



# Methodology of Digitalizing the Elements of Cultural Heritage

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Paper ID: 17A3C

Volume 17 Issue 3

Received 03 January 2025  
Received in revised form 25  
April 2026  
Accepted 09 May 2026  
Available online 11 June  
2026

## Keywords:

Heritage architecture;  
Virtual reality;  
Augmented reality;  
Metadata; 3D Scan;  
Digitalizing intangible  
cultural heritage  
element; Cultural  
heritage information;  
Heritage building;  
Heritage monument;  
Mixed reality.

## Abstract

Digitalization has a role in preserving cultural heritage both tangible and intangible elements by making these elements available to the public in various forms, such as digital libraries, maps, or virtual environments. The important rule of the researchers in this area of study is to convert real information to digital forms scientifically. However, various methods are presented by researchers to construct a platform methodology for collecting, documenting, and digitalizing cultural heritage information and making it available for many purposes such as preservation, tourism, documentation, innovation, education, research, and globalization. The problem statement of the study is “the unclear methodology of digitalization of the cultural heritage due to variety of methods, techniques, and assistant software”. The study aims to find a guideline for researchers for the digitalisation of tangible cultural heritage elements such as buildings and monuments. The study applied a qualitative approach using grounded theory applications. The results show that the digitalization of heritage buildings and monuments must follow clear and sequential ways starting from collecting information as metadata, documenting, modelling, and presenting. The metadata collection is an essential stage in preserving cultural heritage elements and it is more significant in documenting the physical and existing data.

**Discipline:** Architectural Engineering, Cultural Heritage Conservation & Sustainability.

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## Cite This Article:

Ahmed, R.A., Alchalab, O.Q.A. (2026). Methodology of Digitalizing the Elements of Cultural Heritage. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies*, 17(3), 17A3C, 1-8. <http://TUENGR.COM/V17/17A3C.pdf> DOI: 10.14456/ITJEMAST.2026.17

## 1 Introduction

The digitalization of heritage elements as a process contains various steps, each step linked to the previous. Moreover, the sequence of steps must be clear and moved and done in the right method to ensure the reality of digitalization as a result. The study focuses on the methodology of digitalization of physical elements of the cultural heritage. Digitalization of tangible heritage

elements is important as it provides many benefits for the global culture. Various studies and works in this area provided a platform for the right digitalization process and results. However, the variety and a shortage, unclear algorithmic methodology of digitalization provided various results for one or various elements. Economou (2015) mentioned that the heritage in the current digital era is a challenge for researchers and specialists due to the availability of new techniques and tools, which can influence the quality of the heritage elements in terms of interpretation and representation in the virtual environments (Economou, 2015). The current research aims to highlight the algorithmic steps of digitalizing intangible cultural heritage elements by focusing on buildings and monuments. Integrity and authenticity are the important principles considered by WHS (World Heritage Site) within UNESCO for nominating and considering cultural works as heritage. Therefore, the results of digitalization must consider these principles during the process to reflect the reality of the heritage elements' value. Sančanin and Penjišević (2023) mentioned that digitalization is related to the digital innovation area, which has changed the conventional way of acquiring images and reproducing the existing or imaginary world, leading to new forms and dimensions of reality. Moreover, the study mentioned that the right digitalization and the use and presentation of authentic tangible and intangible cultural-historical heritage can contribute to economic, ecological, and social development (Sančanin & Penjišević, 2023).

## 2 Benefits of Digitizing Heritage

The new technologies of documenting and presenting the heritage elements on website platforms, digital libraries, or applications and databases perform a perfect role in preserving the originality of the tangible heritage elements. The main digital forms of preserving cultural heritage are e-forms such as electronic Museums, libraries, exhibitions, databases, etc. Moreover, electronic forms of new cultural objects such as computer programs, networks, technologies, digital works of art, etc. (Nikonova & Biryukova, 2017).

The researchers listed various directions of benefits that enhance the quality and value of the cultural heritage elements, which are (Adane et al., 2019; Economou, 2015; Manžuch et al., 2005; Nikonova & Biryukova, 2017):

- Preserving: this can preserve the cultural heritage elements from future damage by natural or war disasters or the environment, and using factors, which a digital copy can help to conserve and reconstruct these elements.
- Access: this provides access to the public, researchers, and specialists. Digitization provides rich educational and research resources that can be used in educational and research institutions
- Documenting: using 3D and laser scans provided accurate and timely documentation and images for the heritage and historical sites and elements, which provided real information, and database information about the status of these objects.
- Linking between generations: digital copies can be moved from one generation to another, which can understand the past and reality of the places even after the disappearance or extinction of the original objects.

- Virtual tourism: one of the important benefits which providing virtual tours for tourists to visit heritage sites virtually through VR technologies, which enhances cultural tourism. Virtual tours enhanced the “Cultural Marketing” by promoting heritage sites and raising awareness about them.

- Community interaction: the digital museums and library enhance the community to assist the cultural heritage by providing information and data about the objects presented in the virtual museums and tours.

The important applications of digitalization are “World Digital Library” and “Europeana project” (Figure 1), which present one of the heritage doors from Old Mosul City, providing access to millions of digital items from European and world cultural heritage. Moreover, many global organizations show interest and actions in cultural heritage elements such as WHS, UNESCO, ICCROM, etc. (Sotirova et al., 1972).



**Figure 1:** A sample from the Europeana project showing heritage elements in old Mosul City using various virtual tools [https://www.europeana.eu/en/item/181/share3d\\_1520](https://www.europeana.eu/en/item/181/share3d_1520) (Unioun, 2026)

### 3 Literature in Digitalization Methodology

The digitalization process of Cultural Heritage is a multidimensional process that depends on the nature of the object and the purpose of its recording. The whole process involves the three-dimensional digitization, digital data processing and storage, archival and management, representation, and reproduction. Pavlidis et al (2007) reviewed the methods of Digitalization in three dimensions and that apply to cultural heritage recording (Pavlidis et al., 2007). Pavlidis et al (2007) highlighted that 3D digitalization is a complex process that includes three levels in sequence

- The first level is Preparation, which is an important level in choosing the technique and methodology to be adopted as well as the place of digitization.

- The second level is Digital recording, which is the main digitization process according to the plan from level 1.

- The Third level is Data processing and converting to modeling of the digitized object through the unification of partial scans, geometric data processing, texture data processing, texture mapping, etc (Pavlidis et al., 2007).

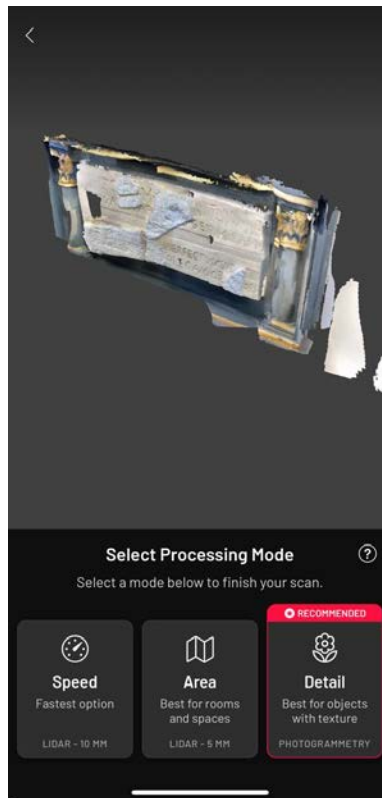
The study of Galantucci & Fatiguso (2019) and Gasimova & Abbasli(2020) mentioned the importance of algorithmic processes in digitalization, using two types ( AI Artificial Intelligence) and photogrammetry, including 3D laser scan. The process includes analysis of the data and data processing using 2D-3D modelling (Galantucci & Fatiguso, 2019; Gasimova & Abbasli, 2020). Rahaman et al (2019) represented in their study “From photo to 3D to mixed reality: A complete workflow for cultural heritage visualisation and experience” the technique of transferring the images (photo) to a 3D mixed reality, which is a method applied to complete a heritage site or object with mixing the recorded models with reality (Figure 2) (Rahaman et al., 2019). Gyawali (2023) highlighted the applications of 3D Mixed reality in engineering and construction as a tool that can create creativity for the future by mixing reality with simulated objects. Various applications, instruments, and software of mixed reality are available partially for the public and researchers, which can shape the future. Mixed Reality is an emerging technology with a lot of potential that is being developed and researched across the globe (Gyawali, 2023).



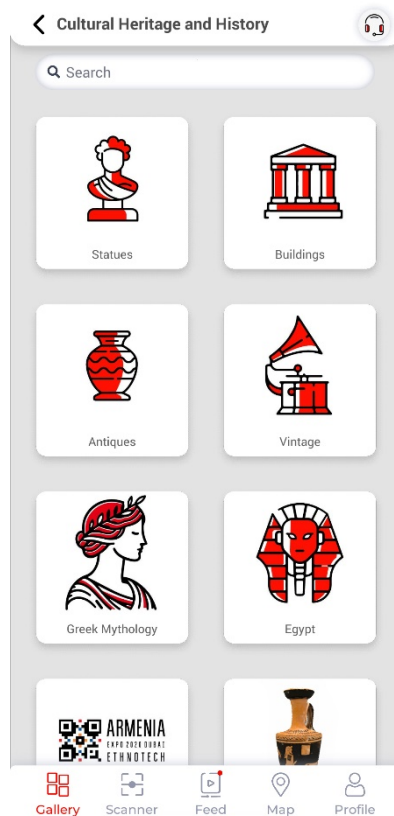
**Figure 2:** Application of Mixed Reality in Engineering and Construction (Gyawali, 2023, p. 4)

## 4 Methodology

The current study applied an experimental design with a descriptive approach to determine the best and right methods with sequences in the digitalization of physical elements related to cultural heritage. Moreover, interviews with five experts from the area of architectural documentation and computer science were conducted. The interview method considered the in-depth non-structured interview in order to reach deep information about the steps of the digitalization of the physical element of the cultural heritage. Moreover, an analysis of previous studies was applied to confirm the interview results. For the application study, the researcher applied two apps for the two main steps. The first step is documenting the physical elements, which is “Scaniverse - 3D Scanner” to create 3D models using the mobile phone camera (Figure 3). The second step is to represent the scanned projects on the digital platform ( ARloopa) (Figure 4).



**Figure 3:** Screenshot of the application after scanning for objects in Scaniverse - 3D Scanner App.



**Figure 4:** Screenshot from the application of the digital platform (ARloopa)

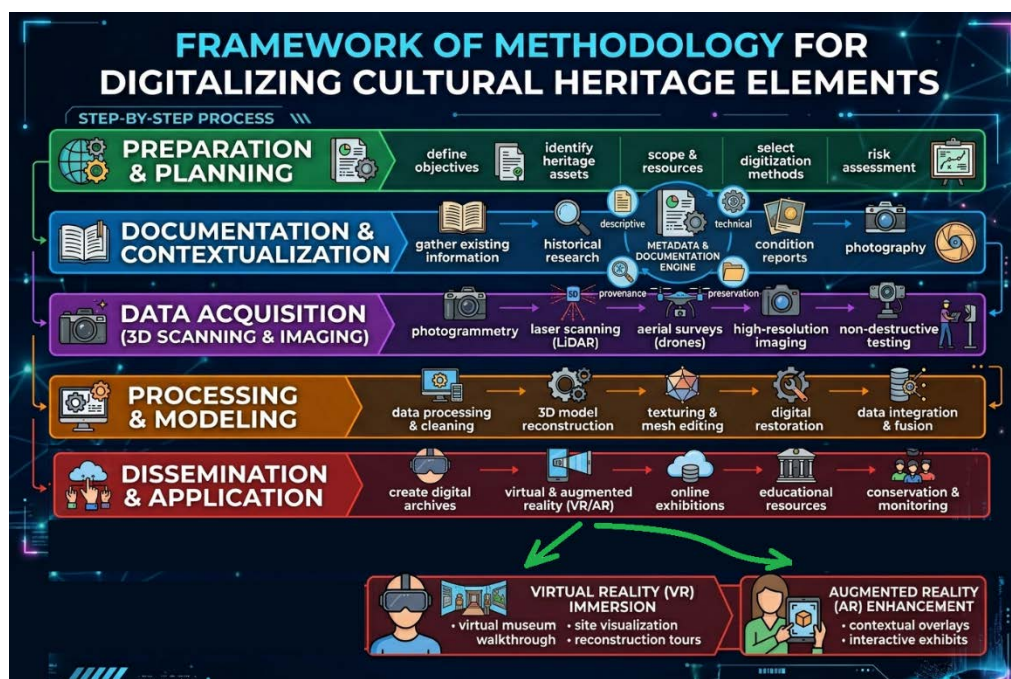
## 5 Results and Discussion

The results from the analysis of the secondary data, interviews, and application study show that the sequences in the digitalization process are the most important principles. However, in some cases, feedback is needed from the mid or last step of Digitalization, and collecting information can

start again from the first steps. The steps of Digitalization of intangible cultural heritage can start with collecting data, data processing, modelling, and verifying the work. Table 1 shows the details of these steps in sequence. Depending on these sequence steps, the architect and programmer can effectively digitalize heritage elements, ensuring their preservation, accessibility, and continued relevance for future generations.

**Table 1:** The steps of the Digitalization of intangible cultural heritage according to the results of the study.

Sequences	Main step	Secondary step
1	Planning & Preparation	<ul style="list-style-type: none"> <li>- Identify Objectives</li> <li>- Selecting elements</li> <li>- Resource</li> <li>- Create an outline of the process</li> </ul>
2	Documentation & Assessment	<ul style="list-style-type: none"> <li>- The physical condition of the elements</li> <li>- Record metadata</li> <li>- Legal and Ethical step</li> </ul>
3	Digitalization Process	<ul style="list-style-type: none"> <li>- Preparation of the elements</li> <li>- Digital capturing of the documents</li> <li>- Digital capturing of the images</li> <li>- Digital capturing of 2D objects</li> <li>- Digital capturing of 3D objects</li> <li>- Digital capturing of the site</li> <li>- Processing of the images</li> <li>- Processing of the 3D model</li> <li>- Review the outputs of the process</li> </ul>
4	Data Management and Storage	<ul style="list-style-type: none"> <li>- File organisation</li> <li>- Metadata integration</li> <li>- Storage and clouding</li> <li>- Data preserving</li> </ul>
5	Access and Dissemination	<ul style="list-style-type: none"> <li>- Create Digital Archives</li> <li>- Online Platforms</li> <li>- Interactive Applications</li> </ul>
6	Outreach	<ul style="list-style-type: none"> <li>- Public Engagement</li> <li>- Crowdsourcing and Community Contribution</li> </ul>
7	Evaluation and Improvement	<ul style="list-style-type: none"> <li>- Feedback Collection</li> <li>- Continuous Improvement</li> <li>- Update and Maintain</li> </ul>



**Figure 5:** A Framework of Methodology of Digitalizing the Elements of Cultural Heritage.

Figure 5 shows a complete framework for methodology of digitalizing the elements of cultural heritage.

## 6 Conclusion

The process of Digitalization of the physical elements of cultural heritage, such as buildings and monuments, is a critical process due to the sequences and the steps of the process that must follow a strong procedure to ensure the validity of the Digitalization outputs. Three main sequence steps and four extra steps with their secondary levels, which all must be done in sequence and rapidly and repeatedly. The Digitalization of cultural heritage elements is an integrational process of collecting, documenting, modelling, and clouding. Therefore, architects, archaeologists, and programmers should work together to integrate. The main objectives of the process are to preserve the cultural heritage elements and assist in the process of restoration and conservation. Additionally, provided rich and real data for researchers to enhance the process and provided a platform to the public to enhance tourism and educational purposes. Using light apps on mobile phones can provide quick and varied documentation on a digital platform, which can be controlled by specialists to ensure the quality of the outputs.

## 7 Availability of Data and Materials

All information is included in this article.

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**Note:** The origin of this article was reviewed, accepted, and presented at the 7th International Conference on Sustainable Architecture and Urban Design (ICWSAUD2024), a Joint Conference with the 2nd International Collaborative Conference on Sustainability (ICCS2024) and the 7th International Conference on Engineering, Innovation, & Technology (ICEIT2024), Kuala Lumpur, Malaysia during 15-16 July 2024.