of the platform to understand cultural heritage. The new multi-media platform considers as a case the cultural heritage site Strijp-S, an industrial Philips factory. The platform uses traditional media, such as 2D map, text, photo, video; and media based on advanced technologies, such as 3D model and Virtual Reality (VR) to display Strijp-S. The platform includes specific buildings, public space, and landscape as tangible cultural heritage elements, and persons, events, and local lifestyle as intangible cultural heritage components. Moreover, it adds a timeline and uploading-experience functions. In this Chapter, the UML-based Web Engineering (UWE) is used to describe the architecture of the web application, the database structure, and the platform's interface.

The chapter is structured as follows: Section 3.2 reviews the studies reported in the literature related to the existing media platforms. Section 3.3 describes the interface of the new Multi Media Platform. Section 3.4 explains the architecture of the platform, and Section 3.5 illustrates the different layers in more detail. Finally, the conclusions are given in Section 3.6.

3.2 Literature review

Media are the carrier to broadcast cultural heritage to the public. In the past century, it was not easy for the public to directly access information on cultural heritage (Ashworth, 2011; Kaddu, 2015).

Usually, people acquire the information from others, such as via oral stories, which results in only limited understanding about heritages. Today ICT is used for the development of websites for cultural heritage often for touristic purposes (Bethapudi, 2013; Cunha et al., 2019; Foni et al., 2010). These websites provide enough information to attract tourists to the cultural heritage sites. However, these platforms are not usually developed by taking into account people's preferences regarding the provided information and media to deliver information for each type of cultural heritage. Therefore, these platforms might not be the most optimal for their users.

In recent years, cultural heritage institutions have explored the opportunity to use ICT to enhance the visitors' experience, considering the need for information and suitable media for information delivery prior, during, and after the visiting experience (Maietti et al., 2021; Rubegni et al., 2010). When tailored to users' needs, ICT platforms can inrease awareness of the site, thus supporting citizens and decision-makers to plan activities to protect the cultural heritage (Moßgraber et al., 2020). Some researches have focused on the relationship between cultural heritage and ICT design, especially to increase people's awareness of cultural heritage (Bødker et al., 2003; Halabi et al., 2015; Kamppuri et al., 2006; Leidner and Kayworth, 2006). For example, a platform, called PLUGGY, a Pluggable Social Platform for Heritage Awareness and Participation, intends to attract citizens to understand cultural heritage (Lim et al., 2018). Other researches have emphasized the use of ICT in relation to cultural heritage for different purposes. For example, ICT platforms can teach students the history and educate

them on the preservation of cultural heritage (Goffredo Haus, 2016; Ott and Pozzi, 2008). Also, specific ICT applications, such as AR/VR applications used in museums, can entertain and inspire the children, while supporting their learning during the recreational time (Machidon et al., 2018).

Although ICT platforms do support users in acquiring information about cultural heritage more easily, they still have shortcomings. First, some platforms use only single media, such as Mobile Vaani (MV), which uses single voice media to broadcast cultural heritage to the public (Moitra et al., 2016). This type of platform can help users to focus on the cultural heritage content through one media without much effort, but due to the lack of visuals, it can't support visitors to understand all aspects of a cultural heritage comprehensively. To gather more information, users have to use other platforms to access more media (Ott and Pozzi, 2011). Second, the existing single or multi-media platforms don't test people's preferences for the content and media type before the development phase, resulting in unattractive and unsustainable platforms Third, most of the existing platforms were developed by official authorities. These platforms do not necessarily provide the type of information preferred by users. For example, these platforms show the differences between the past and the present, but ignore more detailed changes about cultural heritage, such as the process during the changes (Virtudes and Almeida, 2016). Lastly, existing platforms typically can't be edited by the users; users can't share their stories or experiences of the cultural heritage with other users (Rivero Moreno,

2020). Therefore, this research aims to create a new multi media platform as a prototype to address the above problems.

3.3 Multi Media Platform Interface

The Multi Media Platform of Strijp-S (https://strijp-chaware.tue.nl/index.php) developed during this research uses the 2D map of the area as the entrance, because a map can support access to a range of information sources (Marconcini, 2018). On entry, the user can first create a basic understanding of the layout of this area. With the navigation bar on the left, users can choose which Tangible Cultural Heritage object (Buildings, Public Space, and Landscape) they would like to learn more about (see Figure 3.1).

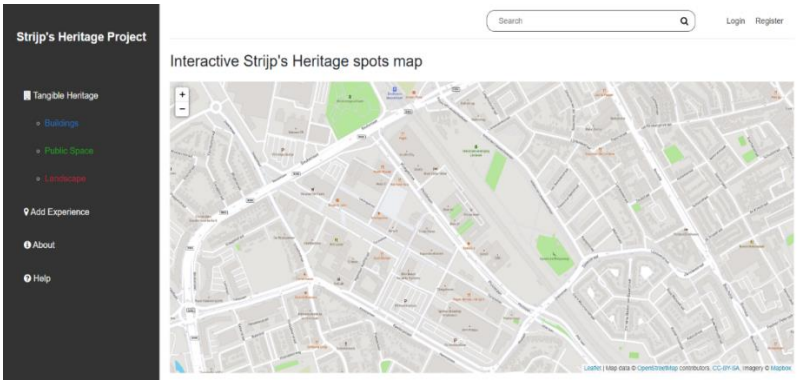

Figure 3.1 Multi Media Platform entry page

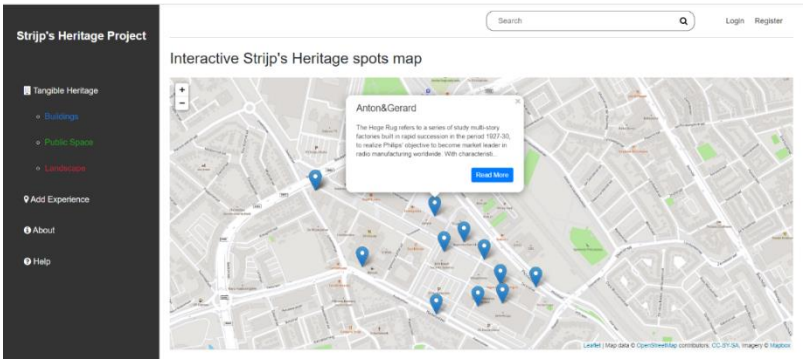

Figure 3.2 Cultural Heritage Objects retrieved from a database

When they choose a category, such as the Buildings, the related pins representing the POIs will show on the 2D map (see Figure 3.2). The users can then select the POIs of their interest.

After clicking a POI, the information index will appear, which lists all related information items about this cultural heritage object (see Figure 3.3). For example, if the user clicks on the "Anton & Gerard" building POI, the building details, related event information, person information, and local lifestyle information are listed. Following this, the user can select any of them to retrieve more information. The stored information about a cultural heritage object includes the following media: text, photo, video, 3D model (optional) and VR media (optional).

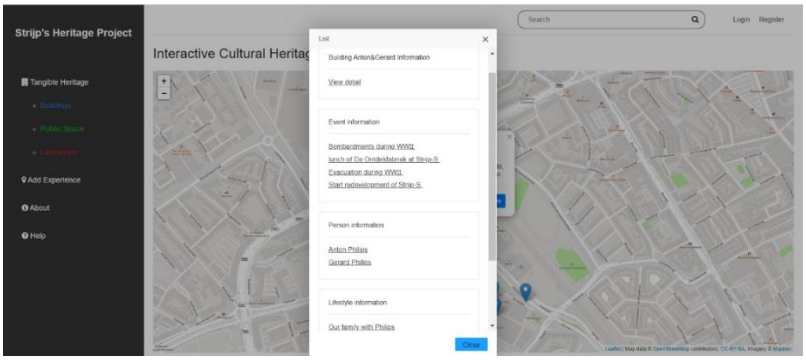

Figure 3.3 Information List for selected CH object

Consider “Anton and Gerard” item as an example. After clicking View detail, available information about the “Anton and Gerard” object is presented, see Figures 3.4, 3.5, and 3.6. Similarly, after clicking Event information, Person information or Lifestyle information about the object, the related intangible cultural heritage information is presented.

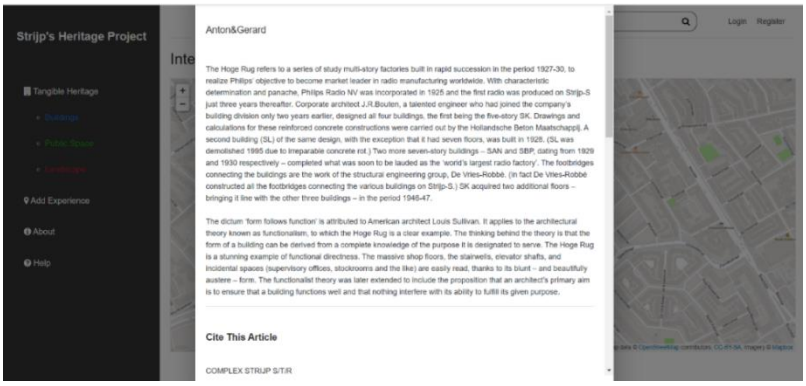

Figure 3.4 View detail on building Anton & Gerard - page 1

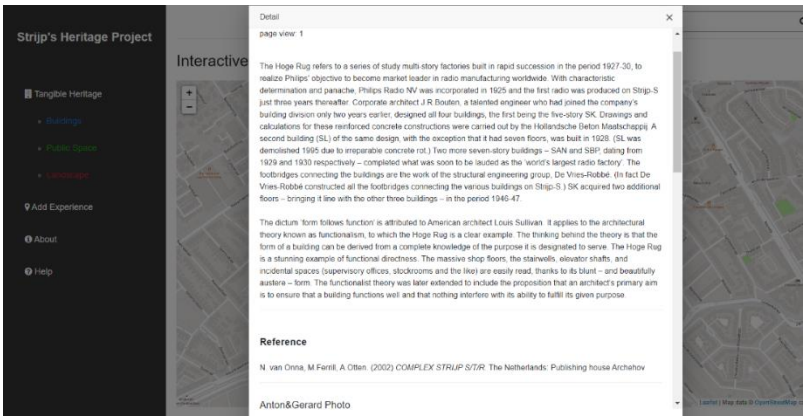

Figure 3.5 View detail on building Anton & Gerard - page 2

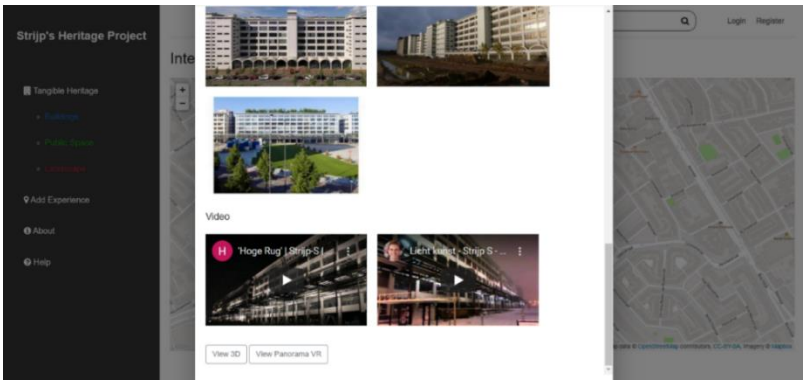

Figure 3.6 View detail on building Anton & Gerard - page 3

In sum, the developed Multi Media Platform includes a variety of media, such as 3D models, Virtual Reality (VR) models, and the functionality of Timeline. These functions and media can be found in the "view details" of the tangible cultural heritage information index. In the 3D models (see Figure 3.7) users can rotate and zoom in/out on the model to see the whole layout or part of the tangible cultural heritage. The VR view (see Figure 3.7) is supported by Google

Panorama VR, with which the users can view the 360° Panorama environment, to watch the real-time tangible cultural heritage and its surrounding environments. For the timeline function (see Figure 3.7), users can use the middle button to drag left or right to show the past and the current pictures of the tangible cultural heritage. In this way, they can compare the obvious changes of an heritage between two different years.

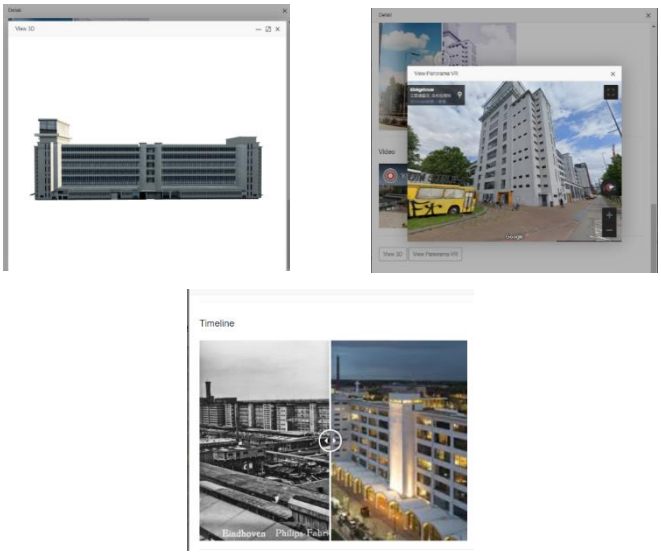

Figure 3.7 Functions of 3D model, VR and Timeline

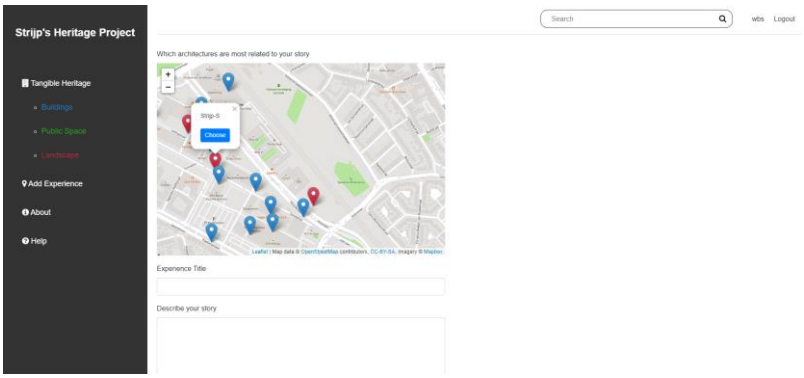

Figure 3.8 Adding personal experience to the platform

In addition to multi media, users can create their own account and upload their personal experience with a cultral heritage object to the platform. For that, users first need to select an existing cultural heritage object on the map, then describe their experience and upload relevant text, photos and videos (see Figure 3.8).

3.4 Multi Media Platform Structure

For explaining the system architecture, we use Unified Modeling Language (UML)-based Web Engineering (UWE). UML-based Web Engineering (UWE) was designed as a common language to define a metamodel-based web mapping method additional to existing software engineering methods (Escalona and Koch, 2007; Koch and Kraus, 2002). The tool was developed by Baumeister et al. (1999) at the end of the 1990s. The UWE methods have recently been adapted to new Web systems such as transaction-based, personalized, context-dependent, and asynchronous applications (Koch et al., 2008). UWE incorporates various software engineering techniques,

such as aspect-oriented modeling and new model transformation languages to improve design quality (Koch et al., 2008). In this project, UML diagrams are used to represent UWE models of the Multi Media Platform prototype. UML has been practiced successfully in the modeling of large and complex systems. The UML is used to explain the design of software projects or systems by means of graphical notations (Koch and Kraus, 2002).

As explained, the Multi Media Platform prototype described in this chapter, uses a 2D map as the first step to explore and access the information available on the cultural heritage of Strijp-S. All the tangible cultural heritage, buildings, public space and landscape, are shown on the map as a Points of Interests (POIs). Given that the platform is designed as map-based, the intangible cultural heritage is attached to the related tangible cultural heritage. For example, if users would like to know about an event, they first need to look up the related artefact on the map. Also, users can type keywords in the search bar to look for information that interests them. Finally, the platform allows users to upload their own travel experience to inspire others.

3.4.1 Multi Media Platform Use Case

Use cases are used to visualize the functionalities that the system provides. The UML elements Actor and UseCase are used to build use case diagrams. A use case diagram illustrates use cases, actors, and associations, showing the actors' roles in interaction with the system (see the Legend of Figure 3.9). Actors are used to model the users of the web system. Normally, the system users include

anonymous users (called General User), registered users (called registered user), and the system administrator. Moreover, the UWE divides the use case into three different types: <<Navigation>>, <<Process>> and <<Personalized>> use cases. The <<Navigation>> use case displays typical user behavior when interacting with a web platform, such as browsing through the content or typing the keywords into the search bar. <<Process>> use case describes business tasks that end users will perform with the system, such as registering an account. <<Personalized>> use case implies the personalization of a web system, it means the users can edit the system, such as uploading their own experience.

The use case model of Figure 3.9 includes the <<Navigation>> (□) use cases of "Search", "Choose one TCH (Tangible Cultural Heritage)", and "View Others' Experiences". In the "Search" use case, users can type keywords in the search bar to search for cultural heritage related information of their interest; while in the "Choose one TCH" use case, users can click on one of the POIs (Points of Interests) of tangible cultural heritage on the map to access information. Users can only access information of intangible cultural heritage through selected tangible heritage.

The platform also allows users to upload their own experience. Therefore, the model includes the "View Others' experiences" use case, at which users can learn about the personal experience of other users related to a Cultural Heritage object. "Register" is an example of a <<Process>> use case (△), that allows the general users to create

their own account. The <<Personalized>> (☆) “Upload own experience” use case is utilized to support users in uploading their personal experience related to a cultural heritage object. Figure 3.9 presents the Multi Media Platform restricted to the functional requirements from the General User and Registered User viewpoint. It identifies the main functionalities and associates them with use cases. General Users can search for information or Choose a tangible cultural heritage(TCH) to retrieve more information and register their own account to become Registered User to upload their own experience and share it with the public.

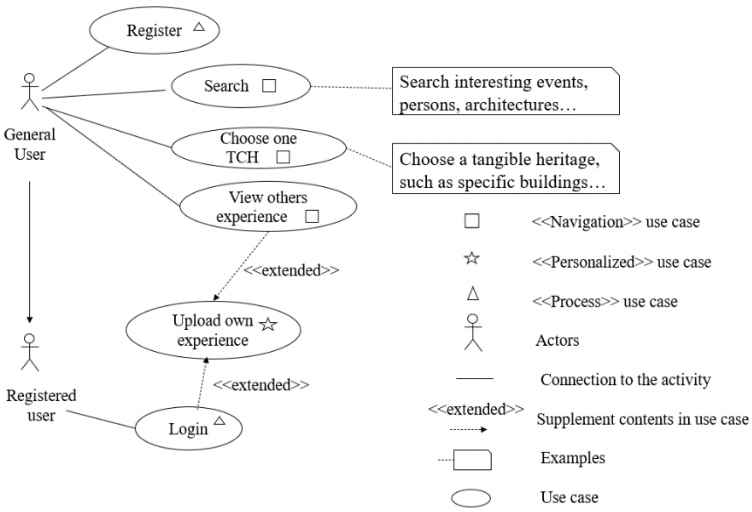

Figure 3.9 UWE case model for the Multi Media Platform

3.4.2 Multi Media Platform Activity Diagram

The UML activity diagram represents workflows of stepwise activities and actions with support for choice, iteration, and

concurrence (Koch et al., 2008). It includes activities and control flow elements (see Legend of Figure 3.10). The activities are the actions that users can perform, and control flow elements determine the sequences of the activities. The UWE profile includes a set of stereotypes adding Web specific semantics to UML activity that is depicted by the icon: ○ for << create content>>. Stereotypes of activities are used to distinguish possible user actions in the web environment browse, and search that comprise changes in at least one database. To this category of stereotypes belong: ⇨ represents <<browse>>, ? represents <<query>>, and ⇔ represents transactional actions (see Legend of Figure 3.10).

Figure 3.10 illustrates the activity diagram for the use case find-interesting-information in the Multi Media Platform. Users choose a category of tangible cultural heritage and click a Point of Interest (POI) on the map. Then, a list is shown with information about the selected Cultural Heritage, such as detailed information about a building and related intangible cultural heritage information. Users can choose an option from the list to browse the content, including the various media. After viewing the content, they can finish their actions (close the pop-up window or go back to the list/homepage to view other contents). Moreover, users can register or login to their accounts and upload their personal experiences anytime.

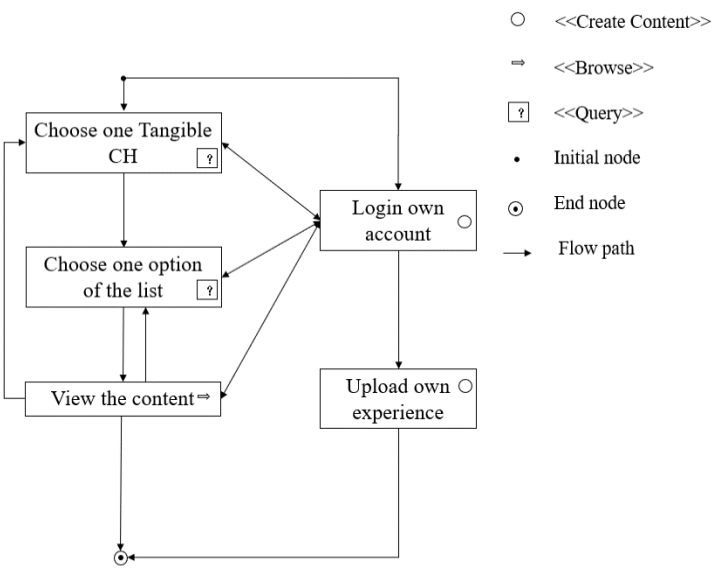

Figure 3.10 UWE activity diagram detailing the finding-interesting-information use case

3.4.3 Multi Media Platform Content

The content model is the basis of a web system. The content model aims to present a visual description of the domain-relevant information for a web platform which mainly contains the content of the web application. Moreover, it also includes entities of the domain required for customized Web applications, called user model. Both content model and user model are graphically represented as UML class diagrams. The content model of the Multi Media Platform is depicted in Figure 3.11. While in UML Class models entities represent content and users, UML associations model relationships between content and user properties (see Legend of Figure 3.11).

Cultural heritage is divided into two classes in the Multi Media Platform: Tangible and Intangible cultural heritage. The Tangible Cultural Heritage class, has three sub-classes: building, public space and landscape. The Intangible Cultural Heritage class is also constituted from three different sub-classes: Significant Person, Significant Event, and Lifestyle. All of these contents are displayed through different media, which are sub-classes of the Media class: Map, 3D model, Virtual Reality (VR), Text, Photo and Video.

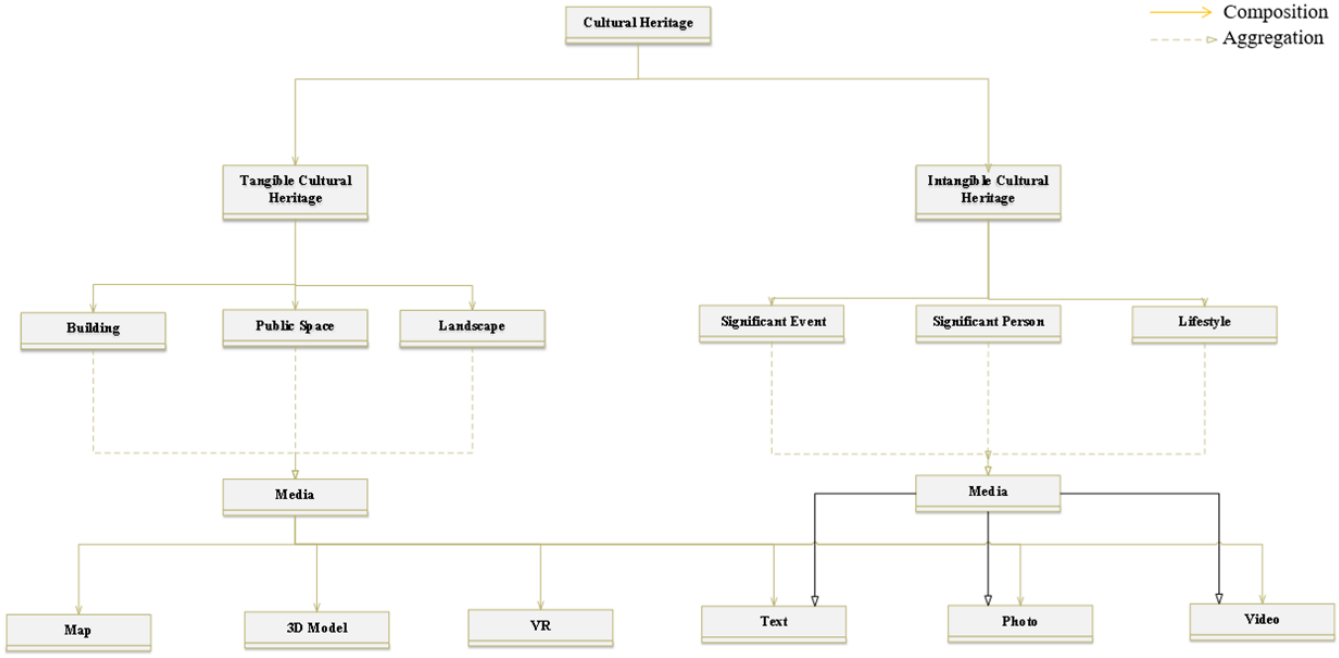

Figure 3.11 Case study: Content model

3.4.4 Multi Media Platform Navigation

Based on the requirement analysis and the content modeling, the navigation structure of the Multi Media Platform is modelled. Navigation classes (visualized as □) represent navigable nodes and the navigation links show the direct links between navigation classes. Access primitives are used to reach multiple instances of a navigation class (<<index>>☰ , it includes the index of the tangible cultural heritage of Strijp-S and the index of information of tangible/intangible cultural heritage), or to select items (<<query>> ?). The entry and exit points of the business process are modeled by the process primitive (△) in the navigation model; process links model the linkage between the navigation classes. Koch and Kraus (2002) designed the UWE as methodological guidelines for developing an initial outline of the navigation structure of a web application. The Navigation structure of the multi-media platform designed and developed for this thesis using the UWE method is shown in Figure 3.12.

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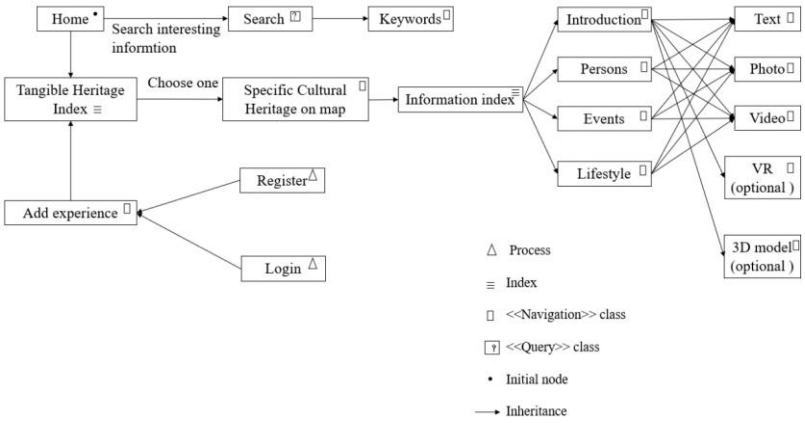

Figure 3.12 Navigation from Specific Cultural Heritage

By means of a query Search, the user can search for any interesting information about a specific Cultural Heritage, using keywords such as the name of a building or event. Moreover, users can go to the main menu (Tangible Heritage Index) of the platform and search for specific Cultural Heritage, by choosing an object on the map to open the information index. Then, they can select one of the available information media (e.g., photos) to open the link. The users can acquire information of intangible cultural heritage through accessing the relevant tangible object. The media will be the carrier to display all content. The Search function can also be used for directly reaching the information index.

3.5 Database Structure

3.5.1 Architecture of Multi Media Platform

In the previous part, the structure of the Multi Media Platform was described by UWE, and in this section, the system components' organization will be explained using the MVC (Model View Controller) pattern, which is well known in software engineering (Pitt, 2012). The MVC is commonly used in developing user interfaces (Reenskaug and Coplien, 2009).

The model layer can be considered as the first layer of interasction with any database used in Multi Media Platform. Meanwhile, the model layer also takes care of tasks such as saving user data. The View layer displays a representation of the modeled data. It is responsible for using the correct media to present users' requested information. The Controller layer handles user requests and is responsible for connecting between Model and View layers.

The MVC architecture provides easy handling of a web application (Chandakanna and Vatsavayi, 2014; ElSayed et al., 2018; Hasan and Isaac, 2011; Lee and Wang, 2019). The Lavarel framework in PHP language for web development that is built upon the MVC architecture, was used for implementing the application. Laravel needs a Web Server running PHP5 or higher (Cunha et al., 2019).

In this research, we designed and deployed a Cultural Heritage Multi Media Platform to give users access to a wide range of multi media content. The platform uses a map-based metaphor to introduce the content delivery process for different kinds of content: text, photo, video, VR and 3D model. The platform architecture is composed of three main layers with two main layers decomposed into two sub-layers, see Figure 3.13. The layers are explained in more detail in the following.

The **View layer** contains two sub-layers: **Map Layer** and **Multi Media Layer** to display the cultural heritage content. The **Map layer** represents the entrance to the platform and shows all the POIs (Point Of Interests) on the map. Users can choose the cultual heritage object of their interest (POI) to retrieve the information. The map is supported by Google maps. The **Multi Media layer** contains all media used by the objects to be displayed, such as video, VR and 3D model. The platform can present all the related media based on the user's request.

The **Controller layer** manages the transfer of data between different media and users' requests. It responds to the user's input and performs interactions on the data model objects. The **Model layer** consists of a repository for managing the storage of the multi media content, which is the database of the platform. The Model layer contains two sub-layers: **Heritage Categories layer** and **User Profiles layer**. The **Heritage categories layer** contains the details of cultural heritage, including tangible and intangible cultural heritage

information. The users' details, such as their account name, e-mail address and password, are stored in the **User Profiles layer**. The database is supported by MySQL.

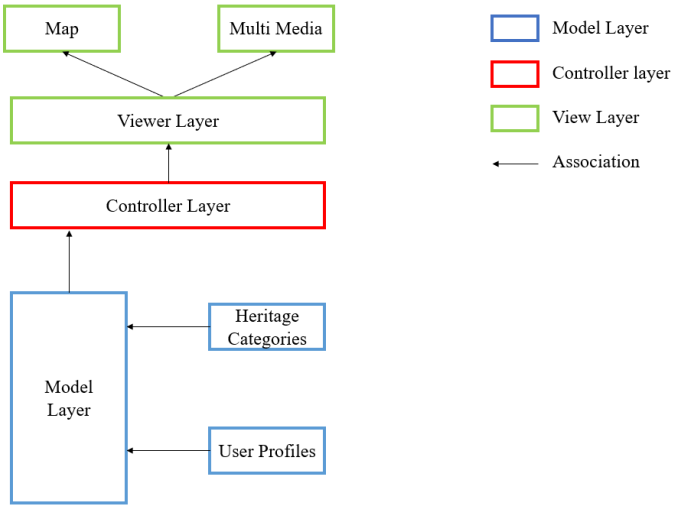

Figure 3.13 Architecture of the Multi Media Platform

3.5.2 Database design

In the last section, we explained that the Viewer Layer has two sub layers: Map Layer and Multi Media Layer to display cultural heritage. All the media content are included in the Model Layer supported by a MySQL database, 8.0 version (*MySQL*, n.d.). In this section, we will explain how the tables (see Figure 3.14) of the MySQL database are designed to connect to the Map Layer and the Multi Media Layer.

In the developed system, the Map Layer is used as the entrance to the Multi Media Platform. Therefore the main table of the database is Spot, that represents the POIs on the map, which contains all information about a specific tangible Cultural Heritage (CH) object, such as name and address. To save storage capacity and increase performance (Haus and Ludovico, 2006), the intangible CH objects Event, Person, Lifestyle, and Experience are the branches of the main table-Spot. They contain similar attributes for every table, such as the title and ID. Because the Spots table is essential to the database structure, the ID is the unique (key) attribute for every CH object in the database. It connects all other tables to the Spot table. Since the media VR and 3D models are used to display only the tangible cultural heritage, they are included in the Spot table. The other media, Photo and Video are available to all tangible and intangible CH objects and therefore are stored in separate tables. The search function can reach all tables from the main Spot table. For example, suppose a user would like to search for interesting information about a specific CH object. In that case, he/she can either choose the object and select from the media list to explore the CH information or type in keywords in the search bar to retrieve CH information. Both methods can lead to reaching what he/she wants, that is, showing the available media content.

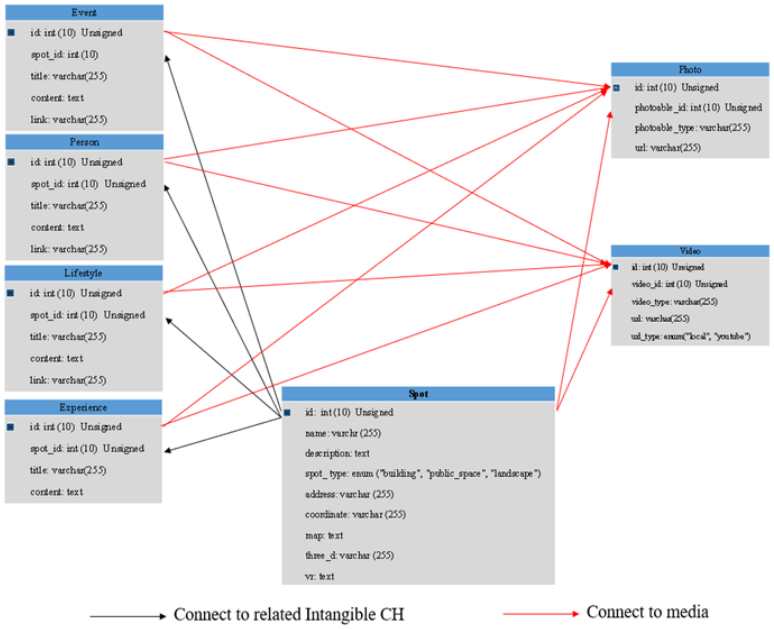

Figure 3.14 Database structure of the Multi Media Platform

Moreover, the platform allows users to upload their own experiences to enrich the database. At first, the user needs to choose a CH object on the 2D map to attach his/her related experience. Then, he/she can upload the related text, photo and video. Because the 3D model and VR need a specific format, varying formats would cause system disorder. Therefore the platform was not set up for uploading 3D model and VR function by users. The users' experiences are stored in the Lifestyle table and are compatible with the selected spot's id.

3.6 Conclusion

This Chapter has described the design of a Multi Media web platform prototype using the UWE technique. A multi media platform as

presented in this chapter is crucial for creating awareness of cultural heritage before or after visiting a heritage site. It can support creating and strengthening the public's knowledge of cultural heritage in Strijp-S in the city of Eindhoven. This platform aims to overcome the shortcomings described in the related work by using multiple media and tailoring the design to known users' preferences.

During the design and development process, several limitations were encountered. The developed Multi Media Platform includes a range of media but still can be extended with new media such as VR models for use with Head-Mounted Displays and Augmented Reality (Petrovič et al., 2021). Currently, most content of the Strijp-S site only includes photos/models of the outside of the CH buildings, given the available information. The Multi Media Platform can be extended by adding more (visual) information about the inside of the buildings. Finally, the platform is only available for (laptop) computers; developing a smartphone app will help to popularize its use, especially on-site during users' visits. In addition, the function of "uploading own experience" allows people to upload any information to the database, which could lead to uploading false information. This function needs a filtering mechanism to select the appropriate information to the public which is to be developed in future work.

Moreover, the Multi Media Platform should be tested by the public to validate its usefulness and functionality to increase awareness of cultural heritage, and to compare it with other existing ways of information acquirement (such as Google Engine).

Chapter 4 A Structural Equation Model to Analyze the Use of a New Multi Media Platform for Increasing Awareness of Cultural Heritage

This chapter is based on the paper:

Wang, B., Dane, G., Arentze, T.A. A Structural Equation Model to Analyze the Use of a New Multi Media Platform for Increasing Awareness and Experience of Cultural Heritage. Submitted for publication.

4.1 Introduction

Previous research have shown that the different media platforms have affected people's awareness of cultural heritage. Cultural heritage awareness is a critical factor (Carbone et al., 2012); residents and other users will have more positive attitudes toward heritage if they are aware of it (Carter, 1994; Light, 1995). The importance of cultural heritage for the perpetuity of society is indisputable. Therefore, efforts to raise people's awareness of cultural heritage have accelerated in the last decades (Şentürk, 2012). In addition, it is essential to allow citizens to recognize their own culture and transfer the culture from one generation to another (Şentürk, 2012). In a more general sense, many examples of historic buildings and sites have been lost due to a lack of public awareness until after the fact, such as fire or demolition for development (Nyaupane and Timothy, 2010; Shankar and Swamy, 2013). Evidence suggests that more heritage users are becoming more cognizant of the heritage value of the places they visit (Fyall and Rakic, 2006; Yan and Morrison, 2008). Cultural

heritage awareness is a critical factor for sustainability of both tangible and intangible heritage elements (Carbone et al., 2012); residents and other users will have more positive attitudes toward them if they are aware of it (Carter, 1994; Light, 1995).

Cultural heritage experience is being viewed as an ongoing lifelong experience (King and Lord, 2015; Oppermann, 1994; Wilkening and Chung, 2009), and heritage protection will not be effective without a certain level of heritage awareness and acceptance among visitors and community residents (Munjeri, 2004; Nyaupane, 2009). Burchum (2002) considered cultural awareness more in general and defined the concept as "Cultural awareness refers to the developing consciousness of culture and how culture shapes values and beliefs". The development of cultural awareness often necessitates a period of time, and it requires the commitment and support of the local community (Boyle-Baise, 2002; Boyle-Baise and Sleeeter, 2000; Hovater, 2007; Srivastava, 2015; Stachowski and Visconti, 1997).

ICT tools such as mobile applications and websites provide possibilities for increasing awareness of cultural heritage by supporting their users' learning and their experience with cultural heritage (Ardito et al., 2010). Information provision on cultural heritage can create a sense of cultural heritage awareness and stimulate an understanding of the culture, values and beliefs in the society (Liew, 2005). ICT tools developed for historical places can provide such rich content and information to users and also offer another way of interaction with heritage which is not always site-bounded (Baxter, 2014). Therefore, digital technologies have been widely used in cultural heritage management to broadcast

information (He et al., 2017). In the study of Liu (2020), it was shown that digital display technologies were highly appreciated by heritage visitors due to the possibilities these technologies offer, such as supporting visitors' discovery and learning about the site and helping them to interact, experience, engage, and communicate with history. Such digital tools and technologies enable a continuous cultural heritage experience that can start before the visit and can continue during and after the visit. Unlike the residents and visitors with prior knowledge of a cultural heritage site, new visitors usually seek for support in finding relevant information. Therefore, different users of cultural heritage sites have varying needs and interests for obtaining information and the way information is provided, which is a challenge that can be addressed with digital tools and technologies. (Ardissono et al., 2012).

To date, however, little attention has been paid to the influence of digital tools and technologies on (potential) visitors' experience and awareness, despite the fact that they have been considered as essential for cultural heritage sites (Packer and Ballantyne, 2016). Only a few studies have considered the effectiveness of digital tools. A survey conducted by Kempiak et al. (2017) in Northern Ireland to test visitors' experience of digital technologies revealed that interactive and digital media can play a major role in visitors' experience. In addition, a survey conducted by Wang et al indicated that visitors prefer to use vivid and multiple media to acquire more information about cultural heritage.

To increase insights on to what extent and how digital technologies can contribute to awareness and experiences, the main goal of this chapter is to investigate the relationships between the functionalities offered by a well-designed multi-media web-platform and its influences on awareness and experience of cultural heritage. Furthermore, we analyze users' preferences of certain media types for collecting information. As a tool, we use a new multi-media platform which was developed by the authors for this research purpose. The tool is applied to a specific cultural heritage site – the former Philips industrial site called Strijp-S in Eindhoven, The Netherlands, which is used as a case area. To collect the data, a national sample of potential visitors of the Strijp-S heritage site was invited to use the tool and fill out a questionnaire. The online questionnaire was sent to the respondents in June 2021. A Structural Equation Model (SEM) was used to analyze their awareness and experiences of the cultural heritage site (Strijp-S).

The remainder of the chapter is structured as follows. In the next section, the hypotheses based on a review of concepts and findings from literature are discussed. Following that, the data collection and the methodology of this study are described, followed by a discussion of the results. Finally, we conclude the chapter by discussing the major conclusions and remaining problems for future research.

4.2. The hypotheses

Potentially, a multi-media platform, such as the prototype system described in Chapter 3, can enhance people’s awareness and

experience of cultural heritage (Liew, 2005, Kempiak et al., 2017). In this section, we will review existing literature on the role of digital tools and purposes of the functionalities offered, to derive the hypotheses for the analysis conducted.

A potentially important function of the ICT platforms concerns information provision. Gradually, digital technologies and tools regardless of being developed by officials and/or private sector, have been recognized as essential to provide information and increase people's knowledge and awareness (Liew, 2005). Compiling cultural heritage information usually involves professionals from different knowledge areas, which implies a huge amount and variety of information and requirements (Soler et al., 2017). Visitors of heritage sites generally prefer to search for cultural heritage information before, during and after their visit (Tong et al., 2018). In some technologically developing regions, much information relevant to tangible and intangible cultural heritage can hardly be reached by laymen (Fanzhuo et al., 2021). Increased sharing of up-to-date digital information is becoming essential to visitors' heritage experience (Liu, 2020). The lacking information may result in limited awareness of cultural heritage and, as a consequence, limited efforts to preserve cultural heritage.

Authors have also pointed to socio-demographic variables (such as gender, age, education level, income level) and other person related variables (notably, current living situation and visit history) as relevant factors for awareness of cultural heritage (Allen et al., 1993;

Kim & Lee, 2000). It is found that experiencing and interacting with local culture increases the probability of having a unique and memorable experience (Teo et al., 2014). An interest in acquiring more information may play a key role in this. Kerstetter et al., (2001) also find that visitors interested in visiting heritage or cultural sites are likely to extend their stays, and are eager to search for all the information about cultural heritage available. Bagnall (2003) and McIntosh and Prentice (1999) argue that acquiring information about heritage sites and buildings can support people's understanding of cultural heritage and increase their awareness to a certain required level. The more information acquired by the visitors, the more they tend to learn about a cultural heritage which also increases their emotional involvement and connection with the heritage (Poria et al., 2006). In addition, many studies have shown that there are gender differences in cultural tourism activities (Ferguson, 2011; Kinnaird and Hall, 1996). Moreover, Sutcliffe and Kim (2014) found that children are more active in engaging in cultural events. Recently, heritage education has become more important in educational and heritage contexts (Abdelazim Ahmed, 2017). Such heritage educational programmes require the involvement of local communities for supporting the relevant heritage activities. As Kim et al., (2007) conclude, high-education and high-income people are more likely to frequent cultural events such as local festivals, fairs, musical attractions, and knowledge/aesthetic seeking attractions. Moreover, a person's visit history and therefore prior knowledge about a site may play a role. Nyaupane and Timothy (2010) found that repeated visitors tend to have more awareness of the sites compared to one-time visitors. Residents and visitors who develop feelings of a sense of belonging or emotional connection, often

become a part of the community (Carroll and Rosson, 2008). People who are part of the local community tend to leave comments and add photos on social media platforms and, thus, may contribute actively to broadcasting cultural heritage (Han et al., 2014; Remoaldo et al., 2014).

Apart from information provision, a multi-media platform generally offers additional auxiliary functions, such as options to view a timeline of the history, to upload one's own experiences, and to read about others' experiences. With the advancement in web technologies and social network platforms, individuals can create and share their own stories and experiences with other users (O'connor, 2008). Sharing the interaction with the heritage with others can enrich users' experiences (Brown and Chalmers, 2003), and enable multiple users to view the same content (Suh et al., 2011). Cultural heritage elements are not permanent (Şentürk, 2012); thus, digitally stored historical information about cultural heritage items offers insights and details about items' characteristics and features. The timeline is a valuable function in the platform that helps people identify meaningful connections over the continuum of a heritage item (Dörk et al., 2017). Time is a fundamental dimension for making sense of digitized cultural heritage information, and timeline visualization can support users in exploring and analyzing the continuity of the heritage (Vane, 2019).

Apart from awareness, multi-media platforms also have the potential to increase experience and the willingness to experience by

supporting users learning, thinking and interacting with other users' experience. Zhang et al., (2018) defined the experience of tourists in cultural heritage areas as the comprehensive psychological responses consisting of perceptual (sensory) and rational aspects (learning and thinking). Previous studies have suggested that there is a significant relationship between awareness of cultural heritage and experience of cultural heritage (Ardito et al., 2010; Lim et al., 2018; Liu, 202s0). Also, in the chapter 2, it was found that a higher awareness of cultural heritage can lead to a stronger positive experience of cultural heritage when they view it online or on-site.

A multi-media platform by definition allows users to retrieve information through different media. Providing spatial information is significant for explaining and supporting the understanding of a heritage site or an artefact (Beraldin et al., 2005), and the map is prominently the media type to access it (Poppinga et al., 2011; Wang et al., 2009). Text and photos are common and indispensable media forms to access cultural heritage information, especially when it comes to intangible cultural heritage (Fanzhuo et al., 2021). The visual form helps the communication of important information and reduces errors in communication. Hence, photos and, particularly, video are excellent tools to satisfy needs (Tong et al., 2018). However, all these traditional media are slow, time-consuming and have several other obvious limitations (Pieraccini et al., 2001). 3D model applications have been used in cultural heritage recently (Abouaf, 1999; Beraldin et al., 1999; Berndt and Carlos, 2000; Boulanger, 1998; Levoy, 1999; Pieraccini et al., 2001; Terashima et al., 1999), because they can provide rich information compared to the 2D maps

(Godin et al., 2002; Guarnieri et al., 2010). Besides the 3D model, virtual reality also has a strong potential to make people more aware of cultural heritage (Cameron, 2007; Kolay, 2016). VR motivates the public to learn more about cultural heritage (Hu et al., 2019). It encourages active participation and by supporting interaction with the site contributes to effective learning (Mikropoulos and Natsis, 2011). Therefore, it is widely recognized that the use of multiple media is an important feature of a platform to engage citizens and stimulate participation in the community (Haji Bibi et al., 2019).

Based on the literature reviewed above, we formulate the following hypotheses regarding the perceived usefulness of a platform's functionality by users and the effects using the platform has increasing awareness and experience of cultural heritage:

- Perceived usefulness of a platform for collecting information has a positive relationship with the extent it increases awareness of cultural heritage (H1);
- Person variables (socio-demographics and visit history) have an influence on perceived usefulness of a platform for collecting information (H2a) and perceived usefulness of auxiliary functions of the platform (H2b);
- Perceived usefulness of auxiliary functions of a platform has a positive relationship with the perceived usefulness of the platform for getting information (H3b) and with the experience of cultural heritage (H3a);
- Awareness of cultural heritage has a positive relationship with the experience of cultural heritage (H4).

Figure 4.1 shows the proposed conceptual model that represents the hypothesized relationships graphically. This model assumes that the information function primarily affects awareness and that auxiliary functions support the information function and, hence, have an effect on awareness indirectly. At the same time, it is hypothesized that auxiliary functions can enhance experience independently of the information function. We will test this set of hypotheses in an integrated fashion by estimating path coefficients using structural equation modelling (SEM).

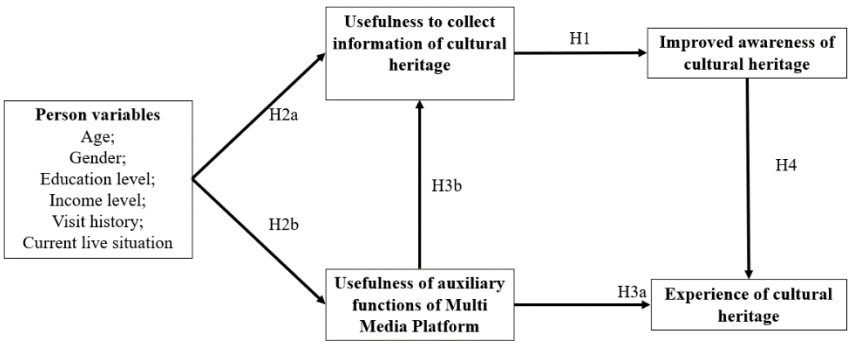

Figure 4.1 Conceptual model

Different media types may support to different extents the information function of the platform. In addition to analyzing these hypotheses with SEM, we analyze the perceived usefulness of different media types to support the acquisition of information on both tangible and intangible cultural heritage.

4.3. Data collection and analysis method

This section describes the data collection procedure, the data collection instrument, and analysis method used.

4.3.1 Data collection

Data were collected in June 2021 among citizens of the Netherlands. We collected data via the Limesurvey system, which is an online survey platform. The respondents were recruited via a paid panel in the Netherlands. This panel resembles the overall Dutch population regarding socio-demographics, occupation and location, so that it should be possible to generalize the findings. The same questionnaire was administered to two experimental groups. Individuals were allocated randomly to either one of the two groups. The groups differed only with respect to the tool they were asked to use – the multi-media platform (a dedicated tool) and Google search engine (a general purpose tool). The last group served as a benchmark. In both cases, respondents were instructed to use the tool (the platform or Google) to explore the Strijp-S heritage site and retrieve whatever information they would like to know. Awareness was measured prior and after having used the tool. For the present analysis in this paper, only the data of the multi-media group is relevant and will be used here. This group consists of 302 respondents.

4.3.2 Data collection instrument

The questionnaire consisted of two parts. The first part included questions about socio-demographic variables, including gender, age, education status and income level. In addition, respondents were

asked to indicate whether they had visited Strijp-S ever before and whether they live in Eindhoven currently. The second part included questions about initial knowledge of Strijp-S, including tangible and intangible cultural heritage. In addition, this part included questions about users preferences for different media types to access cultural heritage information. This was followed by questions regarding whether the used platform (either the multi-media platform or Google) increased their knowledge, experience and awareness of Strijp-S. As said, in this chapter, the data of only the multi-media platform group will be used. The measures related to the relevant concepts are explained in detail below.

a) Auxiliary functions of the multi-media platform

The auxiliary functions of the Multi Media Platform include "timeline", "uploading own experience" and "reading others' experience". Users are asked to indicate their evaluation of the usefulness of these functions by rating statements on a 5-point Likert scale, ranging from strongly agree to strongly disagree. The statements about the functions are represented in Table 4.1.

Table 4.1 Statements related to auxiliary functions

Variables	Statements
Usefulness of auxiliary functions of the multi-media platform	The timeline has helped me to compare the changes of physical architectures between the past and the current
	I would like to upload my own experience related to Strijp-S to the Multi Media Platform
	Reading other's experience on their visitations has helped me to increase my understanding of Strijp-S

b) Information collection of Strijp-S

To measure the perceived usefulness of the multi-media platform to collect information about Strijp-S, we considered tangible, intangible, and interesting cultural heritage information. Statements and a 5-point Likert Scale, ranging from strongly agree to strongly disagree, were used to measure this concept. The statements used are shown in Table 4.2.

Table 4.2 Statements related to information collection

Variables	Statements
Usefulness of the multi-media platform for collecting information	This multi-media platform has helped me to gain information about tangible cultural heritage at Strijp-S
	This multi-media platform has helped me to gain information about intangible cultural heritage at Strijp-S
	This multi-media platform has helped me to gain information about interesting cultural heritage at Strijp-S

c) Experience of cultural heritage

Because cultural heritage includes tangible and intangible aspects, the measurement of experience is considered for both parts. Experience was measured in terms of interest raised and positive attitude to interact with the area on-site. 14 statements were presented to respondents. They are represented in Table 4.3. Also here, respondents were asked to indicate their degree of agreement with statements on a 5-point Likert Scale.

Table 4.3 Statements to measure experience

Variables	Statements
Experience of cultural heritage	I would like to visit specific buildings at Strijp-S
	I would like to visit Strijp-S district when I have an opportunity
	I care about cultural heritage buildings or places at Strijp-S
	I'm interested in buildings at Strijp-S
	I'm interested in public space at Strijp-S
	I'm interested in landscape at Strijp-S
	I'm interested in persons who are related to Strijp-S
	I'm interested in historical and current events of Strijp-S
	I'm interested in local lifestyle related to Strijp-S
	I would like to live in one of the cultural heritage buildings at Strijp-S
	I am interested in cultural heritage redevelopment of Strijp-S
	I would like to join discussions about the future cultural heritage redevelopment of Strijp-S
	I would like to join at least one of the events at Strijp-S
	I will recommend others to visit Strijp-S because of its cultural heritage

d) Preference ranking of media types for information collection

Respondents were furthermore asked to rank media types with respect to their usefulness for collecting information about Strijp-S. Different categories of information were distinguished. Which media types are relevant depends on whether tangible or non-tangible aspects of heritage is involved. In case of tangible heritage (buildings, public space, landscape), all media types (maps, 3D models, panorama VR, text, photo and video) are relevant and in case of intangible heritage (events, persons, local lifestyles) only text, photo, and video. The ranking questions are represented in Table 4.4.

Table 4.4 Preference ranking of media types for information collection

Questions	Supplement
Which media has helped you the most to find information about the buildings at Strijp-S? Please rank them from 1 to 6. 1 meaning the highest ranking	The media include: map, 3D models, panorama VR, text, photo and video
Which media has helped you the most to find information about the public space at Strijp-S? Please rank them from 1 to 6. 1 meaning the highest ranking	The media include: map, 3D models, panorama VR, text, photo and video

Table 4.4 Continued

Questions	Supplement
Which media has helped you the most to find information about the landscape at Strijp-S? Please rank them from 1 to 6. 1 meaning the highest ranking	The media include: map, 3D models, panorama VR, text, photo and video
Which media has helped you the most to find information about significant events at Strijp-S? Please rank them from 1 to 3, and 1 meaning the highest ranking	The media include: text, photo and video
Which media has helped you the most to find information about significant persons at Strijp-S? Please rank them from 1 to 3, and 1 meaning the highest ranking	The media include: text, photo and video
Which media has helped you the most to find information about local lifestyle at Strijp-S? Please rank them from 1 to 3, and 1 meaning the highest ranking	The media include: text, photo and video

e) Improved awareness of cultural heritage

To measure improvement of awareness after having used the tool, subjects could indicate their level of agreement with the statement "The Multi Media Platform has increased my awareness of the cultural heritage of Strijp-S, Eindhoven", on a 5-point Likert Scale statement ranging from strongly agree to strongly disagree.

4.3.3 Analysis method

The data were analyzed using a structural equation model (SEM). This model allows to include both latent and observed variables and estimate in an integrated fashion the structural relationships and measurement relationships between (latent) variables (Ullman and Bentler, 2012;Van Dinter et al., 2022). For this, the SEM consists of a measurement model and a structural model. The measurement model indicates how the indicators used are related to latent variables they intend to measure. The structural model identifies the relationships between latent and observed variables. In this study, the structural model is given by the conceptual model. Figure 2 shows the variables that were considered in the model. The model is estimated using the statistical software package AMOS version 26 (Arbuckle, 2019).

4.4 Results

In this section, we describe the sample and the estimation results of the SEM. Furthermore, we discuss the results of the analysis conducted to reveal the preferences of users for the different media types used in the system to collect information.

4.4.1 Sample description

Table 4.5 Sample characteristics (n=302)

Variable	Value	Sample (%)	Dutch population (%) (CBS, 2020)
Gender	Male	151 (50%)	49.7%
	Female	151 (50%)	50.3%[1]
Age	Young people (below 34)	73 (24.2%)	-
	Middle age (34-49)	77 (25.5%)	-
	Elder (50+)	152 (50.3%)	-
Education level	Low education	37 (12.3%)	30%
	Middle education	129 (42.7%)	40%
	High education	136 (45%)	30%[2]
Income	Low income	56 (18.5%)	27.7%
	Middle income	129 (42.7%)	47.3%
	High income	87 (28.8%)	25%[3]
	Do not want to say	30 (10%)	
Have you visited Strijp-S before?	Yes	71(23.5%)	
	No	231(76.5%)	
Do you live in Eindhoven now?	Yes	13(4.3%)	
	No	289 (95.7%)	

[1]*Netherlands: population, by gender 2021 | Statista*, n.d.

[2]*Education - Figures - Society | Trends in the Netherlands 2018 - CBS*, n.d.

[3]*Income distribution (standardised income)*, n.d.

The distributions of respondents on relevant person variables are shown in Table 4.5. It shows that the number of females is the same as males. As for age, older people are over-represented with a share of 50.3% of the 50+ age group. The sample contains a higher percentage of people in both the middle (42.7%) and high (45%) education level groups compared to low education level. Also, middle and high income groups had a higher share compared to low income. Most of the respondents (76.5%) have visited Strijp-S at least one time before. The majority of the sample (95.7%) did not live in Eindhoven at the time the survey was conducted.

4.4.2 Results of SEM

The conceptual model shown in Figure 4.1 defines the structure of the SEM model to be estimated. On the level of socio-demographic variables, the model does not specify which variables are significant. As it turns out, the socio-demographic variables tested (gender, age, education level, income level) do not have significant relationships with the perceived usefulness of functions (for information collection and auxiliary functions) of the platform. The only person variable that turns out to be significant is the visit history. In order to arrive at a final model specification of the SEM, the socio-demographic variables (gender, age, education level, income level, after dummy coding) which did not have any significant relationships were removed from the model. Figure 4.2 shows the final model specification (as well as the estimation results).

Several goodness-of-fit tests are used to test whether the model fits the data satisfactorily. Table 4.6 shows several measures of model fit. Rules of thumb indicate that a model provides a good fit of the data if the value of Chi-Square divided by the degrees of freedom is close to 1 or at least smaller than 5 (Golob, 2003). In this case, this indicator has a value of 4.144, which indicates an acceptable model fit. An alternative criterion for goodness-of-fit is the root mean square error of approximation (RMSEA). An RMSEA value smaller than 0.05 indicates a good fit and a value smaller than 0.1 a reasonable model fit (Bollen and Long, 1993). Also according to this criterion, this model has a reasonable fit (RMSEA has a value of 0.1). Finally, the goodness of fit index (GFI) is a relevant indicator of goodness-of-fit. The value of GFI should be at least 0.8 (Golob, 2003). Thus, with a value of 0.781, the model, also according to this criterion, shows an acceptable fit. To conclude, therefore, consistently across all relevant criteria, the model structure fits the data.

Table 4.6 Goodness-of-fit of the model

Degrees of freedom	205
Full information Maximum-Likelihood Chi-square	849.445
Chi-square/degrees of freedom	4.144
Root mean square error of approximation (RMSEA)	0.102
Goodness of fit index (GFI)	0.781
90% Confidence internal for RMSEA	0.095; 0.109

Table 4.7 shows the results on the level of the measurement model of the SEM, indicating for each latent variable the relationships with the indicators (items) used to measure the variable. The table shows the

factor loadings for each latent variable as well as the Composite Reliability (CR) and Average Variance Extracted (AVE). The CR represents the internal consistency of the items (Netemeyer et al., 2003). It is a measure of the shared variance among the variables used to measure the latent construct (Fornell and Larcker, 1981). A high CR indicates that the items can be used to measure the same latent construct. AVE is used to measure the amount of variance that is captured by a latent construct in relation to the amount of variance caused by measurement error (Fornell and Larcker, 1981). Aa a rule of thumb, if the CR value is greater than 0.6 and the AVE value is greater than 0.5, the measurement model is satisfactory (Fornell and Larcker, 1981).

As can be seen in Table 4.7, all the CR values are well above this recommended value, which indicates a good internal consistency. The AVE value for the "Usefulness of the auxiliary functions of the multi-media platform", however, is somewhat low. Hence, we should keep in mind the measurement error for of this construct when interpreting the results.

Table 4.7 Factor loadings for latent variables

Variables	Usefulness of the multi-media platform to collect information	Experience of cultural heritage	Usefulness of the auxiliary functions of the multi-media platform
This multi-media platform has helped me to gain information about tangible cultural heritage information at Strijp-S	0.80		
This multi-media platform has helped me to gain information about intangible cultural heritage information at Strijp-S	0.87		
This multi-media platform has helped me to gain information about interesting cultural heritage information at Strijp-S	0.86		
I'm interested in buildings at Strijp-S		0.69	
I'm interested in public space at Strijp-S		0.68	
I'm interested in landscape at Strijp-S		0.67	
I'm interested in persons who are related to Strijp-S		0.58	
I'm interested in historical and current events of Strijp-S		0.61	
I'm interested in local lifestyle related to Strijp-S		0.56	
I would like to visit specific buildings at Strijp-S		0.90	
I would like to visit Strijp-S district when I have an opportunity		0.93	
I care about cultural heritage buildings or places at Strijp-S		0.83	
I would like to live in one of the cultural heritage buildings at Strijp-S		0.56	

Table 4.7 Continued

Variables	Usefulness of the multi-media platform to collect information	Experience of cultural heritage	Usefulness of the auxiliary functions of the multi-media platform
I am interested in cultural heritage redevelopment of Strijp-S		0.84	
I would like to join discussions about the future cultural heritage redevelopment of Strijp-S		0.59	
I would like to join at least one of the events at Strijp-S		0.74	
I will recommend others to visit Strijp-S because of its cultural heritage		0.88	
The timeline has helped me to compare the changes of physical architectures between the past and the current			0.71
I would like to upload my own experience related to Strijp-S to the Multi Media Platform			0.52
Reading other's experience on their visitations has helped me to increase my understanding of Strijp-S			0.74
Composite reliability (CR)	0.880	0.938	0.698
Average Variance Extracted (AVE)	0.711	0.531	0.441

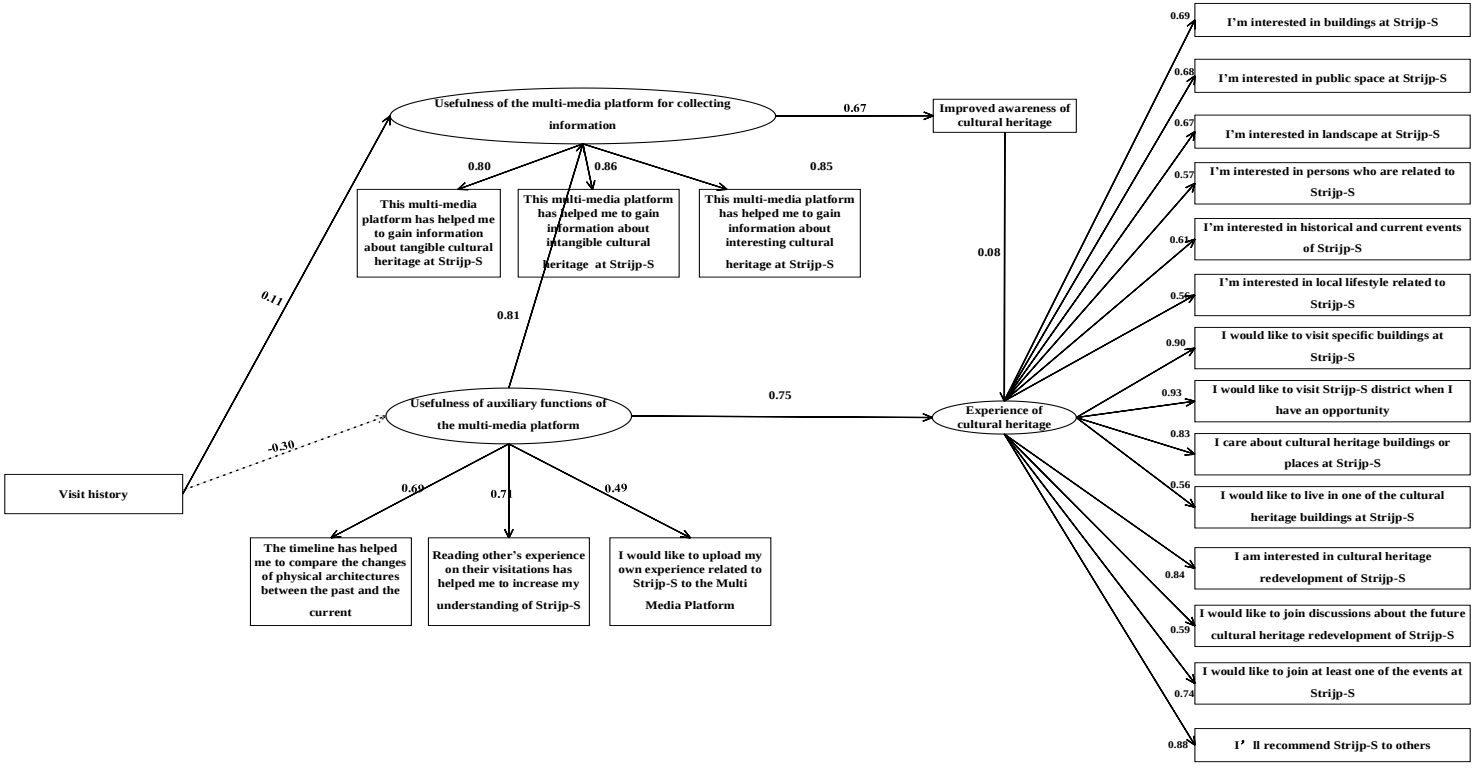

Figure 4.2 Final SEM model (positive relationships are shown with a solid arrow and negative relations with a dashed arrow) (the latent variables are shown in ovals and the observed variables in rectangles).

Table 4.8 represents the estimates of the standardized path coefficients of the model, which are also represented graphically in Figure 4.2.

The results indicate that a positive relationship exists between the perceived usefulness of the multi-media platform for collecting information and the improvement in the awareness of the heritage (Strijp-S). This supports hypothesis H1 and is in line with the existing findings that obtaining information about a site can increase awareness (Polat 2018). However, we do not find support for the hypothesis that socio-demographics (age, gender, education, income) have a significant influence on perceived usefulness of the functions of the platform whether this concerns the information function or auxiliary functions of the platform. The only personal variable of the ones that were tested in this chapter turns out to be the visit history. The results indicate that people who have visited Strijp-S before perceive the multi-media platform to collect information about the site as more useful but the auxiliary functions as less useful compared to people who have not visited the site before. A possible explanation is that when one has more prior knowledge about the site (visited before) one has a clearer idea of what information to search for so that auxiliary functions become less important and the information function more important.

The perceived usefulness of auxiliary functions of the platform has a positive relationship with the perceived usefulness of the platform for information collection and with the experience of cultural heritage. Thus, both hypotheses H3a and H3b are accepted. This indicates that, on the one hand, the auxiliary functions support information collection and on top of that enhance the experience. This is in line with expectations. The timeline can help to organize

history information of heritage and help to compare the past and the present. Uploading users' own experiences possibly can enrich the platform's database, which can help other users acquire more information and also directly influence (positively) their experience.

Improved awareness of cultural heritage shows a positive relationship with the experience of cultural heritage. Thus, hypothesis H4 is accepted: an increase of awareness is associated with an increase of positive experience of the cultural heritage.

Table 4.8 Estimaton results of the final SEM model — standardized coefficients (p-value between brackets)

To	Usefulness of the multi-media platform to collect information		Usefulness of auxiliary functions of multi-media platform		Improved awareness of cultural heritage		Experience of cultural heritage	
From	Direct	Total	Direct	Total	Direct	Total	Direct	Total
Visit history	0.11 (0.05)	0.11	-0.30(< 0.001)	-0.30				
Usefulness of auxiliary functions of multi-media platform	0.81(<0.001)	0.81				1.48	0.75(< 0.001)	0.75
Usefulness of the multi-media platform to collect information					0.67(<0.001)	0.67		0.75
Improved awareness of cultural heritage							0.08(< 0.001)	0.08
R2	0.62		0.09		0.45		0.63	

4.4.3 Preferences for media types for information collection

Table 4.9 represents average preference scores assigned to media types for collecting information on tangible (landscape, public space and landscape) and intangible aspects (events, persons and local lifestyle) of Strijp-S heritage. Because the number of relevant media types differs between tangible and intangible aspects, the scale of the ranking scores differs between these two categories. The tangible items involve six media (scores range from 1 to 6) and the intangible items involve three media (scores range from 1 to 3). In both cases, the original rank scores are transformed to preference scores by reversing the rank scores, such that the higher the rank the higher the score. Hence, the maximum score for tangible items equals 6 (high preference) and the maximum score for intangible items is equal to 3. The p-value shown in the last column of Table 4.9 is related to an ANOVA test of difference in means between groups (media types).

The results show that map is the most popular media type for acquiring tangible cultural heritage information. The 3D model and panorama VR also have a relatively high score, which means that users prefer to use them approximately to the same degree as map to access tangible cultural heritage information. Interestingly, photo is also among the most preferred media types for acquiring tangible information. These results align with the findings reported in chapter 2. Text has the lowest score in both the tangible and intangible category. Also this finding is in line with the findings in chapter 2. For intangible information, the appreciation of video stands out.

Table 4.9 Mean preference rank score for each media type for collecting information about cultural heritage (std. deviation shown in brackets)

	Map	3D models	Panorama VR	Text	Photo	Video	p-value
Specific building	4.517 (1.715)	3.368 (1.754)	3.185 (1.524)	2.874 (1.561)	4.126 (1.413)	2.934 (1.592)	< 0.001
Public space	4.527 (1.668)	3.818 (1.805)	3.169 (1.528)	2.722 (1.497)	4.023 (1.399)	2.745 (1.504)	< 0.001
Landscape	4.583 (1.626)	3.732 (1.751)	3.003 (1.506)	2.702 (1.475)	4.172 (1.420)	2.808 (1.528)	< 0.001
Significant person				1.632 (0.765)	1.917 (0.659)	2.450 (0.8)	< 0.001
Significant events				1.629 (0.765)	1.884 (0.649)	2.487 (0.781)	< 0.001
Local lifestyle				1.818 (0.798)	1.861 (0.734)	2.321 (0.831)	< 0.001

4.5. Discussion of results

An interesting finding of this chapter is that the perceived usefulness of functions of the platform differs between users depending on the visit history. People who have less prior knowledge (not visited Strijp-S before) find the auxiliary functions of the platform more important, possibly because these functions are more useful for exploring cultural heritage when it is new for them. However, people who have more prior knowledge (visited Strijp-S before) assign a more positive value to the information collection function of the platform, possibly because they already have a basic understanding of the site, and know better what information exactly they want to retrieve using the platform. Experience is affected through two paths, namely via information collection and awareness and directly through auxiliary functions of the platform. Thus, the findings indicate that the platform can enhance experience but in different ways depending on the prior knowledge of the user. For users who have more prior knowledge (visited the site before) the platform can enhance the experience primarily through the information collection function it offers, and for users with less prior knowledge (have not visited the site before) predominantly through the auxiliary functions. We conclude therefore that these two types of functions are complementary and together could serve the needs of a wide range of users regarding the level of prior knowledge of a heritage site.

As for the perceived usefulness of media types for acquiring information there are clear differences between tangible and non-tangible information. For tangible information users prefer 2D maps and photo, whereas for intangible information video is the most preferred mode. In all instances, text is the least appealing mode. These results are useful especially for policymakers and heritage institutions to obtain a better understanding of what functions a

platform should offer and which media types should be used to support the functions.

The results confirm that the functions of a dedicated platform such as the one investigated in the present study can help users collect information about cultural heritage. The positive relationship between the perceived usefulness of the information collection function and awareness suggests that the platforms can increase awareness of heritage by means of this function. This is in line with existing literature (Bagozzi, 2006; Shiota et al., 2006) and acknowledged in some early systems, such as AVANTI (Fink et al., 1998), ILEX (Oberlander et al., 1998) and AIFresco (Stock, 1993). The positive relationships (direct and indirect) between perceived usefulness of the platform functions and experience also suggest that citizens would like to use the functionalities of the platform to increase their experience of cultural heritage. For enhancing experience auxiliary functions support the information collection function and in addition have the ability to increase experience directly.

The results also provide evidence for the existence of a positive relationship between awareness and experience of cultural heritage. In this study, the experience of cultural heritage indicated user's behavioral intentions towards Strijp-S cultural heritage site since experience was measured as the interest raised and positive attitude to interact with the area on-site. According to Mascolo and Fischer (1995), awareness mediates the relationship between tourists' emotional experiences and behavioural intentions. Moreover, a positive experience can also enrich and strengthen awareness, and creates an attention to the future of the heritage (Fredrickson, 2013; Junot et al., 2017).

In contrast to earlier findings, this study does not provide evidence for the importance of socio-demographic characteristics for explaining the relationship between awareness of cultural heritage and perceived usefulness of a multi media platform. However, the visit history does affect the perceived usefulness of different functions offered by a multi-media platform and, with that, the relationship between awareness and experience. When auxiliary functions are provided, a multi-media platform, such as the one used in the present study, can have added value for acquiring the information of interest irrespective the level of prior knowledge of the user.

4.6. Conclusion

Empirical research on the relationships between awareness and experience of cultural heritage and functionality offered in a multi-media platform is still limited. Therefore, the main aim of the present study was to analyze the perceived usefulness of functions a multi-media platform offer and the impacts such a system can have on awareness and experience of cultural heritage. As a case, we considered the cultural heritage Strijp-S and a new multi-media platform developed for the research purpose. Data was collected through an online questionnaire involving a national sample of potential visitors of cultural heritage and analyzed using structural equation modeling.

This chapter contributes to existing studies by analyzing expected relationships between person variables, perceived usefulness of functions of the platform, awareness of cultural heritage and experience. It was found that perceived usefulness of particular functions depends on visit history of the user and that preferences for particular media types depend on the tangible or non-tangible nature of the information.

The study also has several limitations that need mentioning. First, the Strijp-S heritage that was used as a case may have specific characteristics, so that the findings cannot be readily generalized to other cases. It is therefore important to replicate this study considering other heritage cases to develop further evidence. Second, also some shortcomings of the specific multi- media platform used should be acknowledged. The system is a prototype and the speed and ease of using the functionality could be improved. Furthermore, the platform can't display well on a smartphone. Therefore, the respondents who used their smartphone to view the platform gave negative comments, which may also have an influence on the results. Therefore, further developing the application of the system and replicating the study is an important objective for future work. Moreover, we tested the developed multi-media platform only with potential users. Another future work would be to test the usefulness of the system functionalities to increase knowledge, awareness and experience, with on-site visitors. This can be done by providing the multi-media platform to visitors of Strijp-S before their visits and comparing their knowledge, interest and awareness of cultural heritage before and after their visit to Strijp-S.

Overall, this chapter provides new insights into how a multi-media platform such as the system used in this study can contribute to people's awareness and experience of cultural heritage. The findings offer important insights for governments and heritage institutions concerned with making heritage better accessible to the general public.

Chapter 5 Evaluation of the Multi Media Platform Prototype for increasing the Awareness of Cultural Heritage

This chapter is based on the paper:

Wang, B., Dane, G., Arentze, T.A., de Vries. B. Design and Test of a Multi-Media Web Platform Prototype Based on People's Preferences, to Increase Cultural Heritage Awareness. Submitted for publication.

5.1 Introduction

Some of the ICT platforms for cultural heritage use single media such as Mobile Vaani (MV) (Moitra et al., 2016), which uses single voice media to provide information on cultural heritage to the public. Moreover, some of the museums' web or mobile phone platforms devote themselves to restoring the cultural heritage objects by using 3D models, such as the Cenobium system (Shehade, 2021). Although this type of single-media ICT platform can support the users to focus on the cultural heritage content without much effort, it can not support visitors to understand all characteristics of a cultural heritage comprehensively. To gather more information, users need to find other platforms to access more media (Ott and Pozzi, 2011). Moreover, providers of such ICT platforms choose the single or multiple media based on intuition, without taking into account potential users' preferences for the content and media types before the development phase, resulting in unattractive and unsustainable platforms, as argued in Chapter 2 of this thesis. For example, the creaters of "Cultural Gate" discussed what information and functions their platform should offer before designing the system (Koukopoulos et al., 2017). All the team members were cultural heritage experts, and they decided on the

cultural heritage contents and functions of the platform based on assumptions rather than based on information about users' preferences to make the final decision. This was a professional platform that can benefit cultural heritage experts because the platform contains broad and professional scopes; however it lacked the integration of visitors' needs into the platform (Koukopoulos et al., 2017). Lastly, the research on user-centred ICT platforms shows that interactive platforms (Roose et al., 2021) that allow users to enrich their experiences and stories, create more sense of ownership of both the platform and the content. However, existing ICT platforms for cultural heritage do not support the kind of interaction whereby users can share their stories or experiences of the cultural heritage with other users (Rivero Moreno, 2020).

Due to the reasons described above, dedicated ICT platforms for cultural heritage accommodate increasingly more multi-media information and additional functionalities in order to provide their users with engaging in and enriching experience of cultural heritage sites, before and during their visits. However, hitherto, there is limited research on whether the dedicated multi-media ICT platforms of cultural heritage areas are needed and sufficient in order to significantly increase users' knowledge and awareness of cultural heritage compared to existing available tools such as internet search engines. Moreover, the testing of existing dedicated multi-media ICT platforms is performed with only a small group of users or are not tested at all (Longueville, 2010; Selmanović et al., 2020). Therefore, it is difficult to establish their efficacy in fulfilling their purposes (i.e. increasing awareness, increasing knowledge and interest).

In order to test whether there is a need for dedicated multi-media platforms and whether they significantly increase the awareness, knowledge and interest of its users, we conducted a survey with a sample of 450 respondents. As explained in Chapter 4, this survey utilized a multi-media platform prototype developed for Strijp-S, an industrial Philips factory campus (in Eindhoven, the Netherlands). The multi-media platform prototype was described in Chapter 3 and is based on the results of preference measurements covered in Chapter 2. The survey included a control group that used the Google search engine and the experimental group that used the platform prototype system. Both groups were asked to gather information on cultural heritage of the Strijp-S area and they were given at least 10 minutes for that process. Via a questionnaire, their knowledge and interest on the cultural heritage of Strijp-S before and after their use of the platform (either the prototype of this study or Google search engine) and how much the used platform contributed to their awareness and knowledge of cultural heritage of Strijp-S were measured. By analysing the contributions of the multi-media platform on users knowledge and interests, the results of the study described in this chapter aims to give insights for the development of dedicated multi-media platforms for cultural heritage sites.

The remainder of this chapter is organized as follows. Section 5.2 describes the sample including both the experimental and control group. Section 5.3 presents the results of the platform testing. Finally, the conclusions are discussed in section 5.4.

5.2 Survey and data collection

The survey conducted to test whether the dedicated prototype is helpful for increasing awareness and knowledge of cultural heritage in this chapter is the same as the survey used in the last chapter. During the survey, respondents were assigned to either the Multi Media Platform prototype or to Google search engine. Respondents were allocated randomly to each one of the two groups. To be able to analyse the Multi Media Platform's effectiveness in more detail, the Platform group was oversampled. A total of 302 respondents used the Multi Media Platform and 148 respondents used the Google search engine. For the testing purpose of the present study, the data of both groups are used in this present chapter.

The questionnaire consisted of four parts. The first part included questions regarding respondents' personal characteristics (gender, age, education level, income level), whether they have visited Strijp-S before and whether they live in Eindhoven. In the second part, the participants were asked about their current knowledge of and interests in Strijp-S (i.e., whether they know about significant people and events from the past, which heritage buildings they know), including their awareness of tangible and intangible cultural heritage. Then, they were asked to use the tool (Multi Media Platform or Google) to search for what heritage related content of Strijp-S they would like to know. After having completed this, they were asked to answer the same questions as in the second part regarding their knowledge of and interests in Strijp-S. This was followed by questions regarding whether the used platform (either multi medi platform or Google) increased their interest, knowledge and awareness of Strijp-S. All the questions employed a 5 point Likert-scale ranging from strongly disagree to strongly agree (from 1 to 5) with a statement presented.

At the end of the survey, respondents were given the chance to comment on the survey and the Multi Media Platform prototype (if they used it).

5.3. Results

5.3.1 Sample characteristics

The distributions of respondents on relevant socio-demographic variables within the two groups are shown in Table 5.1. A Chi-square test is conducted to test whether there is a significant difference in distribution between the Multi Media Platform group and Google group for each variable. As Table 5.1 shows, for none of the tested socio-demographic variables the difference between the two groups is statistically significant (using a significance level of 5%). This means that the two groups do not show any significant differences and therefore they are comparable.

To test whether the prototype was useful for increasing awareness of cultural heritage, a paired-samples t-test was used to analyze the statistical significance of difference before and after using it. Moreover, to test whether the dedicated prototype had a higher effectiveness in improving awareness of cultural heritage than a general purpose search engine (in this case, Google) an independent samples t-test was used to test whether a significant difference exists between the group that used Google and the group that used the Multi Media Platform.

An inspection of the boxplot of each variable used in the independent t-test and paired samples t-test, indicated that there were no outliers. Since the

sample was sufficiently large in each group, we may furthermore assume that the sampling distributions of the variables approximate a normal distribution. Equal variances between the groups may be assumed in none of the tests, as indicated by Levene's Test for Equality of Variances. Therefore, separate variances and the Welch-Satterthwaite corrections were used.

Table 5.1 Sample characteristics of the two groups

Socio-demographics		Frequency MMP group (%)	Frequency Google group	p-value in a Chi-square test
Gender	Male	151 (50.0%)	73 (49.3%)	0.893
	Female	151 (50.0%)	75 (50.7%)	
Age	Young people (below 34)	73 (24.2%)	45 (30.4%)	0.061
	Middle age (34-49)	77 (25.5%)	46 (31.1%)	
	Elder (50+)	152 (50.3%)	57 (38.5%)	
Education level	Low education	37 (12.3%)	18 (12.7%)	0.087
	Middle education	129 (42.7%)	48 (32.4%)	
	High education	136 (45.0%)	82 (54.9%)	
Income	Low income	56 (18.5%)	27 (18.2%)	0.670
	Middle income	129 (42.7%)	69 (46.6%)	
	High income	87 (28.8%)	35 (23.6%)	
	Not willing to say	30 (10.0%)	17 (11.6%)	

Table 5.1 Continued

Socio-demographics		Frequency MMP group (%)	Frequency Google group	p-value in a Chi-square test
Have you visited Strijp-S before?	Yes	71 (23.5%)	44 (29.7%)	0.155
	No	231 (76.5%)	104 (70.3%)	
Do you live in Eindhoven now?	Yes	13 (4.3%)	7 (4.7%)	0.837
	No	289 (95.7%)	141 (95.3%)	

5.3.2 Results of t-tests

Table 5.2 shows the results of the paired samples t-test. The results show that there is a statistically significant difference in respondents' awareness before and after using the dedicated prototype for each statement, except "I care about cultural heritage buildings or public places at Strijp-S". This might be because there are only points of interests (POIs) on the map as the entrance to the detailed information, these POIs can't attract respondents directly, they need to click on the POIs to access more information. Comparing the mean scores of each statement, respondents' knowledge of and interest in Strijp-S did improve after using the Multi Media Platform prototype.

Table 5.3 shows the results of the independent samples t-test. The results indicate that most of the variables show a statistically significant difference in respondents' awareness between using the dedicated prototype and Google. Especially, "The platform has increased my awareness of cultural heritage of

Strijp-S" represents a large difference in the effectiveness of improving awareness of cultural heritage between these two platforms. Comparing the mean scores of the two groups, the Multi Media Platform prototype group has a higher mean score than the Google group on all items.

Table 5.2 Results of paired-samples t-tests of difference before and after using Multi Media Platform (N=302)

Statements	p-value	Group	Mean
I would like to visit specific buildings at Strijp-S	0.002	Before	2.960
		After	3.109
I would like to visit Strijp-S district when I have an opportunity	0.016	Before	3.096
		After	3.199
I care about cultural heritage buildings or public places at Strijp-S	0.688	Before	3.113
		After	3.133
I'm interested in buildings at Strijp-S	0.010	Before	3.083
		After	3.262
I'm interested in public space at Strijp-S	< 0.001	Before	2.772
		After	3.149
I'm interested in landscape at Strijp-S	< 0.001	Before	2.914
		After	3.156
I'm interested in persons who are related to Strijp-S	< 0.001	Before	2.589
		After	2.947
I'm interested in historical and current events of Strijp-S	< 0.001	Before	2.861
		After	3.109
I'm interested in local lifestyle related to Strijp-S	0.001	Before	2.566
		After	2.821
I would like to live in one of the cultural heritage buildings at Strijp-S	< 0.001	Before	1.894
		After	2.209
I am interested in cultural heritage redevelopment of Strijp-S	< 0.001	Before	2.768
		After	2.990
I would like to join discussions about the future cultural heritage redevelopment of Strijp-S	< 0.001	Before	1.911
		After	2.109
I would like to join at least one of the events at Strijp-S	0.022	Before	2.719
		After	2.821

Table 5.3 Results of independent samples t-tests of difference between the Google (N = 148) and Multi Media Platform group (N=302)

Statements	p-value	Group	Mean
The platform can help to gain tangible cultural heritage information	<0.001	Google	2.345
		Multi Media Platform	3.583
The platform can help to gain intangible cultural heritage information	<0.001	Google	2.500
		Multi Media Platform	3.500
The platform can help to gain interested cultural heritage information	<0.001	Google	2.3445
		Multi Media Platform	3.619
I would like to visit specific buildings at Strijp-S	0.096	Google	2.926
		Multi Media Platform	3.109
I would like to visit Strijp-S district when I have an opportunity	0.007	Google	2.905
		Multi Media Platform	3.199
I care about cultural heritage buildings or places at Strijp-S	0.008	Google	2.939
		Multi Media Platform	3.133
I'm interested in buildings at Strijp-S	< 0.001	Google	2.635
		Multi Media Platform	3.262
I'm interested in public space at Strijp-S	0.05	Google	2.899
		Multi Media Platform	3.149
I'm interested in landscape at Strijp-S	0.254	Google	3.014
		Multi Media Platform	3.156
I'm interested in persons who are related to Strijp-S	0.001	Google	2.947
		Multi Media Platform	3.358
I'm interested in historical and current events of Strijp-S	0.698	Google	3.109
		Multi Media Platform	3.162

Table 5.3 Continued

Statements	p-value	Group	Mean
I'm interested in local lifestyle related to Strijp-S	< 0.001	Google	2.821
		Multi Media Platform	3.399
I would like to live in one of the cultural heritage buildings at Strijp-S	<0.001	Google	2.209
		Multi Media Platform	3.777
I am interested in cultural heritage redevelopment of Strijp-S	0.474	Google	2.990
		Multi Media Platform	3.068
I would like to join discussions about the future cultural heritage redevelopment of Strijp-S	<0.001	Google	2.109
		Multi Media Platform	3.926
I would like to join at least one of the events at Strijp-S	0.05	Google	2.821
		Multi Media Platform	3.061
The Platform has increased my awareness of cultural heritage of Strijp-S	<0.001	Google	2.250
		Multi Media Platform	3.672

In addition, the survey also included questions related to the respondent's knowledge about Strijp-S. The respondents were asked which items (architectures/famous persons/historical and current events) related to Strijp-S they know before and after using the system (Multi Media Platform or Google). Using the Paired-samples t-test, we test whether there is a significant difference in number of items known before and after using each platform. The results are shown in Table 5.4 and Table 5.5 for the Multi Media Platform and the Google group respectively. In Table 5.4, the results indicate that the Multi Media Platform allows users to acquire both tangible and intangible cultural heritage information of Strijp-S since they know more about architectures, persons and events after using it. The same holds for the Google

group (Table 5.5). Therefore, we can conclude that both tools helped respondents to increase their knowledge about Strijp-S.

Next, we used an independent samples t-test, to test whether the increase in the number of items known differ between the Multi Media Platform and the google groups. The results are shown in Table 5.6. As the results show the average increase in knowledge is larger in the Multi-Media Platform group compared to the Google group for two of the three items. This result indicates that the dedicated Multi Media Platform prototype is more helpful than Google for providing information. However, the increase in knowledge about significant persons on average is higher in the Google group than the Multi Media Platform. This may be because the Multi Media Platorm includes less information about significant persons of Strijp-S than one can found on the internet when Google is used. Compared to Google, the Multi Media Platform prototype only provides the core part of the person information.

Table 5.4 Results of paired samples t-tests of difference in number of tangible and intangible heritage items known to respondents before and after using Multi Media Platform (N=302)

Questions	Group	Mean score	P-value of t-test
The number of architectural buildings/public-space/heritage- landscape at Strijp-S known to respondents	Before	1.864	<0.001
	After	2.905	
The number of historical persons who had a significant influence related to Strijp-S known to respondents	Before	1.291	<0.001
	After	1.371	
The number of events that are significant for the history of Strijp-S known to respondents	Before	1.581	<0.001
	After	2.432	

Table 5.5 Results of paired samples t-tests of difference in number tangible and intangible heritage items known to respondents before and after using Google search engine (N=148)

Questions	Group	Mean score	P-value of t-test
The number of architectural buildings/public-space/heritage- landscape at Strijp-S known to respondents	Before	1.600	<0.001
	After	2.338	
The number of historical persons who had a significant influence related to Strijp-S known to respondents	Before	1.304	<0.001
	After	1.517	
The number of events that are significant for the history of Strijp-S known to respondents	Before	1.937	<0.001
	After	2.268	

Table 5.6 Results of independent samples t-tests of difference in increase of number of tangible and intangible heritage items known to respondents between Multi Media Platform and Google group

Questions	Group	Average difference	P-value of t-test
The number of architectural buildings/public-space/heritage-landscape at Strijp-S known to respondents	Multi Media Platform	1.041	0.018
	Google	0.738	
The number of historical persons who had a significant influence related to Strijp-S known to respondents	Multi Media Platform	0.08	<0.001
	Google	0.213	
The number of events that are significant for the history of Strijp-S known to respondents	Multi Media Platform	0.851	<0.001
	Google	0.331	

5.3.3 Comments on the Multi Media Platform prototype

The questionnaire also asked responds whether they had any comments about the Multi Media Platform prototype. These answers are informative for understanding any complementary factors that may have an influence on perceived usefulness of the Multi Media Platform prototype to increase awareness of cultural heritage. Most of the comments were positive, which further supports the idea that the dedicated prototype was useful for increasing awareness of cultural heritage of Strijp-S. Some example comments were: “I found it is very interesting that with a few clicks you can search and read the history of Strijp-S” , “A lot of details, you know what to expect, you can choose what you want to visit”, “The platform is very clear and complete as far as I can say”, “It is very interesting to find out more about this place! Before I had a rough idea of what it was about, now I feel my visit will make more sense”, “It makes me inquisitive, I want to see this. It is a wonderful place to be there. When I saw the pictures, I think that when I have the time, I’ll go there”, and “I think someone who is interested in architecture can get off well with this site, especially in this Corona time you can still see everything up close even though you are physically not there.”

However, some users presented disadvantages about the functions and layout of the Multi Media Platform. Examples of comments are: “3D would’t load”, “The only thing I could see were maps of Eindhoven, very boring”, “The platform is not usable on mobile”, “The layout of the information about a specific building/public space could be better organised”, “I couldn’t use the platform at all. At first I saw a map with options to click on. So I clicked on it and got to see text, but not the whole text. I could click on a photo, so I clicked. But then I couldn't go back to the previous page. So, it’s not a usable platform”, and “I’m sorry but the experience on mobile device is horrible. I was not able

to see or read anything". Another comment was that "Multi Media platform can be more interactive. Texts support the information flow, but on some area's the information flow is a huge bundle of text".

Overall, users were satisfied with having access to a multimedia platform that was designed considering potential users' needs and requirements, and the content that was presented to them. However, these responses illustrate that the platform prototype used could still be improved in terms of its functionalities and interactivity.

5.4. Conclusion

This chapter considered a dedicated Multi Media Platform prototype created to test general assumptions about the value of multimedia platforms to increase people's awareness of cultural heritage by providing them information and knowledge through different media types. To test whether the Multi Media Platform is useful and whether it is more effective than a general-purpose search engine, a survey was conducted. The survey involved a comparison between the Multi Media Platform and Google through an experimental set-up. The results indicated that the use of the dedicated Multi Media Platform prototype increased the respondents' awareness of the cultural heritage of Strijp-S more than the Google search engine did for most items. Specifically, users knew more about tangible and intangible information after using the Multi Media Platform prototype, such as the historical events and architecture story. However, compared to Google engine, the Multi Media Platform offered less information about the significant historical persons. This reflects the fact that the bibliography is only a summary and simple compared to what can be found on the internet with Google. The fact that the Google

group on average learned more about the persons, indicates that users would like to search for more information about significant persons than the platform could provide, at least in this Strijp-S case. Comments provided by users about the Multi Media Platform prototype supported the overall idea that a multi-media platform as developed can help users to explore and gain information about Strijp-S and trigger their interest to visit it on-site. However, the comments also indicated that still improvement of its functionality and interactivity is needed.

Chapter 6 Conclusions and future work

6.1 Introduction

Cultural heritage, both tangible and intangible, can only be sustainable when society recognizes, understands, and accepts its significance and the necessity for its continuity. Therefore, the first step to cultural heritage sustainability is to create an awareness of it by making it understandable and accessible to society. In recent years, with the developments in technology, dedicated ICT platforms such as web-platforms and mobile phone apps, are being developed for increasing their users' awareness of cultural heritage while offering them engaging and enriched experiences of cultural heritage sites, before and during their visits. For that purpose, such dedicated ICT platforms for cultural heritage provide more and more multi-media information and additional functionalities.

This thesis addresses two shortcomings of the current literature and practice with respect to this subject: (i) Existing ICT platforms for cultural heritage are usually developed without explicitly considering potential users' preferences on content, media types and functionalities offered, (ii) It is not thoroughly researched to what extent the dedicated ICT platforms developed for cultural heritage sites fulfill their intended purposes (increasing knowledge, awareness and experience). To fill these above-mentioned research gaps, the objective of this thesis is to design and test a dedicated multi-media web platform prototype and analyze the effectiveness of such a platform to enhance experiences and increase the public's awareness of cultural heritage.

The research process for tackling the main objective has been formulated in four sub-objectives which were answered in each chapter, starting with (i) understanding (potential) users' preferences regarding content, media types and functionalities provided by a dedicated web-based multi-media platform for cultural heritage (Chapter 2), (ii) designing a web-based multi-media platform for a cultural heritage site adapted to users' preferences (Chapter 3), (iii) understanding empirically the relationships between the functionalities offered by a well-designed web-based multi-media platform, the increase of users' experience and awareness of cultural heritage and the personal characteristics of users (Chapter 4), and (iv) analyzing and testing empirically the effectiveness of the developed web-based multi-media platform in terms of the increase of users' experience and awareness of cultural heritage.

6.2. Main Conclusions

In this section, conclusions will be presented for each sub-objective of this research.

6.2.1 Conclusions on Sub-Objective 1 (Chapter 2)

The existing literature and practice on cultural heritage sustainability and the dedicated ICT platforms for increasing awareness of cultural heritage clearly show that dedicated ICT platforms are usually short-lived. One of the main reasons is that the preferences of potential users on cultural heritage content, media types and functionalities are not taken into account in the design phase of these ICT platforms. In Chapter 2, a stated choice experiment was conducted in order to measure users' preferences regarding content, media types and functionalities offered by a web-based multi-media platform. The stated choice experiment was administered through an online survey and

completed by 630 respondents. The choice data obtained were analyzed using a mixed logit model.

It was found that people are interested in both tangible and intangible cultural heritage. People preferred to view 2D maps supported with images as the entrance to the platform, specifically for obtaining information on tangible heritage such as buildings and public spaces. It is mainly because tangible heritage is space bounded. For obtaining information on heritage landscapes, 3D model and images were preferred. Furthermore, people preferred to use multiple media types to acquire information, especially, vivid media, such as 3D models and videos.

Looking at the intangible heritage content such as significant events, persons, architectural styles and community lifetsyles, only text was the least preferred type of media for obtaining information. People preferred as much as possible media types altogether for acquiring information about significant events, persons, architecture style and community lifestyle. In addition to the cultural heritage content and preferred media type, this chapter also investigated possible auxiliary functions that a dedicated ICT platform might have. It was found that people preferred to make use of a "timeline" function that can show the continuum of tangible heritage, and an "upload/share experiences" function that can enable them to upload their own experiences with the heritage site in order to share with other users and also access to the experiences of others. The results also showed some heterogeneity with respect to the preference for the "upload/share experience" function, meaning that the taste for this function varies significantly across people.

The results showed that users, on average, have certain specific requirements for the heritage content and associated media type for obtaining information. However, it was also clear that there is heterogeneity in the preferences of people for media types and functions. The results of this chapter laid the foundations for Chapter 3 where the design of a web-based multi-media platform that was developed for this research, was explained.

6.2.2 Conclusions on Sub-Objective 2 (Chapter 3)

Chapter 3 described the design and development of a new web-based multi-media platform prototype based on the preference measurement results described in Chapter 2. Strijp-S neighborhood and the former industrial park of electronics company Philips in Eindhoven, the Netherlands was selected as a case area due to its industrial heritage value.

The technical design was specified using Unified Modeling Language (UML). It included both tangible and intangible cultural heritage content. The new platform used the map as the entrance to all the information via tangible heritage (buildings, public spaces and landscape). The tangible heritage is represented as POIs on the map and users can select one that interests them. The historical content and intangible heritage associated with these POIs appear when a POI is clicked. The information related to each tangible heritage (POIs) is represented by multi-media (text, photo, video, 3D model and panorama VR). The associated historical contents of intangible heritage are represented by text, photo and video.

All information is stored in a MySQL database and displayed using multiple media types. The platform is functional and published on a web server and can be used by anyone with the link. The prototype system was later used for testing the usefulness and effectiveness of the different functionalities and analyzing the impacts on experiences and awareness of cultural heritage in Chapter 4 and Chapter 5.

6.2.3 Conclusions on Sub-Objective 3 (Chapter 4)

Chapter 4 aimed to obtain empirical insights on the relationships between the perceived usefulness of functionalities offered by the designed multi-media web platform (in Chapter 3) and the impacts of that on the increase of awareness and experience of cultural heritage, and to what extent and how this was influenced by personal characteristics of the user. In order to do that, an online survey was administered to a national sample of potential visitors of cultural heritage. The relationships were analyzed using a Structural Equation Modelling (SEM) approach based on a sample of 302 respondents using the multi-media platform to view Strijp-S. The results showed that the multi-media platform helped users to collect information and this information collection increased their awareness of cultural heritage. Moreover, it was found that both basic and auxiliary functionalities of the platform increased people's experiences of cultural heritage. The results also indicated that improved awareness increased the experience of cultural heritage. Furthermore, it was found that the perceived usefulness of particular functions depends on the visit history of the user. Finally, results provide evidence that preferences for particular media types depend on the tangible or non-tangible nature of the content that they will present.

6.2.4 Conclusions on Sub-Objective 4 (Chapter 5)

In chapter 4, the expected relationships were empirically proved indicating that a thoroughly considered and well-designed multi-media platform for a cultural heritage site increases users' awareness and experience of cultural heritage. It is also important to consider whether there is a need for a dedicated platform because the availability of the internet allows accessing a plethora of information on cultural heritage (amongst other topics) via search engines such as Google. Although the search engines are not specifically designed for cultural heritage sites, they are usually the first consideration when a person would like to search for information before they conduct a leisure or touristic visit. Therefore, Chapter 5 focused on empirically benchmarking the dedicated multi-media platform to a well-known search engine Google. For that purpose, the same dataset represented in Chapter 4 was used but in this chapter, the analysis included also the respondents from the Google test group. A total of 302 respondents used the multi-media platform and 148 respondents used the Google search engine. By using bivariate analysis, this chapter tested whether the dedicated multi-media platform was useful and whether it was more effective for learning and increasing awareness of cultural heritage compared to a general-purpose search engine Google.

The results showed that the dedicated multi-media platform increased users' awareness and helped them learn about tangible and intangible cultural heritage more than Google. However, Google engine users learned more about significant historical persons compared to the users of multi-media platform. It might be because Google offered more information about significant historical persons compared to a short bibliography on the multi-media platform.

6.3. Reflections

This section reflects on the main scientific and societal contributions of the research and also describes the limitations of the current study and gives some potential perspectives for further research.

This research overcomes two main problems that were mentioned in chapter 1. First, it fully considers users preferences related to the content of cultural heritage and the media types that people prefer to use. Therefore, it can help users to have a better experience in acquiring information of cultural heritage, and increase their awareness of it. Second, an experiment was conducted to compare the dedicated multi media platform with a general purpose search engine, Google. The results indicated that the dedicated multi media platform, which considers users' preferences is more effective compared to this benchmark.

6.3.1 Main Scientific and Societal Contributions

This research has addressed the main research question by developing a multi-media web platform that fulfills its intended purposes (increasing knowledge, awareness and experience) by taking into account potential users' preferences of heritage content, media type and functionalities. To do so, this research followed the necessary steps consisting of measuring the preferences of potential users, designing a multi-media web platform, testing its effectiveness in increasing awareness and experiences, and finally benchmarking with a comprehensive internet search engine. The earlier studies on preference measurement and also on testing and benchmarking the ICT tools usually rely on small and under-representative samples. This thesis contributed to the

existing body of literature with new empirical insights based on large samples. One of these empirical insights clearly shows that there are differences in the perceived usefulness of media types between tangible and intangible heritage information. For tangible heritage, users prefer to receive the information with 3D models & photos, whereas for the intangible heritage they prefer video & text. In all instances, text alone is the least appealing mode. Overall, they prefer to have access to multi-media for information retrieval.

Another contribution to the existing literature is the finding that the experience of cultural heritage is positively affected through two paths, namely via information collection and awareness and directly through auxiliary functions of the platform, depending on the prior knowledge of the user. Meaning that, for users who have more prior knowledge of the site (visited the site before) the platform can enhance the experience primarily through the information collection function it offers, and for users with less prior knowledge of the site (have not visited the site before) predominantly through the auxiliary functions. It can be concluded that basic and auxiliary functions are complimentary to each other and can serve different user groups based on their prior knowledge of the site. Finally, although a comprehensive search engine is sufficient to increase knowledge, interest and awareness of the cultural heritage site, it can be concluded that a well-considered and designed multi-media platform (dedicated to a cultural heritage site) is more effective.

Overall, this study provides a new understanding of how a multi-media platform can contribute to people's awareness and experience of cultural heritage. The findings offer important insights and can be used as guidelines by governments, heritage institutions and destination marketing organizations

concerned with the sustainability of heritage by making it better accessible to the general public. Moreover, a multi-media platform such as developed in this study can be used as an educational tool for the cultural heritage since it proved to increase the learning of its users. A platform as such can also be considered an essential tool in the preparation and planning phases of a cultural heritage site visit. Since it enables interaction between place and (potential) visitors and residents, it can be exploited for ongoing marketing and communication strategies.

6.3.2 Limitations

During this research, several limitations and challenges were encountered. First, a potential limitation is the number of attributes that were presented in the stated choice experiment. Although based on the literature, the most important media types were covered as attributes, there is still a risk that other attributes, such as the visualization with advanced media (i.e. use of immersive VR models with Head-Mounted Displays and Augmented Reality (Petrovič et al., 2021)), could have been included. Moreover, presenting many levels per attribute in the hypothetical platform was another limitation. Because a stated choice experiment based on text relies on respondents' imagination of the hypothetical platform, that might have exhausted the respondents. The respondents could have a better survey experience if there was a simple mockup visualization presented to them. Moreover, in the Chinese sample of the first experiment, the young population was more representative which might have influenced the generalization of the results.

Another limitation was the limited available data for the database of the designed multi-media web platform. Most of the available photos and 3D

models of the Strijp-S represented the outside of the cultural heritage buildings. Moreover, the majority of the data was collected from one resource, which is the Philips Museum archive (*Philips Museum | Philips*, n.d.). The multi-media platform database can be extended by adding more content and more (visual) information about the inside of the buildings.

Regarding the user interface of the designed multi-media web platform, currently, it is available only for laptop/desktop users. The comments from the multi-media platform users demonstrate that the platform would benefit from compatibility with a smartphone. For instance, people can only accesss it before or after their trip while a smartphone app would allow them accessing the platform during their visits. Moreover, users also commented on the necessity of improvements to the layout and the viewer of 3D models. In addition, the function of "uploading own experience" allows people to upload any information to the database, which could lead to the upload of false information.

Since the designed multi-media platform is a prototype, it still has some shortcomings such as speed and ease of some functionalities and incompatibility with smart phones. This might have caused some respondents to spend a relatively long time finding information, and caused negative experiences with the platform use. This might have influenced responses to the surveys and impacted the empirical results on the relationship between functionalities of the platform and the experience and awareness of cultural heritage. Finally, the Strijp-S industrial heritage site that was used as a case may have specific characteristics, so that the findings cannot be readily generalized to other cases.

6.3.3 Recommendations for Future Work

Through the empirical analysis, it can be concluded that the designed multi-media web platform dedicated to a specific cultural heritage site (in this study Strijp-S, Eindhoven) improves the experience and awareness of cultural heritage and has more effectiveness than a comprehensive search engine such as Google. However, there are still some improvements that can be made in the future. First, the survey for user preference measurement can be improved by adding more media types in the attribute levels. In order to avoid respondents' burden and to improve their understanding, the hypothetical platform can be visualized as a mockup system. Secondly, the designed multi-media platform can be extended by using newly available media types. Moreover, the information on Strijp-S stored in the platform database was collected from available books and can be extended with more resources. Thirdly, and most importantly, further developing the system's user interface and functionalities is necessary since these have an impact on the awareness and experience of cultural heritage. A well-functioning and user-friendly platform could increase awareness and experience of cultural heritage and attract more users. This reserch did not analyze the influence of the shortcomings of the dedicated multi media platform to account for differences related to different socio-demographic groups. For example, Virtural Reality may have different influences on different groups. Fro future research, it is important to analyze how the existing shortcomings effect different respondents, and how the platform can be adapted to accommodate the differences. Moreover, the compatibility of the platform for smartphones should be operationalized. This would enable users to view the platform before, during and after their visits. In addition, the "upload own experiences" functionality needs a filtering mechanism to select the appropriate information for the public. In addition, the current version of the platform doesn't allow

users to upload their own 3D model and VR model due to data format compatibility issues. In the future, data format compatibility problems should be addressed. In this way, the database could be more enriched and provide more information to the users. Finally, this study focused on a case area Strijp-S, Eindhoven. This area might have specific characteristics that influenced the users' behavior while exploring the platform or that impacted their awareness and experience of cultural heritage. Therefore it is important to replicate this study by considering other heritage cases to develop further evidence.

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Appendix 1

Questionnaire 1

Part 1: Background of responders

1. What is your gender?

o Male

o Female

2. What is your age? _____ years old

3. What is your nationality? _____

4. What is the highest level of education you finished?

o None

o Primary school/special education

o Secondary education

o Vocational education

o Undergraduate (university bachelor level)

o University Master, PDEng, PhD

o Other, namely……

5. What is your yearly net income?

o Not more than €10,000

o €10,001 till €20,000

o €20,001 till €30,000

o €30,001 till €40,000

o More than €40,000

o I'd rather not say

6. How many people in your family? …….

7. What is your living situation?

o Single without children

o Single with child(ren) living with me

o Married/living together without child(ren) living with us

o Married/living together with child(ren) living with us

o Living with (grand)parents/family

o Living with other people (no family)

o Other, namely…….

8. How many times do you on average visit a heritage site in your city within a year as a local citizen? _____

9. What kind of heritage do you prefer to visit as a local citizen?

o Natural heritage

o Industry heritage

o Archaeology heritage

o Others

10. How many times do you on average visit a heritage site in a year as a tourist?_____

11. What kind of heritage do you prefer to visit as a tourist?

o Natural heritage

o Industry heritage

o Archaeology heritage

o Others

12. How many time have you visited an industrial heritage site over the last 3 years?

……..

Part 2 (A) New platform for increasing Cultural Heritage awareness

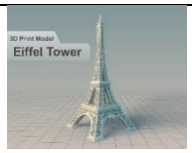
The aim of this part is to investigate how a new multimedia platform can increase the awareness of people for heritage.

In this part, you will be presented with the specifications of a new multimedia platform for increasing the awareness of people for heritage sites. The heritage sites consist of two types of contents: spatial and historical. Spatial contents are specific buildings (e.g. Eiffel tower), public spaces (e.g. Hide park) and districts (e.g. Strijp-S) while historical contents are events (e.g. end of war), persons (e.g. Mao Zedong, architecture (e.g. Rome mausoleum), institutions (e.g. Dutch East India Company) and lifestyles (e.g. Religious rituals). In order to increase awareness for heritage, it is crucial to provide information about these contents to people. Such information on spatial and historical contents can be represented in different ways and forms.

The spatial content can be represented/visualized by means of 2D maps, images, 3D city models. By using such information, people can find heritage locations, the points of interests at a heritage sites, accessibility possibilities and learn everything related to spatial information. The historical content can be represented/visualized by means of texts, photos and videos. With these media, people can find the development of a heritage, the interesting stories about this area and about the people with their lifestyles; the representative architectures and the changes from past to current.

In next pages, you will see 16 different sets where a new platform visualizes spatial and historical content with one or multiple media. Moreover, the platform can include additional functions such as sharing your own experiences at the heritage site, walk in the virtual environment (being immersed) and show different stages in time of the building or site (timeline). Considering all the possible options, we would like you to think how much the given platform would increase your understanding for a heritage site and therefore increase your awareness for the heritage.

Explaination for the legend

Specific building	 (2D maps)	 (Images)	 (3D model)
Public space	 (2D maps)	 (Images)	 (3D model)
Heritage district	 (2D maps)	 (Images)	 (3D model)
Historical context	(text)	(photo)	(video)

1 one example: Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><th colspan="2">Attribute</th><th>Visualization A</th><th>Visualization B</th><th rowspan="6">None of both</th></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td>None</td><td></td></tr>
<tr><td>Public space</td><td>None</td><td>  </td></tr>
<tr><td>Heritage site</td><td>  </td><td> 
  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show previous and current use</td><td>Timeline to show previous use of the area</td></tr>
<tr><td>Support Virtual Reality</td><td>Not support Virtual Reality</td></tr>
<tr><td rowspan="2">Historical context</td><td>Event</td><td>  </td><td>None</td></tr>
<tr><td>Person</td><td>  </td><td>None</td></tr>
</table>

	Architecture			
	Institution			
	Lifestyle			
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

Example explanation for choice A:

For the specific building and public space, there is no visualization. For the heritage district, users can view the 3D model. The platform supports a timeline to show the previous and current situation for this heritage. By using this, people can see what has changed over the decades. As for the functionality, it supports virtual reality, which means people can walk through the 3D model.

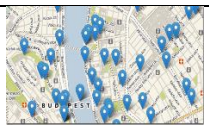
In the historical context part, people can acquire information about events through text and video, while for persons and architecture information is only available from images. Historical information about Institutions can be

accessed by text and information about people's lifestyle is available through images and video.

After they visit heritage on site, users can upload their own experience as text, images or video to the platform to enrich the database.

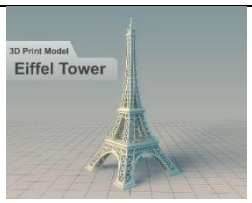
Example explanation for Choice B: Likewise example choice A

1. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td>None</td><td>  </td></tr>
<tr><td>Public space</td><td>None</td><td>  </td></tr>
<tr><td>Heritage site</td><td>  </td><td> 
  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show previous and current use</td><td>Timeline to show previous use of the area</td></tr>
<tr><td>Not Support Virtual Reality</td><td>Not support Virtual Reality</td></tr>
</table>

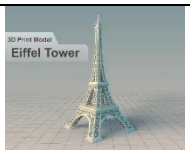
Historical context	Event		None	
	Person		None	
	Architecture			
	Institution			
	Lifestyle			
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

2. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="6">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td> 
</td><td>  </td></tr>
<tr><td>Public space</td><td> 
 </td><td>  </td></tr>
<tr><td>Heritage site</td><td> 
 </td><td>  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show previous and current use</td><td>Timeline to show previous and current use of the area</td></tr>
<tr><td>Not Support Virtual Reality</td><td>support Virtual Reality</td></tr>
<tr><td>Historical context</td><td>Event</td><td> 
</td><td> 
</td></tr>
</table>

	Person			
	Architecture			
	Institution		None	
	Lifestyle			
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

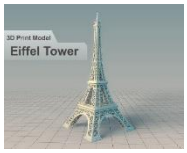
3. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5"></td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td> 

 </td><td>None</td></tr>
<tr><td>Public space</td><td> 
 </td><td>  </td></tr>
<tr><td>Heritage site</td><td>  </td><td> 
 </td></tr>
<tr><td rowspan="2">Functionality</td><td>No timeline</td><td>Timeline to show current use of the area</td></tr>
<tr><td>Support Virtual Reality</td><td>Not support Virtual Reality</td></tr>
</table>

Historical context	Event	None		
	Person	 		
	Architecture		  	
	Institution	 		
	Lifestyle			
	Functionality	Not Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

4. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><th colspan="2"></th><th>Visualization A</th><th>Visualization B</th><th rowspan="3">None of both</th></tr>
<tr><td rowspan="2">Spatial content</td><td>Specific building</td><td> 

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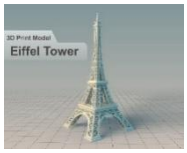
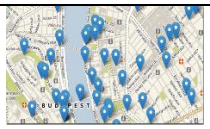
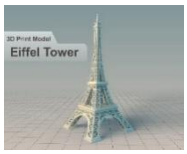

</td></tr>
<tr><td>Public space</td><td> 

 </td><td> 
 </td></tr>
</table>

	Heritage site	 	 	
	Functionality	No Time line	Timeline to show previous and current use of the area	
		Support Virtual Reality	support Virtual Reality	
Historical context	Event			
	Person			
	Architecture			

	Institution			
	Lifestyle			
	Functionality	Not Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

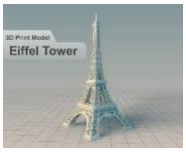
5. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td> 
  </td><td>  </td></tr>
<tr><td>Public space</td><td>  </td><td>None</td></tr>
<tr><td>Heritage site</td><td> 
 
  </td><td>None</td></tr>
<tr><td rowspan="2">Functionality</td><td>No Time line</td><td>No Timeline</td></tr>
<tr><td>Support Virtual Reality</td><td>support Virtual Reality</td></tr>
</table>

Historical context	Event			
	Person			
	Architecture			
	Institution			
	Lifestyle			

	Functionality	Not Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

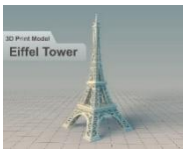
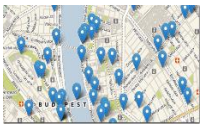
6. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building	 	 	None of both
	Public space	 		
	Heritage site	 		

	Functionality	Time line to show previous and current use	Timeline to show current use of the area	
		Not Support Virtual Reality	support Virtual Reality	
Historical context	Event			
	Person			
	Architecture			
	Institution			

	Lifestyle			
	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

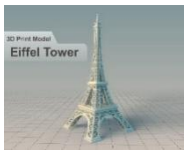
7. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building	  		None of both
	Public space	 	 	

	Heritage site			
	Functionality	Time line to show previous and current use	No Timeline	
		Support Virtual Reality	Not support Virtual Reality	
Historical context	Event	None		
	Person			
	Architecture			
	Institution			

	Lifestyle	None		
	Functionality	Not Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

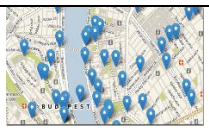
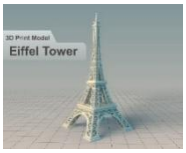
8. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building		 	None of both
	Public space	 	None	

	Heritage site	  	  	
	Functionality	Time line to show previous and current use	Timeline to show current use of the area	
		Not Support Virtual Reality	Not support Virtual Reality	
Historical context	Event			
	Person		  	
	Architecture	 	 	

	Institution			
	Lifestyle		None	
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

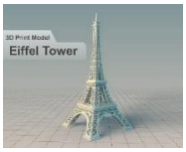
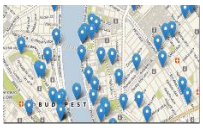
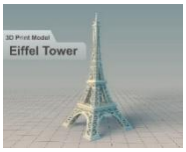
9. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><th colspan="2"></th><th>Visualization A</th><th>Visualization B</th><th rowspan="5">None of both</th></tr>
<tr><td rowspan="4">Spatial content</td><td>Specific building</td><td>  </td><td>    </td></tr>
<tr><td>Public space</td><td>    </td><td>   </td></tr>
<tr><td>Heritage site</td><td>  </td><td>  </td></tr>
<tr><td>Functionality</td><td>Time line to show previous and current use</td><td>Timeline to show current use of the area</td></tr>
</table>

		Not Support Virtual Reality	support Virtual Reality	
Historical context	Event		None	
	Person			
	Architecture			
	Institution			
	Lifestyle			

	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

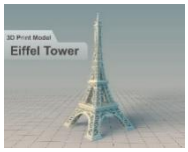
10. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building	 	 	None of both
	Public space		 	
	Heritage site	 	None	

	Functionality	Time line to show previous and current use	Timeline to show previous and current use of the area	
		Not Support Virtual Reality	support Virtual Reality	
Historical context	Event			
	Person			
	Architecture			

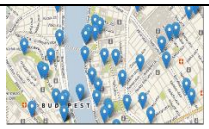
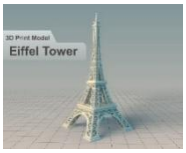
	Institution	 	None	
	Lifestyle	 		
	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

11. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="6">None of both</td></tr>
<tr><td rowspan="6">Spatial content</td><td>Specific building</td><td>None</td><td> 
  </td></tr>
<tr><td>Public space</td><td>  </td><td> 
  </td></tr>
<tr><td>Heritage site</td><td> 
  </td><td> 
  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show and current use</td><td>Timeline to show previous use of the area</td></tr>
<tr><td>Not Support Virtual Reality</td><td>support Virtual Reality</td></tr>
</table>

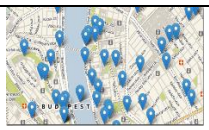
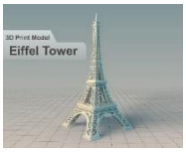
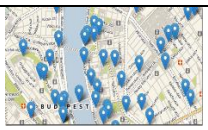
Historical context	Event			
	Person			
	Architecture		None	
	Institution		None	
	Lifestyle			
	Functionality	Not Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

12. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><th colspan="2"></th><th>Visualization A</th><th>Visualization B</th><th rowspan="4">None of both</th></tr>
<tr><td rowspan="3">Spatial content</td><td>Specific building</td><td> 
 
  </td><td>  </td></tr>
<tr><td>Public space</td><td>  </td><td> 
  </td></tr>
<tr><td>Heritage site</td><td>  </td><td> 
 
  </td></tr>
</table>

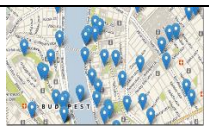
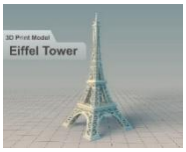
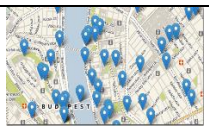
	Functionality	Time line to show previous and current use	Timeline to show previous and current use of the area	
		Not Support Virtual Reality	support Virtual Reality	
Historical context	Event			
	Person	None		
	Architecture	None		
	Institution	 	 	
	Lifestyle			
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

13. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="4">Spatial content</td><td>Specific building</td><td> 
  </td><td> 
  </td></tr>
<tr><td>Public space</td><td>  </td><td> 
 
  </td></tr>
<tr><td>Heritage site</td><td>  </td><td> 
  </td></tr>
<tr><td>Functionality</td><td>Time line to show previous use</td><td>Timeline to show previous use of the area</td></tr>
</table>

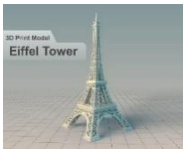
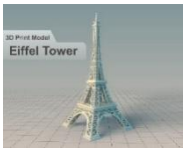
		Support Virtual Reality	support Virtual Reality	
Historical context	Event			
	Person	 	None	
	Architecture	 	 	
	Institution	 	 	
	Lifestyle	None		
	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

14. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building	 	 	None of both
	Public space	 	None	
	Heritage site	None	 	
	Functionality	Time line to show previous and current use	Timeline to show current use of the area	
		Not Support Virtual Reality	support Virtual Reality	

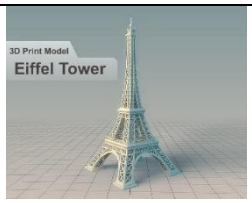
Historical context	Event			
	Person			
	Architecture			
	Institution	None	None	
	Lifestyle			
	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

15. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="6">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td>  </td><td>   </td></tr>
<tr><td>Public space</td><td>None</td><td>   </td></tr>
<tr><td>Heritage site</td><td>None</td><td>None</td></tr>
<tr><td rowspan="2">Functionality</td><td>No Time line</td><td>Timeline to show previous and current use of the area</td></tr>
<tr><td>Support Virtual Reality</td><td>support Virtual Reality</td></tr>
<tr><td>Historical context</td><td>Event</td><td>  </td><td>  </td></tr>
</table>

	Person		None	
	Architecture	 	 	
	Institution	 	 	
	Lifestyle		 	
	Functionality	Not Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

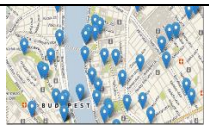
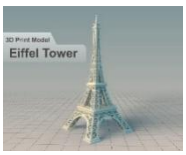
16. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="6">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td>  </td><td>  </td></tr>
<tr><td>Public space</td><td>  </td><td> 
  </td></tr>
<tr><td>Heritage site</td><td> 
  </td><td> 
  </td></tr>
<tr><td rowspan="2">Functionality</td><td>No Time line</td><td>Timeline to show previous and current use of the area</td></tr>
<tr><td>Support Virtual Reality</td><td>Not support Virtual Reality</td></tr>
<tr><td>Historical context</td><td>Event</td><td>  </td><td>  </td></tr>
</table>

	Person			
	Architecture			
	Institution			
	Lifestyle			
	Functionality	Not Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

Part 2 (B) New platform for increasing Cultural Heritage awareness

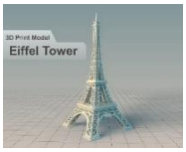
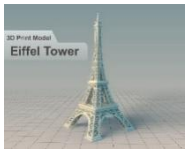
1. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><th colspan="2"></th><th>Visualization A</th><th>Visualization B</th><th rowspan="3">None of both</th></tr>
<tr><td rowspan="2">Spatial content</td><td>Specific building</td><td> 
 
  </td><td>None</td></tr>
<tr><td>Public space</td><td> 
 
  </td><td> 
  </td></tr>
</table>

	Heritage site	 		
	Functionality	Time line to show previous an current use	No Timeline	
		Support Virtual Reality	support Virtual Reality	
Historical context	Event			
	Person		None	
	Architecture			

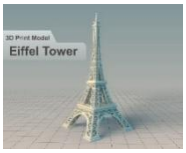
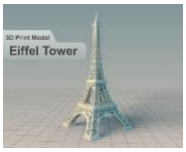
	Institution			
	Lifestyle		None	
	Functionality	Not Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

2. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="4">None of both</td></tr>
<tr><td rowspan="4">Spatial content</td><td>Specific building</td><td> 
  </td><td> 
 
  </td></tr>
<tr><td>Public space</td><td> 
  </td><td> 
  </td></tr>
<tr><td>Heritage site</td><td>  </td><td> 
  </td></tr>
<tr><td>Functionality</td><td>No Time line</td><td>Timeline to show previous and</td></tr>
</table>

			current use of the area	
		Not Support Virtual Reality	support Virtual Reality	
Historical context	Event	  	None	
	Person			
	Architecture	 		
	Institution			
	Lifestyle	 	None	
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

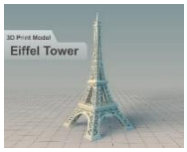
3. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td> 
</td><td> 

</td></tr>
<tr><td>Public space</td><td> 
 </td><td>  </td></tr>
<tr><td>Heritage site</td><td>  </td><td> 
 </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show previous use</td><td>Timeline to show previous and current use of the area</td></tr>
<tr><td>Not Support Virtual Reality</td><td>Not support Virtual Reality</td></tr>
</table>

Historical context	Event	None		
	Person			
	Architecture			
	Institution			
	Lifestyle			

	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

4. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building		 	None of both
	Public space			
	Heritage site	None	 	
	Functionality	Time line to show and current use	No Timeline	
		Support Virtual Reality	Not support Virtual Reality	

Historical context	Event	None	 	
	Person			
	Architecture		 	
	Institution	None		
	Lifestyle	  		
	Functionality	Not Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

5. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="4">Spatial content</td><td>Specific building</td><td>  </td><td>  </td></tr>
<tr><td>Public space</td><td> 
  </td><td>  </td></tr>
<tr><td>Heritage site</td><td> 
  </td><td>  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show previous use</td><td>Timeline to show previous use of the area</td></tr>
<tr><td>Support Virtual Reality</td><td>Not support Virtual Reality</td></tr>
</table>

Historical context	Event			
	Person			
	Architecture			
	Institution		None	

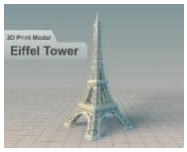
	Lifestyle		None	
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

6. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building		None	None of both
	Public space	None	None	
	Heritage site			
	Functionality	Time line to show previous use	Timeline to show previous and use of the area	
		Support Virtual Reality	Not support Virtual Reality	
Historical context	Event	 	 	

	Person			
	Architecture			
	Institution			
	Lifestyle			
	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

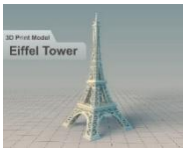
7. Before you visit one heritage, which platform visualization you would like to choose?

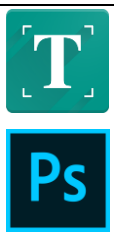
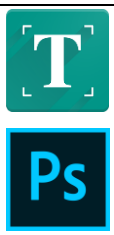
<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td>None</td><td> 
  </td></tr>
<tr><td>Public space</td><td> 
  </td><td> 
 
  </td></tr>
<tr><td>Heritage site</td><td>None</td><td>  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show previous use</td><td>Timeline to show previous use of the area</td></tr>
<tr><td>Support Virtual Reality</td><td>Not support Virtual Reality</td></tr>
</table>

Historical context	Event			
	Person	  		
	Architecture	 	  	
	Institution		  	

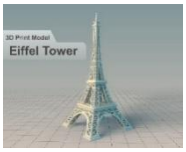
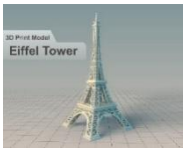
	Lifestyle			
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

8. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building	 		
	Public space		  	
	Heritage site	 		
	Functionality	No Time line	Timeline to show previous and	

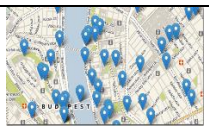
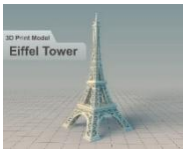
			current use of the area	
		Not Support Virtual Reality	Not support Virtual Reality	
Historical context	Event			
	Person			
	Architecture			
	Institution			
	Lifestyle			
	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

9. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="4">None of both</td></tr>
<tr><td rowspan="4">Spatial content</td><td>Specific building</td><td> 
  </td><td> 
  </td></tr>
<tr><td>Public space</td><td>None</td><td> 
  </td></tr>
<tr><td>Heritage site</td><td> 
 
  </td><td> 
  </td></tr>
<tr><td>Functionality</td><td>Time line to show current use</td><td>Timeline to show previous use of the area</td></tr>
</table>

		Not Support Virtual Reality	Not support Virtual Reality	
Historical context	Event			
	Person	  		
	Architecture	 		
	Institution	 		
	Lifestyle	None		
	Functionality	Not Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

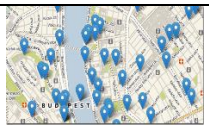
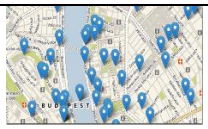
10. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><th colspan="2"></th><th>Visualization A</th><th>Visualization B</th><th rowspan="5">None of both</th></tr>
<tr><td rowspan="4">Spatial content</td><td>Specific building</td><td> 
 
  </td><td>None</td></tr>
<tr><td>Public space</td><td>  </td><td>  </td></tr>
<tr><td>Heritage site</td><td> 
 
  </td><td> 
  </td></tr>
<tr><td>Functionality</td><td>Time line to show previous use</td><td>Timeline to show previous and use of the area</td></tr>
</table>

		Support Virtual Reality	support Virtual Reality	
Historical context	Event			
	Person			
	Architecture			
	Institution			

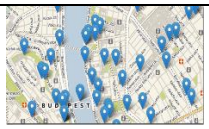
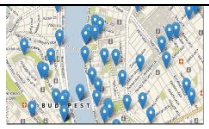
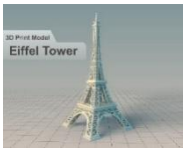
	Lifestyle		  	
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

11. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><th colspan="2"></th><th>Visualization A</th><th>Visualization B</th><th rowspan="5">None of both</th></tr>
<tr><td rowspan="4">Spatial content</td><td>Specific building</td><td> 
  </td><td> 
  </td></tr>
<tr><td>Public space</td><td> 
 
  </td><td>  </td></tr>
<tr><td>Heritage site</td><td> 
  </td><td>  </td></tr>
<tr><td>Functionality</td><td>Time line to show previous use</td><td>Timeline to show current use of the area</td></tr>
</table>

		Support Virtual Reality	Not support Virtual Reality	
Historical context	Event			
	Person	None		
	Architecture			
	Institution			
	Lifestyle			
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

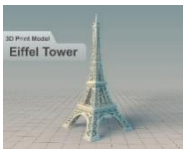
12. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="6">None of both</td></tr>
<tr><td rowspan="6">Spatial content</td><td rowspan="2">Specific building</td><td>  </td><td>  </td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Public space</td><td>  </td><td>None</td></tr>
<tr><td>Heritage site</td><td>  </td><td> 
  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show current use</td><td>Timeline to show previous and current use of the area</td></tr>
<tr><td>Not Support Virtual Reality</td><td>support Virtual Reality</td></tr>
</table>

Historical context	Event		None	
	Person			
	Architecture		None	
	Institution			
	Lifestyle			
	Functionality	Not Upload own experience	Not upload own experience	

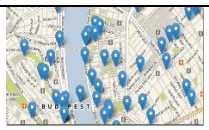
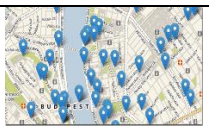
Your choice	[ ]	[ ]	[ ]

13. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building	 	None	None of both
	Public space	 	 	
	Heritage site	 		
	Functionality	Time line to show previous use	Timeline to show current use of the area	

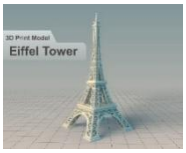
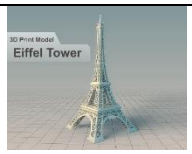
		Support Virtual Reality	support Virtual Reality	
Historical context	Event			
	Person			
	Architecture	Nonoe		
	Institution	None		
	Lifestyle			
	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

14. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="4">Spatial content</td><td>Specific building</td><td>  </td><td>  </td></tr>
<tr><td>Public space</td><td> 
  </td><td>  </td></tr>
<tr><td>Heritage site</td><td> 
  </td><td> 
  </td></tr>
<tr><td>Functionality</td><td>Time line to show current use
Not Support Virtual Reality</td><td>No Timeline
support Virtual Reality</td></tr>
<tr><td>Historical context</td><td>Event</td><td>  </td><td>  </td></tr>
</table>

	Person	 	  	
	Architecture	  	 	
	Institution			
	Lifestyle			
	Functionality	Not Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

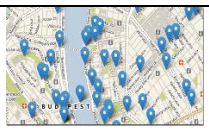
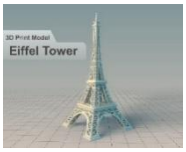
15. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td> 
</td><td> 

 </td></tr>
<tr><td>Public space</td><td> 
 </td><td> 
 </td></tr>
<tr><td>Heritage site</td><td>  </td><td>  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show current use</td><td colspan="2">No Timeline</td></tr>
<tr><td>Not Support Virtual Reality</td><td>support Virtual Reality</td></tr>
</table>

Historical context	Event		None	
	Person	None		
	Architecture			
	Institution	None		
	Lifestyle			
	Functionality	Not Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

16. Before you visit one heritage, which platform visualization you would like to choose?

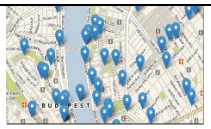
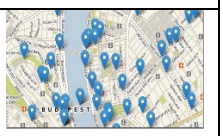
<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td> 
  </td><td>  </td></tr>
<tr><td>Public space</td><td> 
  </td><td> 
  </td></tr>
<tr><td>Heritage site</td><td>  </td><td> 
  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show current use</td><td>Timeline to show previous use of the area</td></tr>
<tr><td>Not Support Virtual Reality</td><td>support Virtual Reality</td></tr>
</table>

Historical context	Event			
	Person			
	Architecture			
	Institution			

	Lifestyle			
	Functionality	Not Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

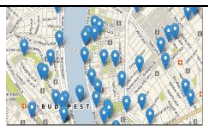
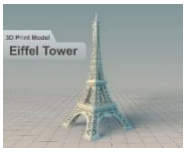
Part 2 (C) New platform for increasing Cultural Heritage awareness

1. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building			None of both
	Public space		 	
	Heritage site	 	  	
	Functionality	Time line to show previous use	Timeline to show previous and current use of the area	

		Not Support Virtual Reality	Not support Virtual Reality	
Historical context	Event	None		
	Person	none		
	Architecture	 	 	
	Institution	 	  	
	Lifestyle	 	 	
	Functionality	Not Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

2. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="6">None of both</td></tr>
<tr><td rowspan="6">Spatial content</td><td>Specific building</td><td>  </td><td> 
  </td></tr>
<tr><td rowspan="2">Public space</td><td> 
  </td><td> 
  </td></tr>
<tr><td rowspan="2">Heritage site</td><td> 
  </td><td>  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show current use</td><td>Timeline to show current use of the area</td></tr>
<tr><td>Support Virtual Reality</td><td>Not support Virtual Reality</td></tr>
</table>

Historical context	Event			
	Person			
	Architecture			
	Institution			
	Lifestyle			
	Functionality	Upload own experience	Not upload own experience	

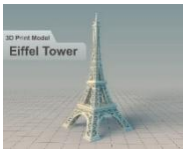
Your choice	[ ]	[ ]	[ ]

3. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="4">Spatial content</td><td>Specific building</td><td>  </td><td> 
  </td></tr>
<tr><td>Public space</td><td>  </td><td> 
  </td></tr>
<tr><td>Heritage site</td><td>  </td><td>None</td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show previous use</td><td>Timeline to show previous use of the area</td></tr>
<tr><td>Not Support Virtual Reality</td><td>Not support Virtual Reality</td></tr>
</table>

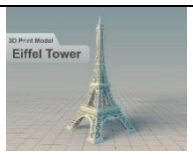
Historical context	Event			
	Person			
	Architecture			
	Institution	None		
	Lifestyle	None		
	Functionality	Not Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

4. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building		  	None of both
	Public space	  		
	Heritage site	none		
	Functionality	Time line to show current use	Timeline to show previous and	

			current use of the area	
		Support Virtual Reality	Not support Virtual Reality	
Historical context	Event			
	Person		None	
	Architecture	None	None	
	Institution			
	Lifestyle	None		
	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

5. Before you visit one heritage, which platform visualization you would like to choose?

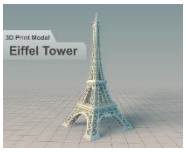
<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td>None</td><td> 
</td></tr>
<tr><td>Public space</td><td> 
 </td><td> 

 </td></tr>
<tr><td>Heritage site</td><td>  </td><td>  </td></tr>
<tr><td>Functionality</td><td>No Time line</td><td>Timeline to show previous and current use of the area</td></tr>
<tr><td></td><td>Support Virtual Reality</td><td>support Virtual Reality</td></tr>
</table>

Historical context	Event			
	Person	None		
	Architecture			
	Institution			
	Lifestyle	None		
	Functionality	Not Upload own experience	Not upload own experience	

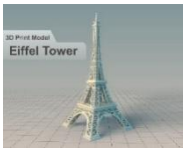
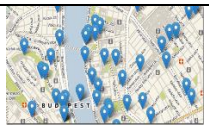
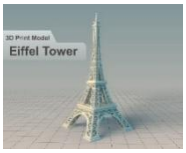
Your choice	[ ]	[ ]	[ ]

6. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="4">None of both</td></tr>
<tr><td rowspan="4">Spatial content</td><td>Specific building</td><td>  </td><td> 
  </td></tr>
<tr><td>Public space</td><td>  </td><td> 
 
  </td></tr>
<tr><td>Heritage site</td><td>  </td><td> 
  </td></tr>
<tr><td>Functionality</td><td>No Time line</td><td>No Timeline</td></tr>
</table>

		Support Virtual Reality	support Virtual Reality	
Historical context	Event		 	
	Person	 		
	Architecture	None		
	Institution		 	
	Lifestyle	 	 	
	Functionality	Not Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

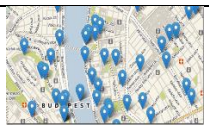
7. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building	 	  	None of both
	Public space		  	
	Heritage site		 	

	Functionality	Time line to show current use	Timeline to show current use of the area	
		Support Virtual Reality	Not support Virtual Reality	
Historical context	Event			
	Person			
	Architecture			
	Institution			
	Lifestyle			

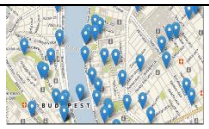
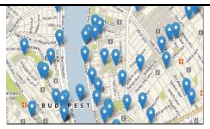
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

8. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building	None		None of both
	Public space	 	 	
	Heritage site		 	
	Functionality	Time line to show current use	Timeline to show current use of the area	
		Support Virtual Reality	Not support Virtual Reality	

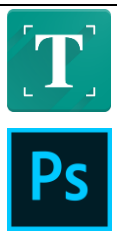
Historical context	Event			
	Person			
	Architecture			
	Institution			
	Lifestyle			
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

9. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td rowspan="2">Specific building</td><td>  </td><td>  </td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Public space</td><td>None</td><td> 
  </td></tr>
<tr><td>Heritage site</td><td> 
  </td><td> 
  </td></tr>
<tr><td>Functionality</td><td>Time line to show current use

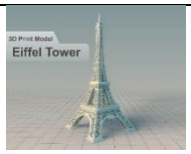
Support Virtual Reality</td><td>Timeline to show previous and current use of the area

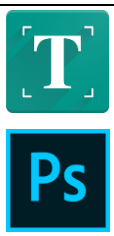
Not support Virtual Reality</td></tr>
</table>

Historical context	Event			
	Person			
	Architecture			
	Institution	None		
	Lifestyle			
	Functionality	Upload own experience	upload own experience	

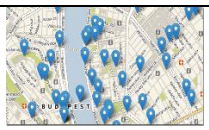
Your choice	[ ]	[ ]	[ ]

10. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building			None of both
	Public space			
	Heritage site	 		
	Functionality	Time line to show current use	No Timeline	
		Support Virtual Reality	support Virtual Reality	
Historical context	Event	 		

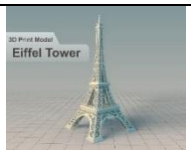
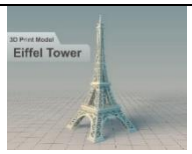
	Person			
	Architecture		None	
	Institution			
	Lifestyle			
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

11. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="6">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td> 
  </td><td>  </td></tr>
<tr><td>Public space</td><td> 
  </td><td>None</td></tr>
<tr><td>Heritage site</td><td>none</td><td> 
  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show previous use</td><td>No Timeline</td></tr>
<tr><td>Not Support Virtual Reality</td><td>Not support Virtual Reality</td></tr>
<tr><td>Historical context</td><td>Event</td><td></td><td></td></tr>
</table>

	Person		None	
	Architecture			
	Institution			
	Lifestyle			
	Functionality	Not Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

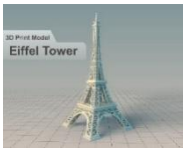
12. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td>  </td><td>  </td></tr>
<tr><td>Public space</td><td>   </td><td>  </td></tr>
<tr><td>Heritage site</td><td>    </td><td>   </td></tr>
<tr><td>Functionality</td><td>Time line to show previous use</td><td>Timeline to show current use of the area</td></tr>
<tr><td></td><td>Not Support Virtual Reality</td><td>support Virtual Reality</td></tr>
</table>

Historical context	Event			
	Person			
	Architecture	none		
	Institution			
	Lifestyle			
	Functionality	Not Upload own experience	upload own experience	

Your choice	[ ]	[ ]	[ ]

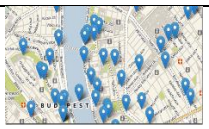
13. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><th colspan="2"></th><th>Visualization A</th><th>Visualization B</th><th rowspan="5">None of both</th></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td> 
 
 
</td><td> 
  </td></tr>
<tr><td>Public space</td><td>None</td><td> 
  </td></tr>
<tr><td>Heritage site</td><td>  </td><td>  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show previous use</td><td>No Timeline</td></tr>
<tr><td>Not Support Virtual Reality</td><td>Not support Virtual Reality</td></tr>
</table>

Historical context	Event			
	Person			
	Architecture		None	
	Institution			

	Lifestyle			
	Functionality	Not Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

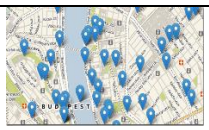
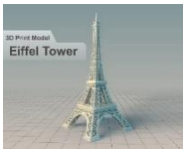
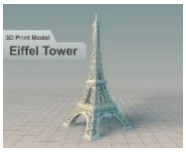
14. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building	None	 	None of both
	Public space			

	Heritage site	 		
	Functionality	Time line to show previous use	Timeline to show previous and current use of the area	
		Not Support Virtual Reality	support Virtual Reality	
Historical context	Event			
	Person			
	Architecture			

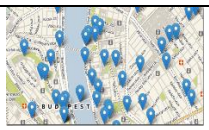
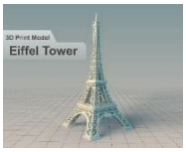
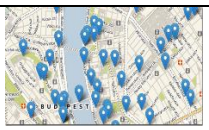
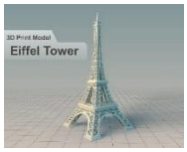
	Institution			
	Lifestyle		None	
	Functionality	Not Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

15. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="6">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td> 
 
  </td><td>  </td></tr>
<tr><td>Public space</td><td> 
  </td><td> 
  </td></tr>
<tr><td>Heritage site</td><td>  </td><td>  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show current use</td><td>Timeline to show previous use of the area</td></tr>
<tr><td>Support Virtual Reality</td><td>support Virtual Reality</td></tr>
<tr><td></td><td>Event</td><td>None</td><td>None</td></tr>
</table>

Historical context	Person			
	Architecture			
	Institution			
	Lifestyle			
	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

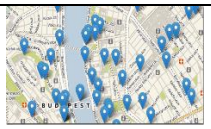
16. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="6">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td> 
  </td><td> 
  </td></tr>
<tr><td>Public space</td><td> 
  </td><td>  </td></tr>
<tr><td>Heritage site</td><td> 
  </td><td>  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show previous use</td><td>Timeline to show previous use of the area</td></tr>
<tr><td>Not Support Virtual Reality</td><td>support Virtual Reality</td></tr>
<tr><td>Historical context</td><td>Event</td><td>  </td><td>  </td></tr>
</table>

	Person			
	Architecture			
	Institution			
	Lifestyle		None	
	Functionality	Not Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

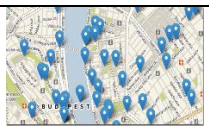
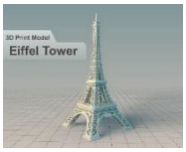
Part 2 (D) New platform for increasing Cultural Heritage awareness

1. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="6">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td>  </td><td>  </td></tr>
<tr><td>Public space</td><td> 
  </td><td>None</td></tr>
<tr><td>Heritage site</td><td>  </td><td>  </td></tr>
<tr><td rowspan="2">Functionality</td><td>No Time line</td><td>Timeline to show previous use of the area</td></tr>
<tr><td>Not Virtual Reality</td><td>support Virtual Reality</td></tr>
<tr><td>Historical context</td><td>Event</td><td>  </td><td>  </td></tr>
</table>

	Person			
	Architecture			
	Institution			
	Lifestyle			
	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

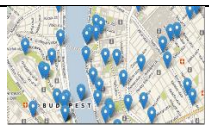
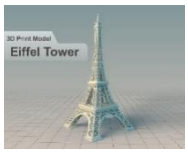
2. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td> 
  </td><td>  </td></tr>
<tr><td>Public space</td><td>None</td><td> 
  </td></tr>
<tr><td>Heritage site</td><td> 
  </td><td> 
  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show previous and current use</td><td>Timeline to show current use of the area</td></tr>
<tr><td>Support Virtual Reality</td><td>support Virtual Reality</td></tr>
</table>

Historical context	Event	None	 	
	Person	 		
	Architecture	None	 	
	Institution	  	 	
	Lifestyle		 	
	Functionality	Not Upload own experience	upload own experience	

Your choice	[ ]	[ ]	[ ]

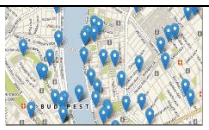
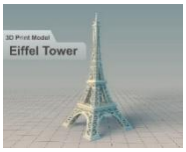
3. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="3">None of both</td></tr>
<tr><td rowspan="2">Spatial content</td><td>Specific building</td><td> 
  </td><td> 
 
  </td></tr>
<tr><td>Public space</td><td> 
  </td><td>  </td></tr>
</table>

	Heritage site		  	
	Functionality	No Time line	Timeline to show previous use of the area	
		Not Support Virtual Reality	support Virtual Reality	
Historical context	Event			
	Person			
	Architecture	None		

	Institution	 	 	
	Lifestyle	  		
	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

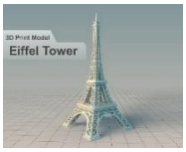
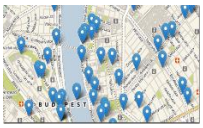
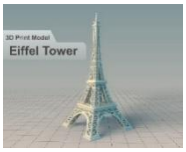
4. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building	None	 	None of both
	Public space	  		
	Heritage site	  	  	

	Functionality	No Time line	Timeline to show current use of the area	
		Not Support Virtual Reality	support Virtual Reality	
Historical context	Event	None	 	
	Person	 	None	
	Architecture	 		
	Institution	None		
	Lifestyle		  	

	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

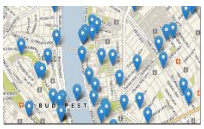
5. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building	 	 	None of both
	Public space	  	 	
	Heritage site			
	Functionality	Time line to show previous use	No Timeline	

		Not Support Virtual Reality	Not support Virtual Reality	
Historical context	Event			
	Person			
	Architecture			
	Institution			

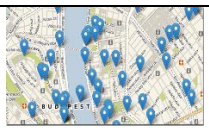
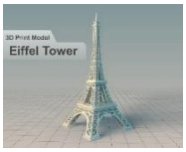
	Lifestyle			
	Functionality	Not Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

6. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building			None of both
	Public space			
	Heritage site		None	
	Functionality	Time line to show previous and current use	Timeline to show current use of the area	

		Support Virtual Reality	Not support Virtual Reality	
Historical context	Event		None	
	Person			
	Architecture			
	Institution	None	None	
	Lifestyle	 	  	
	Functionality	Not Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

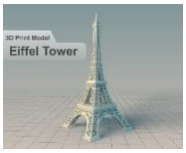
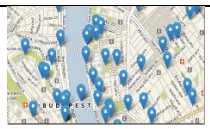
7. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><th colspan="2"></th><th>Visualization A</th><th>Visualization B</th><th rowspan="5">None of both</th></tr>
<tr><td rowspan="4">Spatial content</td><td>Specific building</td><td> 
  </td><td>None</td></tr>
<tr><td>Public space</td><td>  </td><td> 
  </td></tr>
<tr><td>Heritage site</td><td> 
 
  </td><td>None</td></tr>
<tr><td>Functionality</td><td>Time line to show current use</td><td>Timeline to show previous use of the area</td></tr>
</table>

		Support Virtual Reality	support Virtual Reality	
Historical context	Event			
	Person	None		
	Architecture			
	Institution			
	Lifestyle			

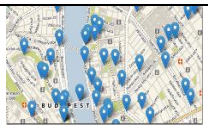
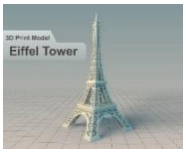
	Functionality	Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

8. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building		 	None of both
	Public space			
	Heritage site	 	  	
	Functionality	No Time line	No Timeline	
		Not Support Virtual Reality	support Virtual Reality	

Historical context	Event			
	Person			
	Architecture			
	Institution			
	Lifestyle	None		
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

9. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="6">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td> 
  </td><td> 
 
  </td></tr>
<tr><td>Public space</td><td>  </td><td>  </td></tr>
<tr><td>Heritage site</td><td>  </td><td>None</td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show previous and current use</td><td>No Timeline</td></tr>
<tr><td>Support Virtual Reality</td><td>Not support Virtual Reality</td></tr>
<tr><td>Historical context</td><td>Event</td><td>  </td><td>  </td></tr>
</table>

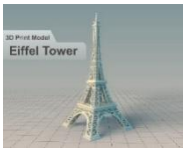
	Person			
	Architecture			
	Institution			
	Lifestyle	None		
	Functionality	Not Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

10. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="6">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td>  </td><td>None</td></tr>
<tr><td>Public space</td><td>None</td><td>  </td></tr>
<tr><td>Heritage site</td><td> 
  </td><td> 
  </td></tr>
<tr><td rowspan="2">Functionality</td><td>No Time line</td><td>Timeline to show previous use of the area</td></tr>
<tr><td>Not Support Virtual Reality</td><td>Not support Virtual Reality</td></tr>
<tr><td>Historical context</td><td>Event</td><td>  </td><td>  </td></tr>
</table>

	Person	None		
	Architecture			
	Institution			
	Lifestyle			
	Functionality	Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

11. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="6">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td> 
  </td><td>  </td></tr>
<tr><td>Public space</td><td> 
  </td><td> 
 
  </td></tr>
<tr><td>Heritage site</td><td>None</td><td>None</td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show previous and current use</td><td>Timeline to show current use of the area</td></tr>
<tr><td>Support Virtual Reality</td><td>support Virtual Reality</td></tr>
</table>

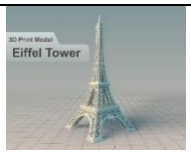
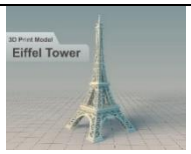
Historical context	Event			
	Person	None		
	Architecture		None	
	Institution			
	Lifestyle		None	
	Functionality	Not Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

12. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building		None	None of both
	Public space	 	  	
	Heritage site	  	  	
	Functionality	Time line to show previous and current use	No Timeline	

		Support Virtual Reality	Not support Virtual Reality	
Historical context	Event		None	
	Person		 	
	Architecture		 	
	Institution	 	None	
	Lifestyle			
	Functionality	Not Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

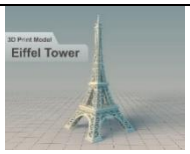
13. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><td colspan="2"></td><td>Visualization A</td><td>Visualization B</td><td rowspan="5">None of both</td></tr>
<tr><td rowspan="5">Spatial content</td><td>Specific building</td><td> 
</td><td> 
</td></tr>
<tr><td>Public space</td><td> 

 </td><td> 
 </td></tr>
<tr><td>Heritage site</td><td>  </td><td>  </td></tr>
<tr><td rowspan="2">Functionality</td><td>Time line to show previous and current use</td><td>Timeline to show current use of the area</td></tr>
<tr><td>Support Virtual Reality</td><td>Not support Virtual Reality</td></tr>
</table>

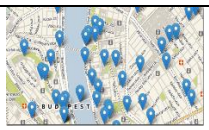
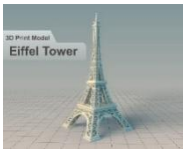
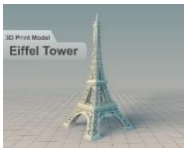
Historical context	Event			
	Person		None	
	Architecture			
	Institution		None	
	Lifestyle			
	Functionality	Not Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

14. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building	None		None of both
	Public space			
	Heritage site	 	 	
	Functionality	Time line to show previous and current use	No Timeline	
		Support Virtual Reality	Not support Virtual Reality	
Historical context	Event	  		

	Person			
	Architecture			
	Institution			
	Lifestyle		None	
	Functionality	Not Upload own experience	upload own experience	
Your choice		[ ]	[ ]	[ ]

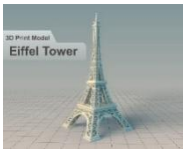
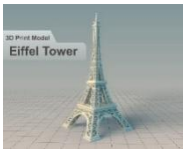
15. Before you visit one heritage, which platform visualization you would like to choose?

<table>
<tr><th colspan="2"></th><th>Visualization A</th><th>Visualization B</th><th rowspan="4">None of both</th></tr>
<tr><td rowspan="3">Spatial content</td><td>Specific building</td><td> 
 
  </td><td>  </td></tr>
<tr><td>Public space</td><td>  </td><td> 
  </td></tr>
<tr><td>Heritage site</td><td>None</td><td> 
 
  </td></tr>
</table>

	Functionality	No Time line Not Support Virtual Reality	Timeline to show previous use of the area Not support Virtual Reality	
Historical context	Event			
	Person			
	Architecture		None	
	Institution			
	Lifestyle			

	Functionality	upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

16. Before you visit one heritage, which platform visualization you would like to choose?

		Visualization A	Visualization B	
Spatial content	Specific building	  	  	None of both
	Public space	 	None	

	Heritage site	 		
	Functionality	Time line to show previous and current use	Timeline to show previous use of the area	
		Support Virtual Reality	Not support Virtual Reality	
Historical context	Event			
	Person			

	Architecture			
	Institution			
	Lifestyle	None		
	Functionality	Not Upload own experience	Not upload own experience	
Your choice		[ ]	[ ]	[ ]

Part 3: Information Retrieval before site visit

Heritage is the full range of our inherited traditions, monuments, objects and culture. In this research, we divide heritage knowledge into two parts: spatial knowledge and historical context. The spatial knowledge consists of knowledge about specific buildings, heritage sites such as a district and public space. The historical context consists of stories about significant events, persons, architecture, institution and community.

Spatial information can be obtained from 2D maps, images and 3 D models. The 2D maps show the location, transportation and points of interests for heritage; the images illustrate what the heritage looks like, their shape, style and also the surrounding environment; 3D model can provide a spatial view

of the building or site. Finally a virtual environment (VR/AR) allows for navigation through the cultural heritage.

Historical context can be obtained from text, images, or video.

People can read books, newspapers and magazines to understand the history for heritage.

Heritages can be recorded by camera as image or video. Through the historical recordings people can understand what happened in the past and they can compare with the present to see changes.

Please rank the options for each questions.

1. Before you visit a heritage site, what kind of heritage are you most interested in?

- ❒ Specific buildings in the heritage site
- ❒ Heritage site as a district
- ❒ Public space in the heritage site
- ❒ Others……..

2. Before you visit a heritage site, what media sources do you prefer to show the spatial information (such as the locations and transportations) about the heritage site?

- ❒ 2D maps
- ❒ Images
- ❒ 3D model

3. Before you visit a heritage site, what media sources do you prefer to obtain spatial information about a heritage building?

- ❒ 2D maps
- ❒ Images
- ❒ 3D model

4. Before you visit a heritage site, what media sources do you prefer to obtain spatial information about a district?

- ❒ 2D maps
- ❒ Images
- ❒ 3D model

5. Before you visit a heritage site, what media sources do you prefer to obtain spatial information about a public space?

- ❒ 2D maps
- ❒ Images
- ❒ 3D model

6. Before you visit a heritage site, what kind of historical context do you prefer to obtain?

- ❒ Stories about significant events
- ❒ Stories about significant persons
- ❒ Stories about architecture
- ❒ Stories about institutions
- ❒ Stories about community lifestyles.
- ❒ Others

7. Before you visit a heritage site, what media do you prefer to obtain stories about significant events?

- ❒ Text
- ❒ Images
- ❒ Video

8. Before you visit a heritage site, what media do you prefer to obtain stories about significant persons?

- ❒ Text
- ❒ Images
- ❒ Video

9. Before you visit a heritage site, what media do you prefer to obtain stories about significant architecture?

- ❒ Text
- ❒ Images
- ❒ Video

10. Before you visit a heritage site, what media do you prefer to obtain stories about significant institutions?

- ❒ Text
- ❒ Images
- ❒ Video

11. Before you visit a heritage site, what media do you prefer to obtain stories about significant communities?

- ❒ Text
- ❒ Images
- ❒ Video

Part 4: Media support

Heritage knowledge can be presented by different media, and these media could have different effect on an individual. Therefore we ask you opinion on each of these.

Please choose the appropriate option for each question.

1. 2D maps can help me to gain spatial knowledge of the heritage site

- o Strongly agree
- o Agree
- o Neutral
- o Disagree
- o Strongly disagree

2. Images can help me to gain spatial knowledge of the heritage site

- o Strongly agree
- o Agree
- o Neutral
- o Disagree
- o Strongly disagree

3. 3D model can help me to gain spatial knowledge of the heritage site

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

4. VR (Virtual Reality) or AR (Augmented Reality) can help me to gain spatial knowledge of the heritage site

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

5. Text can help to gain the historical context of the cultural heritage

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

6. Images can help to gain the historical context of the cultural heritage

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

7. Video can help to gain the historical context of the cultural heritage

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

8. Multiple media (text, images and video) embedded in a 2D map can help me to learn about heritage site

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

9. Multiple media (text, images and video) embedded in a 3D model can help me to learn about heritage site.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

10. I prefer multiple media embedded in a 2D map instead of web pages for a heritage site.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

11. I prefer multiple media embedded in a 3D model instead of web pages for a heritage site

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Appendix 2

Questionnaire 2

Part 1 Background of responders

1. What is your gender? *

Please choose only one of the following:

- Female
- Male

2. What is your age?

Please write your answer here:

3. What is the highest level of education you finished? *

Please choose only one of the following:

- Basic Education
- VMBO/MAVO
- HAVO/VWO (Secondary education)
- MBO (Junior college education)
- HBO/WO (College education)
- Graduate studies (Master, Ph.D)

4. What is your yearly net income? *

Please choose only one of the following:

- Not more than €10,000
- €10,001 till €20,000
- €20,001 till €30,000
- €30,001 till €40,000
- More than €40,000
- I'd rather not say

5. Have you visited Strijp-S (Philips old factory campus in Eindhoven) before? *

Please choose only one of the following:

- Yes
- No

6. Do you live in Eindhoven now? *

Please choose only one of the following:

- Yes
- No

7. Do you think cultural heritage is important for a city? *

Please choose only one of the following:

- Definitely
- Very probably
- Possible
- Probably not
- Definitely not

8. Do you think using a multiple media platform helps you to understand cultural heritage before/after visiting the cultural heritage site? *

Please choose only one of the following:

- Definitely
- Very probably
- Possible
- Probably not
- Definitely not

9. Are you interested in increasing your awareness of cultural heritage? *

Please choose only one of the following:

- Definitely
- Very probably
- Possible
- Probably not
- Definitely not

10. Are you usually interested in searching for more information after you become aware of a cultural heritage? *

Please choose only one of the following:

- Definitely
- Very probably
- Possible
- Probably not
- Definitely not

Part 2 Awareness for Strijp-S before using the platform

Strijp-S is a neighborhood and former industrial park in the Eindhoven district of Strijp. The area belonged to electronics company Philips. Since 2000, creative companies and housing have been established in the former industrial buildings. Eindhoven Strijp-S railway station serves the district.

The name Strijp-S comes from the naming pattern that Philips used in its industrial parks. Strijp-S was the first park, and Strijp-T and Strijp-R followed.

In 1916 Anton Philips built the first factory in Strijp-S, a glass factory for incandescent light bulbs. The Philips Natuurkundig Laboratorium was completed in 1923. Strijp-S was where first radios, then televisions were invented and produced, as well as many other devices. The credo Van zand tot klant ("from sand to customer") stood behind the idea that Philips

controlled every phase of production from research to storage, from glass blowing to cardboard factory: everything on one enormous piece of land.

In the 1990s Philips gradually left Eindhoven and in 2000 the first discussions took place about the repurposing of Strijp-S. In 2002 the land was sold for €140 million to Park Strijp Beheer B.V., a public private partnership between the city of Eindhoven and VolkerWessels. Philips was able to lease some of the buildings back temporarily until its full withdrawal in 2006, although there are still two small Philips departments present.

1. Which of the architectural buildings/public-space/heritage- landscape do you know at Strijp-S? Please click below (multiple choices possible). *

Please choose all that apply:

- o Veemgebouw
- o Klokgebouw
- o SX
- o Hoge Rug
- o Ketelhuis
- o Torenallee
- o Leidingstraat
- o Area51
- o Microlab
- o Ketelhuisplein
- o Natlab
- o Kartonnagefabriek
- o Industrial design centre
- o Glasgebouw
- o Oorlogsmonument
- o AUDIO/VIDEO

- Keramieklab
- None of them

2. Do you know any historical persons who had significant influence related to Strijp-S (multiple choices)? Please write down their names in the below boxes. *

Please choose all that apply:

- Anton Philips
- Gerard Philips
- Frits Philips
- None of them
- Other:

3. Which of the events below do you know that are significant for the history of Strijp-S(multiple choices)? If you know any other events, please write them down in the below boxes. *

Please choose all that apply:

- Start of construction of Strijp-S in the twentieth century
- Dutch Design week at Strijp-S
- Feelgood Market at Strijp-S
- STRP Festival
- De Ontdekfabriek at Strijp-S
- The invention of glass bulbs at Strijp-S
- Bombardments during WW II
- Evacuation during WW II
- Philiwood event at Strijp-S
- The invention of Philips Radio
- Start redevelopment of Strijp-S

- None of them
- Other:

4. I would like to visit a specific cultural heritage building or place at Strijp-S *

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly
- Not at all
- Not at all, because I don't know Strijp-S

5. I would like to visit the Strijp-S district when I have an opportunity *

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly
- Not at all
- Not at all, because I don't know Strijp-S

6. I care about cultural heritage buildings or places at Strijp-S. *

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly

- Not at all
- Not at all, because I don't know Strijp-S

7. I am interested in *

	Buildings at Strijp-S	Public space at Strijp-S	Landscape at Strijp-S	Persons who are related to Strijp-S and its history	Historical and current events of Strijp-S	Local lifestyle related to Strijp-S and its history
Extremely						
Very						
Moderately						
Slightly						
Not at all						
Not at all, because I don't know Strijp-S						

8. I would like to live in one of the cultural heritage buildings at Strijp-S.*

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly
- Not at all
- Not at all, because I don't know Strijp-S

9. I am interested in the cultural heritage redevelopment of Strijp-S. *

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly
- Not at all
- Not at all, because I don't know Strijp-S

10. I would like to join discussions about the future cultural heritage redevelopment of Strijp-S. *

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly
- Not at all
- Not at all, because I don't know Strijp-S

11. I would like to join at least one of the events/festivals (e.g. Dutch Design Week) at Strijp-S. *

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly
- Not at all
- Not at all, because I don't know Strijp-S

Part 3 Display platforms

In this part, you will use a new multiple media platform to view information about Strijp-S. You don't need to log in unless you want to upload your own experiences to the platform. You can choose one category on the left navigation bar or type keywords in the search bar to look for your interested information. Explore the platform to learn about Cultural Heritage at Strijp-S for at least 5 minutes .In the following part, questions are asked about the content (architecture, persons, events and lifestyle of Strijp-S), the media and the functionality of the platform. If you spend less than 5 minutes with the multiple media platform, then the system prevents you from continuation of the questionnaire. Spending more than 5 minutes is no problem of course. Attention: If you return to the multiple media platform, using the Previous button in the questionnaire, then the 5 minutes rule applies again.

(In this part, you can use Google to search for any information you are interested in Strijp-S. When you click the “here” button, a new window is opened to use Google. Explore the internet to learn about Cultural Heritage at Strijp-S for at least 5 minutes. Close the new window to return to the questionnaire. In the following part questions are asked about the content (architecture, persons, events and lifestyle of Strijp-S) and the media that are used.)

Part 4 Awareness for Strijp-S after using the multiple media platform

1. Which of the architectural buildings/public-space/heritage- landscape do you know at Strijp-S? Please click below *

Please choose all that apply:

- Veemgebouw
- Klokgebouw
- SX
- Hoge Rug

- Ketelhuis
- Torenallee
- Leidingstraat
- Area51
- Microlab
- Ketelhuisplein
- Natlab
- Kartonnagefabriek
- Industrial design centre
- Glasgebouw
- Oorlogsmonument
- AUDIO/VIDEO
- Keramieklab
- None of them

2. Do you know any historical persons who had a significant influence related to Strijp-S? Please click below, and if you know more names, please write down their names in the below boxes. *

Please choose all that apply:

- Anton Philips
- Gerard Philips
- Frits Philips
- Other:

3. Which of the events below do you know that are significant for the history of Strijp-S (multiple choices)? *

Please choose all that apply:

- Start of construction of Strijp-S in the twentieth century

- Dutch Design week at Strijp-S
- Feelgood Market at Strijp-S
- STRP Festival
- De Ontdekfabriek at Strijp-S
- The invention of glass bulbs at Strijp-S
- Bombardments during WW II
- Evacuation during WW II
- Philiwood event at Strijp-S
- The invention of Philips Radio
- Start redevelopment of Strijp-S
- Other:

4. I would like to visit a specific cultural heritage building or place at Strijp-S. *

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly
- Not at all

5. I will recommend others to visit Strijp-S because of its cultural heritage. *

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly
- Not at all

6. I would like to visit/revisit the Strijp-S district when I have an opportunity. *

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly
- Not at all

7. I would like to live in one of the cultural heritage buildings at Strijp-S. *

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly
- Not at all

8. I care about cultural heritage buildings or places at Strijp-S. *

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly
- Not at all

9. I am interested in *

	Buildings at Strijp-S	Public space at Strijp-S	Landscape at Strijp-S	Persons who are related to Strijp-S and its history	Historical and current events of Strijp-S	Local lifestyle related to Strijp-S and its history
Extremely						
Very						
Moderately						
Slightly						
Not at all						
Not at all, because I don't know Strijp-S						

10. I am interested in the cultural heritage redevelopment at Strijp-S. *

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly
- Not at all

11. I would like to join discussions about the future cultural heritage redevelopment of Strijp-S. *

Please choose only one of the following:

- Extremely
- Very
- Moderately

- Slightly
- Not at all

12. I would like to join at least one of the events/festivals (e.g. Dutch Design Week) at Strijp-S. *

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly
- Not at all

13. This multi-media platform/Google has helped me to gain information about tangible information (e.g. buildings) Cultural Heritage at Strijp-S. *

Please choose only one of the following:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

14. This multi-media platform/Google has helped me to gain information about intangible (e.g. lifestyle) Cultural Heritage at Strijp-S. *

Please choose only one of the following:

- Strongly agree
- Agree
- Neutral
- Disagree

- Strongly disagree

15. This multi-media platform/Google has helped me to find interesting information on Cultural Heritage of Strijp-S easily. *

Please choose only one of the following:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

16. Which media has helped you the most to find information about the buildings at Strijp-S?

Please rank all items. You can drag your choice and drop it in the ranking box. *

Please number each box in order of preference from 1 to 6.

- ❒ Map
- ❒ Photo
- ❒ 3D model
- ❒ Panorama VR
- ❒ Text
- ❒ Video

17. Which media has helped you the most to find information about public spaces at Strijp-S?

Please rank all items. You can drag your choice and drop it in the ranking box.*

Please number each box in order of preference from 1 to 6.

- ❒ Map
- ❒ Photo
- ❒ 3D model
- ❒ Panorama VR
- ❒ Text
- ❒ Video

18. Which media has helped you the most to find information about landscape heritage at Strijp-S?

Please rank all items. You can drag your choice and drop it in the ranking box.*

Please number each box in order of preference from 1 to 6.

- ❒ Map
- ❒ Photo
- ❒ 3D model
- ❒ Panorama VR
- ❒ Text
- ❒ Video

19. Which media has helped you the most to find information about significant events at Strijp-S?

Please rank all items. You can drag your choice and drop it in the ranking box.*

Please number each box in order of preference from 1 to 3.

- ❒ Text
- ❒ Photo
- ❒ Video

20. Which media has helped you the most to understand information about famous persons at Strijp-S?

Please rank all items. You can drag your choice and drop it in the ranking box.*

Please number each box in order of preference from 1 to 3.

- ❒ Text
- ❒ Photo
- ❒ Video

21. Which media has helped you the most to have information about the local lifestyle at Strijp-S?

Please rank all items. You can drag your choice and drop it in the ranking box.*

Please number each box in order of preference from 1 to 3.

- ❒ Text
- ❒ Photo
- ❒ Video

22. The timeline has helped me to compare the changes of physical architectures between the past and the current. *

Please choose only one of the following:

- o Strongly agree
- o Agree
- o Neutral
- o Disagree
- o Strongly disagree
- o I cannot say

23. I would like to upload my own experience related to Strijp-S to the multi-media platform. *

Please choose only one of the following:

- Extremely
- Very
- Moderately
- Slightly
- Not at all

24. Reading other's experiences on their visitations has helped me to increase my understanding of Strijp-S. *

Please choose only one of the following:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

25. The new Multiple Media Platform/Google has increased my awareness of the cultural heritage of Strijp-S, Eindhoven. *

Please choose only one of the following:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

27. I will recommend this multi-media platform to others to learn more about the cultural heritage of Strijp-S. *

Please choose only one of the following:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

27. Please enter any additional comments about the multi-media platform.

Please write your answer here:

Curriculum Vitae

Benshuo Wang was born in 29th March 1992 in Shandong Provience, China.

After finishing the Bachelor degree of Civil Engineering at Jinan University in 2014, he continued his study in Geotechnical Engineering at Shandong University. In 2017, he obtained the Master degree within the Geotechnical Center group with his Master thesis titled “Early Warning in Major Disaster Area of Weak Rock Tunnel and Application". His master thesis won the prize of the “Excellent Master Thesis Award” from Shandong University. Parallel to his master studies, he joined several research projects related to tunnel surround rock monitor, advanced geological forecast and big data monitoring platform.

From 2017, he started a Ph.D. project in the Built Environment at Eindhoven University of Technology (TU/e) at Eindhoven, the Netherlands funded by the China Scholar Council (CSC). His Ph.D. project titled “Increasing awareness of cultural heritage based on a Multi Media Platform”, which the results are presented in this dissertation.

List of publications

Journal papers

Wang, B., de Vries, B., & Dane, G. (2021). Preferences for a multimedia web platform to increase awareness of cultural heritage: A stated choice experiment. Journal of Heritage Management, 6(2), 188-208.

Wang, B., Dane, G., Arentze, T.A., de Vries. B. Design and Test of a Multi-Media Web Platform Prototype Based on People's Preferences, to Increase Cultural Heritage Awareness. Submitted for publication.

Wang, B., Dane, G., Arentze, T.A., de Vries. B. A Structural Equation Model to Analyze the Use of a New Multi Media Platform for Increasing Awareness and Experience of Cultural Heritage. Submitted for publication.

Conference papaers

Wang, B., Dane, G. Z., & Vries, B. De. (2018). *INCREASING AWARENESS FOR URBAN CULTURAL HERITAGE BASED ON 3D NARRATIVE SYSTEM*. *XLII*(October), 1–2.