AN AUGMENTED REALITY SUPPORTED PARTICIPATORY WEB PLATFORM TO TRACK EASTERN ANATOLIAN CARAVANSERAIS

UMA PLATAFORMA WEB PARTICIPATIVA APOIADA POR REALIDADE AUMENTADA PARA LOCALIZAR CARAVANÇARAIS (KHANS) ANATOLIANOS ORIENTAIS

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ABSTRACT

The focus of this research is digital heritage in emergence. This study deals with how to use digital media tools to collect information about caravanserais (khans) to digitise lost heritage attributes. The study involved researchers compiling information about these caravanserais from references, and digitally mapping and generating identification tags based on the information in the sources. The researchers generated an online platform for information dissemination, consisting of the projection augmented model of the khans, and participatory web archive platform for crowdsourcing information. The interaction with users through the augmented representation and participation are the main features of this study, which represents a proposal for a method of interactive digital archiving. The digital khans can be exhibited in a virtual museum, or to be used as a database for those wishing to explore vanished heritage. The digital archiving project contributes to knowledge generation in placemaking using digital mediums and methods.

Keywords: Digital Caravanserais, Virtual Cultural Heritage, Augmented Reality (AR), Participatory Platform, Crowdsourcing

RESUMO

O foco da presente investigação é o património digital. O estudo trata da utilização de ferramentas digitais na recolha de informações sobre *khans*[1] (caravançarais) para digitalizar atributos do património julgado perdido. No âmbito do estudo, os investigadores compilaram informações sobre estes khans, cartografaram digitalmente e geraram etiquetas de identificação a partir das referências recolhidas. Assim, foi gerada uma plataforma online com vista à divulgação da informação, e que inclui o modelo ampliado dos *khans*; igualmente, foi criada uma plataforma web participativa (crowdsourcing) que arquiva a informação recolhida. A interação com o utilizador, através da representação mediante a realidade aumentada, permite a participação que é marca identitária deste estudo que visa a construção de um arquivo digital interativo. Os *khans* digitais são expostos num museu virtual, disponibilizando uma base de dados que permite explorar o património desaparecido. Este projeto de arquivamento contribui para a geração de conhecimento em modo de placemaking, utilizando meios e métodos digitais.

Palavras-Chave: Caravançarais (Khans) Digitais, Património Cultural Virtual, Realidade Aumentada (RA), Plataforma Participativa, *Crowdsourcing*

[1] Khans em português caravançará (no singular) e caravançarais (no plural) são instalações destinadas a albergar as carruagens e os comerciantes que se deslocavam nas antigas rotas comerciais da Pérsia Antiga fonte etimológica do termo.

1. INTRODUCTION

Anatolia has a central position due to its geographical location as a natural bridge between Asia and Europe, across which important trade routes pass, including the silk road. The silk road trade network started in Istanbul and branched out towards Konya, the capital in Anatolian Seljuk period, to southeast and northeast Anatolia (Darendeli, 2019). Cities such as Konya, Kayseri, Sivas, Malatya, and Diyarbakir also became vital centres with the development of trade (Darendeli, 2019). The interaction of these centres with other neighbouring districts led to the emergence of more specific routes (Kutlu, 2019). These developments led to the need for caravansaries (Kutlu, 2019). The caravanserais served for accommodation, and trading posts on these routes, which represented a network between commercial, economic, and cultural centres in Anatolia. Both the trade routes and caravanserais have importance for local cultural heritage. The loss of traces of these routes and caravansaries over time underlines the need to rediscover and record this infrastructure in the digital environment.

The interactive digital archiving project focuses on the caravanserais located in the Eastern and South-eastern Anatolia regions. The research challenge is the limited number of academic and local resources, and the fact that the few available resources contain inadequate information about the condition and exact location of the caravanserais in the region. The steps of the process are generated based on Manovich's categorization of the new media approach, which are creation, recording, storage, and distribution (Manovich, 2011). The study's aim is twofold: First, to create an interactive representation environment by creating a digital culture inventory for the caravanserais located in the Eastern Regions of Anatolia, and second, to propose a crowdsourcing method to retrieve more information about caravanserais. In this context, this study overviews the use of AR and crowdsourcing concepts in the field of cultural heritage. The methodology examines the process of the development of Digital Caravanserais with the steps of creation, recording, representation, and storing. The digital interactive archiving project contributes to knowledge generation in placemaking using digital mediums and methods; therefore, the project focuses on digital placemaking in heritage in emergence.

2. LITERATURE REVIEW

The use of new media technologies in the field of cultural heritage enables digital media to be used not only for the presentation and storage, but also for creating an interactive social and cultural framework. This method also creates a new approach, referred to as virtual cultural heritage. Research topics and practices in cultural heritage have changed over time, due to these new approaches to sharing and transferring information. Various search engines and databases enable creating and storing these digital contents for presentation or dissemination (Kalay, Kvan & Affleck, 2008). Among these, the use of web service provides different audiences with access to this content. (Kalay, Kvan & Affleck, 2008). In this sense, multimedia approaches in the field of cultural heritage can be used for different purposes, such as education, reconstruction, excavation, and exploration, or creating virtual museum experiences (Bekele et al., 2018). Computer technologies allow for working with any form of data (textual, image, numeric, and 3D) for analysis, protection, and visualisation of cultural heritage (Bekele et al., 2018; Alkhamisi et al., 2013). They have enabled the use of augmented, virtual, and mixed reality for an immersive experience, and, since the mid-2000s, created a sensory experience space between the virtual and the real environments (Bekele et al., 2018; Alkhamisi et al., 2013). These immersive technologies allow the reconstruction of the remains of a building that no longer exists (Saggio & Borra, 2011), the display of works that otherwise would be impossible to examine without damage, the creation of a virtual touristic route experience (Jamil, 2019; Vlahakis et al., 2001), and change in the scale from a city to an artifact (Luna et al., 2019). They offer a more user-oriented digital platform, especially for situations for which physical access or haptic interaction is impossible (Bekele et al., 2018).

This study exploits AR technology, which has a broader media representation than VR

(Alkhamisi et al., 2013; Wang et al., 2013). It stems from the greater options of the elements in the representation of content, and greater ease of equipment use. In addition, AR allows users to represent the content with different media on a single screen, and to take a hybrid approach to interaction with content such as photos, models, and text (Wang et al., 2013). In virtual cultural heritage, AR applications exploit marker-based technologies through the recognition of the descriptive image or 3D model to visualize a specific object or image in GLAMs (galleries, libraries, archives, and museums). The most preferred method for markerless AR is the image recognition based on geographical location. AR technology generally provides an outside experience that allows greater scope for spatial exploration in a historical site (Saggio & Borra, 2011). In such a frame, in this study, the AR method was used to generate a virtual model for representing a digital archive in a virtual environment in terms of compiled information, rather than experiencing a particular object or space.

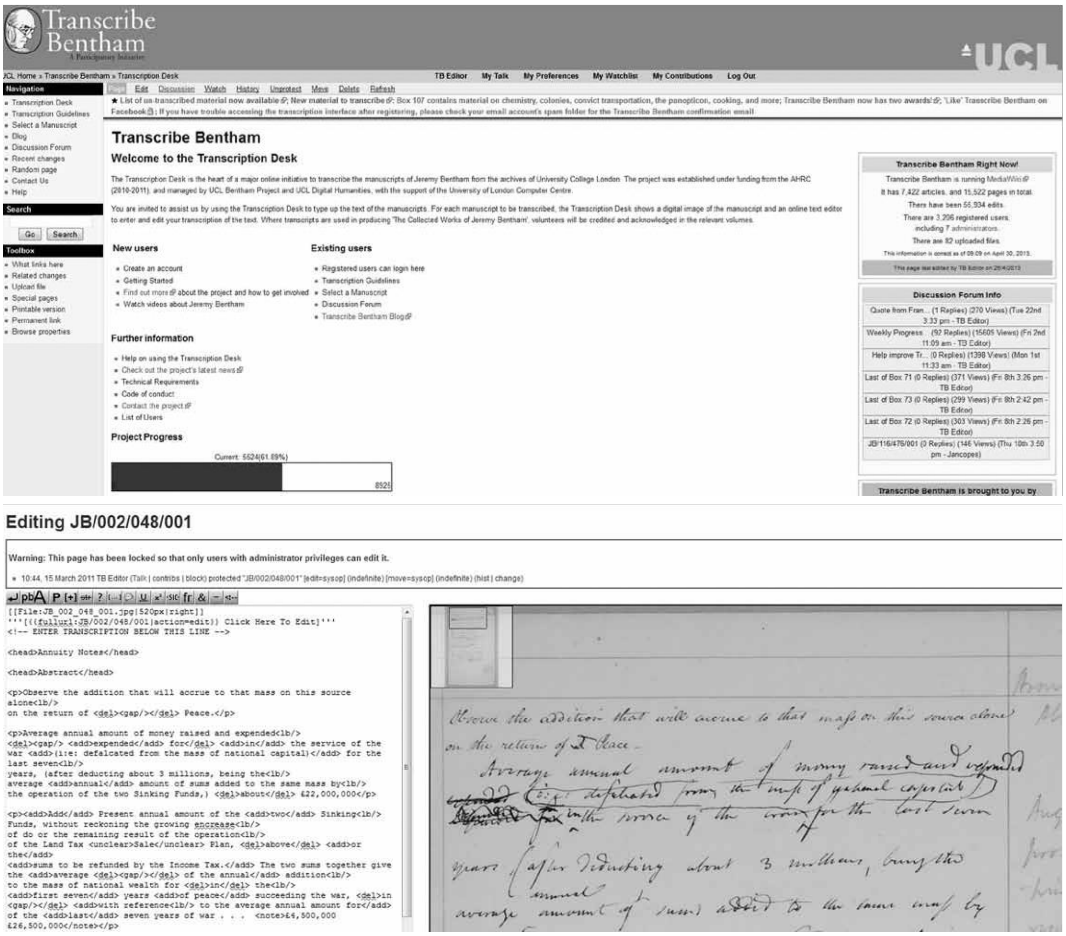
This paper implements crowdsourcing as a participatory method to exploit the wisdom of crowds for data collection and organization in the digital environment. In view of the limited information about the condition and location of the Seljuk khans in the East and Southeast Anatolia Region, the study aims to digitize the lost and vanished heritage and increase the general knowledge and public awareness about these institutions. This study also seeks to contribute to the field of public archaeology by raising public awareness on lost heritage through crowdsourcing. King (2012) features public archaeology as a community-based approach and defines the concept of public archaeology as 'the practice of archaeology with significant public participation' (p.6). The study hypothesizes that public participation in heritage data collection can facilitate its digital reconstruction, and increase awareness on the lost heritage attributes. Additionally, representation of khans in augmented reality increases the interactivity with the heritage attributes and also contributes to the public knowledge and awareness on emerging heritage knowledge.

Brabham (2009) defines crowdsourcing as 'a mechanism for leveraging online users' collective intelligence' (p. 250), and he points out that crowdsourcing uses the medium of the Web for collective decision-making or problem-solving with the intelligence of the crowds. This method has been widely used as a tool for digitizing data by outsourcing it to the general public in galleries, libraries, archives, and museums (GLAMs). In the context of cultural heritage, crowdsourcing concentrates on using the interested public's capacity to digitize cultural content or create new artefacts with collective wisdom, known as crowd-curation (Ridge, 2014). Ridge (2014) indicates that "crowdsourcing is immensely useful for engaging audiences with the work of GLAMs and cultural heritage-related disciplines "(p.2). Despite its challenges in authority and credibility, crowdsourcing is a commonly used method in digital culture to increase public awareness, gather information, or transform digital content. Encoding the textual cultural heritage content into the digital environment through crowdsourcing corresponds to the first wave in the digital humanities movement.

Transcribe Bentham Project sets a precedent for a crowdsourcing model in cultural heritage. The project was developed by Bentham Papers Transcription Initiative, which includes Digital Humanities, UCL Library Services, UCL Creative Media Services, and the University of London Computer Centre (ULCC) in 2012. The project is named after Jeremy Bentham, a remarkable philosopher and reformer in the 19th century. The Bentham Papers Transcription Initiative uses a specially developed a web platform to digitize Bentham's handwritten manuscripts to make them available for public access in digital platforms with the support of the crowd (Causer and Terras, 2014). The main objectives of the Transcribe Bentham project are to archive Bentham's manuscripts in the digital environment by allowing volunteers to contribute to humanities research via crowdsourcing method, and to evaluate the volunteers' transcription capacity in terms of quality, cost, and time. Causer and Terras (2014) incorporate text visualization and analysis techniques, within the intelligent search interfaces to digitize the collection, and

Handwritten Text Recognition (HTR) to assist volunteers in transcribing manuscripts. Volunteers encode the documents via the Transcription Desk interface, and customize installation of the MediaWiki platform for a participatory approach, as seen in Figure 1 (Causer and Terras, 2014). The MediaWiki platform is a widely used collaborative open-source software due to its stable, well-documented, and global user base. The project applies a checking mechanism for the accuracy of the transcriptions, evaluating each participant with a transcription rate based on their skill and accuracy. As the survey (Causer and Terras, 2014) demonstrates, the interest in Bentham philosophy, the sense of altruism, and the technology behind the crowdsourcing project motivate the project.

Figure 1 - The Transcribe Desk Platform, transcription interface, and transcription toolbar



Source: Transcribe Bentham Platform (Causer and Terras, 2014)

The methodology and motivation factors of the Transcribe Bentham Project inspired the proposed study. The study utilizes a MediaWiki platform chosen from among Wikimedia platforms to generate a crowdsourcing model in Seljuk khans. MediaWiki operates with GNU operating system and uses Hypertext Preprocessor and SQL for database management. MediaWiki is a feature-rich and extensible platform with its flexible and user-friendly structure. The MediaWiki platform has the potential to be used in crowdsourcing for data collection and organization. A wiki is a site designed for people to capture and share ideas quickly. In this study, the researchers investigate how to create and edit a wiki platform and create a flow diagram for each method, as displayed in Figure 2. The different ways of creating and editing a wiki are as follows

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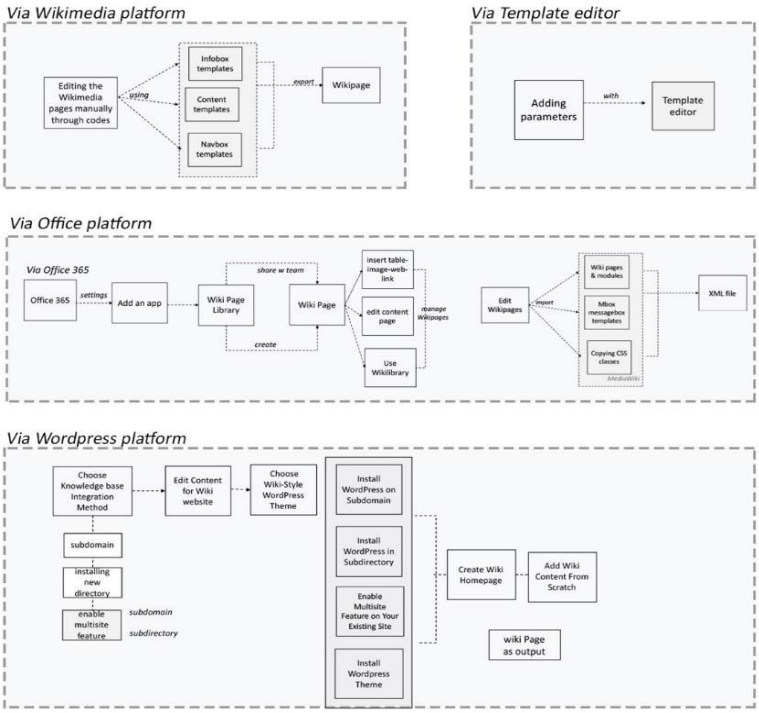
Figure 2 - The used methods of creating and editing wiki using different tools



Source: Own elaboration (2022)

Digital placemaking in heritage in emergence is the context of the study. In digital placemaking, the location-specific technologies range from the extended reality (VR/ AR), ICT, to ambient intelligence (IoT), and these improve people-place interaction by augmenting the experience (Morrison, 2019). They create hybrid spaces which have the potential to become attractive destinations. Morrison (2019) defines the term of digital placemaking as “the augmentation of physical places with location-specific services, products or experiences to create more attractive destinations.” Morrison (2019) states that digital placemaking aims to enhance the place experience from social, cultural, and environmental perspectives with the use of ‘location-specific technologies.’ The recent developments in the virtual environment (VR/ AR), information technologies, and ambient intelligence (IoT) are location-specific technologies. These give opportunities to reshape the places we share and create hybrid spaces by adding a digital layer on the physical public space. Digital placemaking practices involve location-based storytelling, mapping gamification, immersive and participatory applications and contribute to civic engagement with the place through digital mediums. The digital interactive archiving

project targets civic engagement and public participation on knowledge generation about the place using digital mediums and methods.

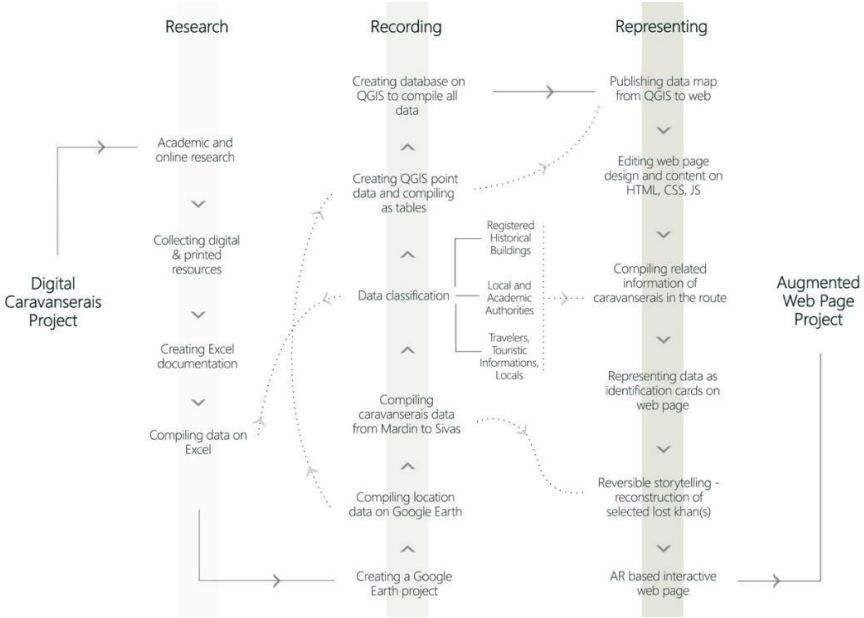
The next section starts with the examinations of the digital mapping and representation process of the Seljuk caravanserais, termed as 'Digital Caravanserais.' Due to the limited information on the selected site, heritage in emergence is the focus of the study. As a solution, the study presents an application, discussed this section. The app, named as p<ARC>, combines a participatory approach and augment reality technologies to reveal and represent heritage assets in emergence.

3. METHODOLOGY

The caravanserais of the Digital Caravanserai project, between eastern- southeastern Anatolia, create the content of the AR application. The project boundary

encompasses the provinces of Mardin, Sirnak, Siirt, Batman, Diyarbakir, Bingol, Malatya, Elazıg, Tunceli, and Sivas. This section explains the three stages of the project methodology, as displayed in Figure 3. The steps of the methodology process are generated based on Manovich's (2011) new media approach: research, recording, representation. The creation part is the digital excavation process. The researchers compiled information from administrative resources (official institutions), academic publications, within local and informal resources. They digitized the existing information about the location and condition of the khans by scanning and categorizing the archives, representing a digital excavation. The recording part deals with the information processing of the compiled caravansaries into a geographical information system (GIS) to create a digital database. The distribution part focuses on digital presentation methods in the forms of online maps and information cards for information dissemination. The study implements AR for visualization and dissemination of information and crowdsourcing as a participatory platform method in the representation stage. The online map represents geolocations, while the information cards give information about the location, architecture, and condition of the khans. The storage part deals with the crowdsourcing platform. As a data collection method, the crowdsourcing platform presents interactive and updated content that raises awareness of and interest in Seljuk caravanserais. AR application functions with this platform create an interactive digital representation method for information dissemination in order to motivate the users for the participatory process.

Figure 3 - The process flow diagram of the study



Source: Own elaboration (2022)

3.1. Creation

The creation part starts with the collecting and scanning of academic and non-academic printed and digital resources on the Anatolian Seljuk Period Caravanserais. The research and recording parts are the collaborative efforts of a research team, in the scope of Digital Heritage course at ITU. At this phase, the researchers gather information from different sources. The stage aims to form the background of the study. The researchers compile references coming from different sources, categorized as different levels, based on data source type: Level 1 sources are registered caravanserais in the project area, derived from administrative sources such as the web pages of local municipalities and official institutions. These provide the most accurate and reliable data. References at Level 2 are academically prepared articles, publications, and research theses. Level 3

references are the web resources at local level, describing where caravanserais are located, although this is not official information. In this context, Figure 4 shows the classification of the caravanserais in the region according to these levels. The digital interactive archiving project aims to retrieve more information about caravanserais in level 2 and level 3 references in particular.

Figure 4 - The caravanserais list classified according to resource levels

Source: Own elaboration (2022)

3.2. Recording

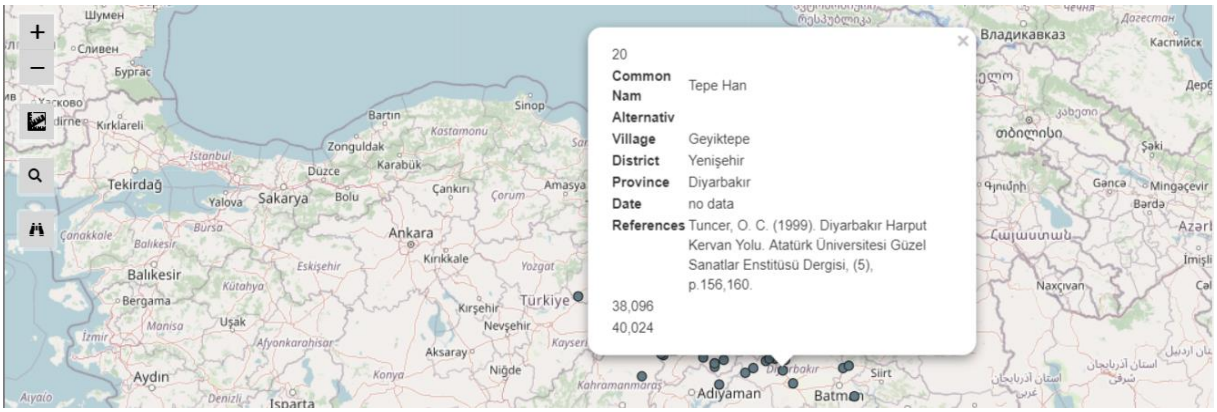
The recording part deals with the information processing of the compiled caravansaries in the digital medium. The research team aims to digitize the khans' location in the Google Earth project and create a database on QGIS. They will map the khans according to their coordinate data, and the khans with limited data, onto their estimated location, i.e., nearest district or village. Afterward, these coordinates and compiled information will be used to create both a web-based map and a shared database on QGIS. Each caravanserai has an identification tag for the database. This tag gives information about the city, district, village, date of construction, coordinates, and references.

3.3. Distribution (Representation)

The distribution part of the project contains the digital presentation methods of all the caravanserais whose information has been compiled. In this stage, the researchers aim to generate an online map by digitizing the geolocation data of the khans in the selected region using the QGIS environment (Figure 5) and add the descriptive information about the khans to the html content of this online map. There is also a web page that functions with the AR application, for digital archiving of the caravanserais. They will create separate information cards for each khan on the website giving information about the location, construction, and condition of the khans. The images in these cards will function as a recognition marker for AR. The image can be enlarged by hovering a mouse cursor over it (Figure 6).

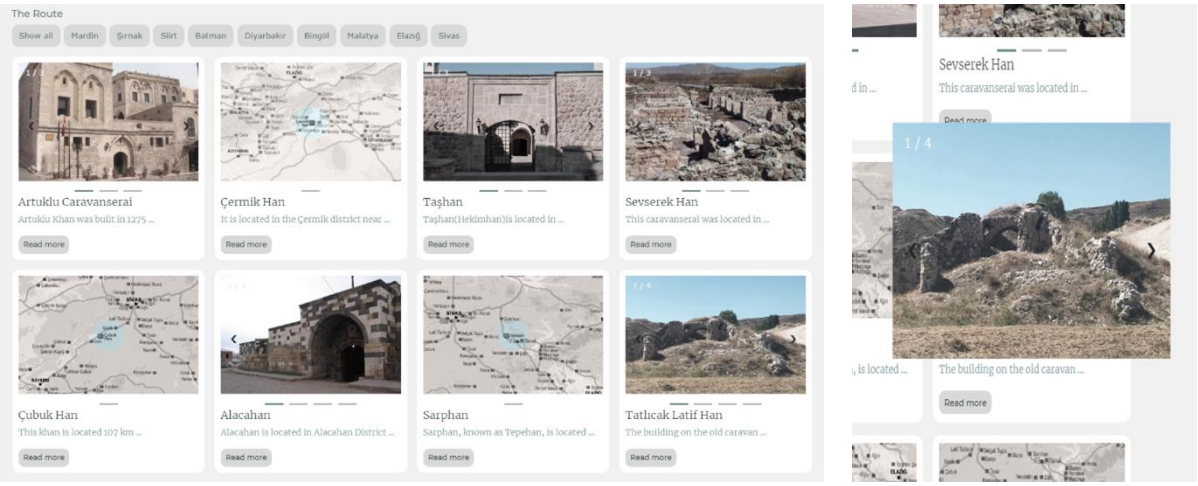
Figure 5 - The online-exported map that shows the identification tags of caravanserais

HERANÇA
Check for Updates



Source: Own elaboration (2022)

Figure 6 - The web page content and the enlarged image that works with AR

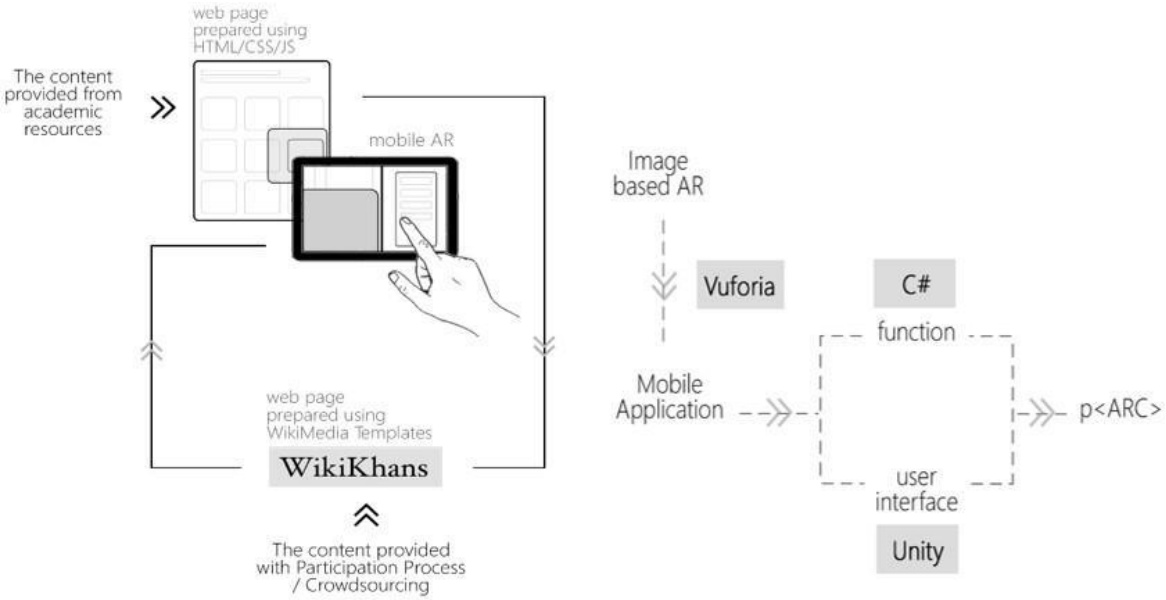


Source: Own elaboration (2022)

4. P<ARC> PROJECT FOR INTERACTIVE DIGITAL ARCHIVING

The challenge in this research is the limited information about the majority of the khans on the selected route. This paper concentrates on the different alternatives for creating archives using digital heritage technologies and aims to employ mixed media -merging virtual and web- to enhance the communication between the user and information. The researchers develop an application, p<ARC>, that stands for the Participatory Augmented Reality of Caravanserais. The p<ARC> app is a web-based application that integrates AR with participatory digital archiving. The app creates a virtual journey between the representative caravanserai models, and also a participatory platform that will encourage new researchers to enter data into this digital archive (Figure 7). The researchers will develop a conceptual framework for the participatory platform and its integration into AR-based web content; however, the execution of these stages is not within the scope of this paper. Researchers will develop the further steps of this research. In the AR section, they will develop a mobile application, built on a tablet. The researchers will employ the Unity platform for the interface of the application and generate image-based recognition with Vuforia extension. Figure 7 illustrates the process and flow of the application development.

Figure 7 - The proposed use scenario and application development process



Source: Own elaboration (2022)

4.1. INFORMATION DISSEMINATION WITH AR

The immersive representation of Caravanserais with Augmented Reality has three stages in its current situation. The first stage focuses on the location of the khans on the map to create a virtual route. The second stage focuses on the digital enrichment of a particular virtual khan using academic resources, and the third aims to use crowdsourcing in AR as a virtual information. The first two stages of AR are discussed in this section, as they are implemented within the scope of the p<ARC> application; the virtual information phase, which is still underway with the scenario and design process, is considered as a participation platform in the next section.

The web page does not show the route between the caravanserais based on the distance between them. This route map is not available on the web page, despite the online map provided by QGIS. The information about the khans is fragmented; so, it is difficult to associate the khans with a specific trade route. Therefore, the first part of the application deals with the recognition of the photos in the AR camera's web content and the generation of a route network represented in the AR environment (Figure 8). The application aims to illustrate the virtual route between the khans as part of the process of creating a digital library of the caravanserais. This study attributes the visualization process of the trade route and khans within the information as an augmented journey

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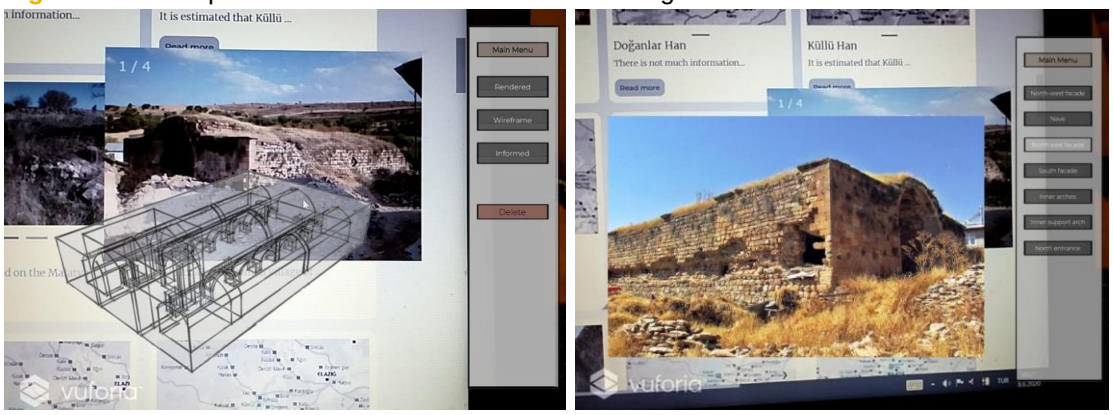
Figure 8 - The virtual route between the caravanserais that scanned by AR

Source: Own elaboration (2022)

The second step of the application concentrates on visual representation of the particular caravanserais in an AR environment based on limited information. Makit Khan is an example of this visual representation. This process is based on information from Şen's research article (2015) about Makit Khan titled 'Keban-Denizli Village Caravanserai (Makit Han).' Based on the descriptions in the article, the researchers generate a simple 3D model. In addition to the representation of this model in the AR environment, the web page provides an informative text and photo album describing the khan's basic features. At this stage, the researchers develop the application only for Makit Khan, but later this application will be available for each caravanserai. The representation of the model is as a solid model, currently. The options representative models will be enhanced by including Wireframe, X-Ray, or textured models (Figure 9).

Figure 9 - The representative wireframe model and images of Makit Han



Source: Own elaboration (2022)

4.2. Participatory Platform for Digital Archiving

The researchers establish a wiki site via the Wordpress platform as a basis for a crowdsourcing platform. An information table (infobox) is generated for khans according to Council of Europe Natural and Cultural Heritage Protection Inventory Form guidelines. The template includes general (location, commissioned by), architectural (structure, building elements), and observational information. The actors are the system, users - who voluntarily share information- and the expert -who are responsible for data accuracy. The target group is researchers interested in heritage, within the experts and the institutions responsible for the preservation and registration of the heritage.

The actors of this participatory process are the system, user (participant), and the expert. The user is the participant who volunteers to share information. The expert is responsible for the accuracy and quality of the shared data, the evaluation of the participants' effort, and the control of the participatory system. The system is the participatory website interface that connects the expert and user as a communicator. The study's target group is the researchers interested in heritage, the experts in reconstruction, and the institutions responsible for the preservation and registration of the buildings. Table 1 presents the use case scenario of the participatory system. Authority and ambiguity are the main challenges of crowdsourcing. The study makes reference obligatory and develops a labelling system to show the credibility level of the sources. The experts will assess the accuracy of the reference and share information. There are three types of references represented by different colours. Level 1 is the formal textual information with academic/ scientific or institutional reference and corresponds to the green label. Level 2 is informal information from the observations; this is non-scientific and corresponds to the yellow label, and level 3 is informal visual information such as images or videos about the khans and corresponds to the red label.

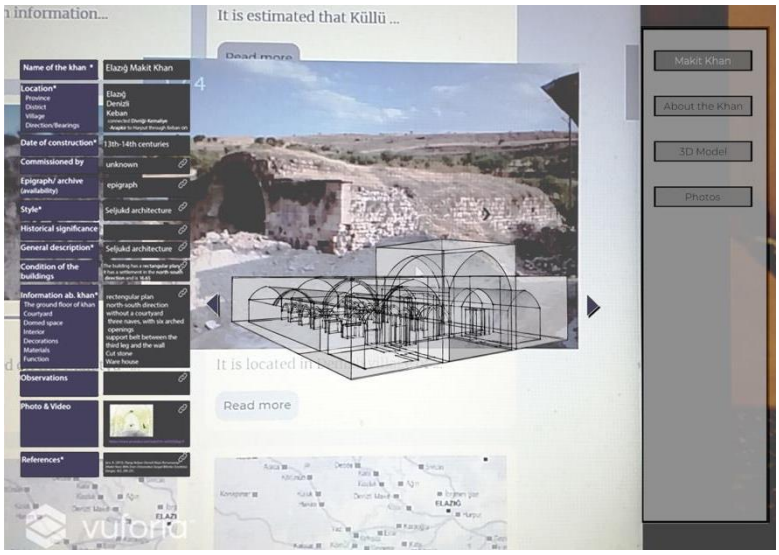
Table 1 - The case scenario of the participatory system

Steps	***Actor***	***Action Description***
1	*User*	Check the available information about the selected khans from the website Decide to participate to information sharing
2	*User*	Log in to the system as registered participants
3	*System*	Open an infobox of Mediawiki template allow user to enter information
4	*User*	Add information about the khans into the infobox template
5	*User*	Classify the reference level of information according to the information type; **Level 1;** formal textual information with academic/ scientific or institutional reference, **Level 2;** informal textual information from the observations and/or non-scientific reference, **Level 3;** informal visual information such as images or videos about the khans
6	*User*	Include any sketches, architectural drawings, or documents about the khans as a file into the system
7	*User*	Participate to transcribe the inscription of the khans if it is available
8	*System*	Label the levels of references with different colors to inform users about them Level 1 □ green / Level 2□ yellow / Level 3□ red label
9	*Expert*	Evaluate the accuracy of the information and references, within the architectural drawings and documents
10	*System*	Publish the infobox table on the website Reflect the related information onto the augmented image
11	*Expert*	Evaluate the participants according to the accuracy and quality of input information and give points to to them as a reward for motivation Publish the ranking of the participants' points (optional to participants)

Source: Own elaboration (2022)

In the further stages, the study connects the wikitable to digital caravanserais website via hyperlink. The three ways of generating a wikitable are the use of Office program, Wikimedia software, or Wordpress interface. As another alternative, the table generator tools can help to generate a table. The wikitable can also be included in a website via coding manually. The table generators (Url 2) have a quick markup summary for the Wiki table. Once the user enters the information, this tool transforms it into a Wiki table. The generated wikitable can be directly inserted into the interface of the HTML code resource of the website. First, the user can get information about the khans from the digital caravanserai's website. Then, the users will be directed to a MediaWiki interface via the hyperlink connection, or display the wikitable to enter information, if they want to participate. After the experts have completed the evaluation process, the information will be reflected in the augmented image as an information model. The researcher will utilize structured query language (SQL) to create a database and SQL Lite integration into the Unity 3D program to integrate the labelled information into the virtual model. In this way, the researchers aim to generate a virtual information model in the AR environment using the database system's connection. The researchers will design the content and interface of the participatory system; however, the scope of the study does not include the database design and the inclusion of the interactive infobox templates. Figure 10 gives information about the design of the AR environment's information model in the case of Elazig Makit Khan.

Figure 10 - The representative integration of Makit Han model with infobox on the virtual environment



Source: Own elaboration (2022)

5. CONCLUSION

In this study, an information model was proposed for research, recording, and representing caravanserais, which were of great importance for trade routes and cultural flow in the past, but whose structural and social traces disappeared over time. The discussion focused on new media approaches to these caravanserais, located in the eastern and south-eastern regions of Anatolia, were discussed. The previous studies in the literature are about compiling and digitizing data. However, the p<ARC> application differs from these studies because its information model is generated via a participatory process and visualized in an AR environment. Currently, this AR application is based on the routes between caravanserais and representation of the information content for each one. The extension of this study aims to integrate AR application with georeferencing modelling. In the future, the user will be able to navigate the indoor or outdoor space of the khan models through the advanced 3D modelling and user interaction techniques. It is also possible to transfer the modelling to the database created in the study's QGIS phase.

The most promising part of the project is developing a digital archive content with a participatory platform in further stages. This project has the potential to evolve into a crowdsourcing Wiki project in which many users can enter data. The participatory approach allows opportunities to create an information pool targeting academicians and local people. As a next step, this information model can be integrated into the existing AR application with new data entries. Thus, the representation of this information model could shift from the web content to an interactive virtual environment. In this way, the study sets a precedent for a user interactive virtual archive. Last but not least, this study contributes to digital archiving in the field of digital heritage. The study presents unique approaches to data organization, visualization, and information dissemination in the field of digital archiving. It shows how the current new media technologies can protect heritage values in the emergence, and how to make the process attractive for the public to raise awareness about a particular place. The impact of the study will be towards an increase in place attachment, place identity and place memory. It also has an impact on knowledge generation about the lost heritage attributes. In this regard, this study contributes to the field of placemaking in historical places, creating an increase in awareness for places whose heritage attributes are disappearing or lost.

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