Digital technologies to improve public fruition in Heritage sites through cultural significances and perception analysis

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Abstract

In the field of Cultural Heritage, digital documentation is currently a necessity to manage monitoring and maintenance actions, as an essential support for thorough analyses. The use of digital surveying techniques and 3D models has a strategic relevance in the conservation and mitigation process, considering possible risks and natural hazards. In this framework, the paper addresses documentation as a tool of knowledge (digital and not), considering it as essential in the initial phase of construction of urban and landscape models and capable of giving the bases for in-depth analyses and the prefiguration of strategies for regeneration. Starting from historical maps, the aim is to integrate different analysis methods through the use of digital models, which more and more have the capacity to include several data simultaneously (urban, territorial, social, cultural). The research is part of the iNEST project (Interconnected Nord-Est Innovation Ecosystem), an interdisciplinary study which aims at extending the beneficial effects of digitalisation to the areas of "Nord-Est" Italy, also through digital data as a cross-domain analysis tool, founded by PNRR (Piano Nazionale Ripresa Resilienza). Focusing on the case study of the historical city and landscape of Piazzola sul Brenta, the research is aimed at understanding the dynamics between the natural environment, the historical built one and the inhabitants, bringing together psycho-physical factors linked to the physical space and the perception of the place. The main topics of research exploration include new strategies to access, discover, and understand cultural assets leveraging on digital technologies and digital data management, applications for small cultural sites also focusing on social aspects linked to heritage significances, and possible new perspectives in the use of digital documentation for the management of public use of heritage.

Keywords: cultural heritage, digital documentation, historic landscapes management, perception analysis, heritage awareness, 3D models.

1. Introduction

In the field of Cultural Heritage, the use of digital documentation has become essential for effectively managing monitoring and maintenance endeavours. It provides a comprehensive and accessible means of capturing complex details and characteristics of cultural artifacts, sites, and monuments. Through digital technologies such as high-resolution imaging, 3D scanning, and Geographic Information Systems (GIS), it is now possible to develop detailed records that not only document the current state of heritage assets but also facilitate ongoing monitoring and preservation efforts. Digital repositories and databases give the possibility to monitor changes over time, assess deterioration, and plan conservation interventions. Overall, in the field of Cultural Heritage, digital documentation serves as an essential tool for managing, monitoring, and maintenance actions, ensuring the preservation and safeguarding of our Cultural Heritage for future generations.

Digital documentation plays a crucial role in disaster preparedness and response for cultural heritage sites. By creating digital backups of cultural assets, institutions can mitigate the risk of permanent loss in the event of natural disasters, conflicts, or other emergencies. Digital documentation also facilitates collaborative conservation efforts by enabling the sharing of data and resources among institutions and stakeholders worldwide (Bonazza et al., 2018). Moreover, Cultural Heritage is a crucial identity element of cities, sites and landscapes, and digital technologies can be an extremely useful tool for supporting Heritage interpretation and analysis of significances, providing new data to strengthen awareness, and accessibility and enhance fruition experiences (Giovannini et al., 2021; Münster et al., 2021).

Using documentation as a tool to acquire knowledge should be the initial stage in constructing models of urban and landscape environments, facilitating detailed analyses and the anticipation of strategies for regeneration. Alongside traditional methods of representing and describing on a territorial scale (such as planimetric representations and cartography), the advancement of 3D surveying technologies and modelling systems opens up new methodologies for understanding and representing the landscape. Accurate documentation as a tool of knowledge, both digital and not, is essential in the initial phase of the construction of urban and landscape models and is able to provide the basis for in-depth analysis and the prefiguration of strategies for regeneration and mitigation. This concept extends beyond the mere collection of information: Documentation, whether "analogue" or digital, plays a crucial role in capturing and preserving the complexity and richness of our urban and landscape settings.

Besides serving as a tool for acquiring knowledge, documentation also acts as a means for the preservation of historical and cultural memory. Through the accurate and detailed recording of structures, monuments, and landscape contexts, we are able to preserve tangible evidence of the past for future generations. This is particularly important in a rapidly changing world, where many urban areas and landscapes are undergoing significant changes due to population growth, urbanisation and climate change. It is important to remember that documentation (and its interpretation) is not limited to the preservation of existing heritage but plays an active role in planning and decision-making for future urban and landscape development. The collected information provides a solid foundation for the design of sustainable and culturally sensitive urban regeneration interventions. This approach allows to develop strategies that respect the historical and cultural identity of a place while ensuring harmonious and environmentally friendly urban growth (Contin et al., 2014).

Since this research examines the correlation between individuals and historical buildings and sites located within the case study chosen, to investigate whether residing in a small city with a rich historical backdrop significantly influences the psychological and physical well-being of inhabitants, the notion of "place attachment" has a central role in the analysis. In this regard, place identity has been considered as the way in which a place contributes to the identity of a person or people (Proshansky, 1983) and the composites of its characteristic features (Relph, 1976). The concept of place identity was explored as the manner in which a place contributes to an individual's or community's sense of self, encompassing its defining characteristics and features. Within an urban setting, the study posited that identity is shaped to varying degrees by the elements, activities, and events occurring within the environment. Digital representations and city models allow to integrate various types of data (urban, territorial, social, cultural) (Campi et al., 2022) and give the possibility to consider spaces in their whole entire complexity.

Additionally, digital documentation enables the dissemination of Cultural Heritage information to a wider audience through online platforms and virtual exhibitions, fostering greater public engagement and appreciation for heritage conservation efforts. Digital documentation in the field of Cultural Heritage allows for the dissemination of valuable information to a broader audience through online platforms and virtual exhibitions. Traditionally, access to cultural heritage artifacts and sites has been limited to physical visits, which may be constrained by factors such as geographical distance, travel costs, or time constraints. However, digital documentation offers possible solutions to these limitations by providing virtual access to heritage resources from anywhere in the world with an internet connection. This increased accessibility fosters greater public engagement with cultural heritage and encourages a broader appreciation for heritage conservation efforts, especially for those "minor" sites that usually struggle to reach a wider audience (Maietti, 2023). The potential of digital technologies also makes it possible to enhance the physical enjoyment of cultural heritage through applications that facilitate or stimulate cultural routes or make people discover previously unknown places. Moreover, people who may not have had the opportunity to visit heritage sites in person can now access them virtually, gaining insights into their historical, artistic, and cultural significance. This virtual access also extends to individuals with disabilities or mobility issues, ensuring that Cultural Heritage remains inclusive and accessible to all.

Furthermore, digital documentation facilitates educational initiatives and research collaborations by providing researchers, students, and educators with online resources and tools for studying and analysing Cultural Heritage materials. Digital archives, databases, and online repositories enable the sharing of data and research findings, fostering collaboration and knowledge exchange within the global cultural heritage community.

Overall, digital documentation plays a vital role in democratising access to cultural heritage and promoting public engagement and appreciation for heritage conservation efforts. By leveraging digital technologies to make cultural heritage resources more accessible and interactive, institutions can inspire curiosity, learning, and preservation of our shared cultural heritage for future generations.

The first article of the document by the European Commission entitled "Commission Recommendation of 10.11.2021 on a common European data space for cultural heritage" states that "Digital technologies have been changing our lives at a fast pace, providing new opportunities for society, including cultural heritage institutions. Digital technologies offer cultural heritage institutions more effective tools with which they can digitise cultural heritage assets and reach broader audiences. This creates more ways for the public to access, discover, explore and enjoy cultural assets and creates more possibilities for reusing cultural assets for innovative and creative services and products in various sectors, such as other cultural and creative sectors, as well as tourism". And, article 8 states that "The development of advanced digital technologies, such as 3D, artificial intelligence, machine learning, cloud computing, data technologies, virtual reality and augmented reality, has brought unprecedented opportunities for digitisation, online access and digital preservation. Advanced digital technologies lead to more efficient processes (e.g. automated generation of metadata, knowledge extraction, automated translation, text recognition by optical character recognition systems) and higher-quality content. They allow innovative forms of artistic creation while opening up new ways of digitally engaging with and enjoying cultural content through co-curation, co-design and crowdsourcing, empowering public participation […]". This document is particularly significant in revealing how digitisation is creating unprecedented opportunities for Cultural Heritage while emphasising the urgency of digitally preserve heritage assets, improving accessibility, fostering the reuse of contents, including previously

digitised assets, and providing solutions for processing, accessing and managing datasets (Commission proposes a common European data space for cultural heritage, n.d.).
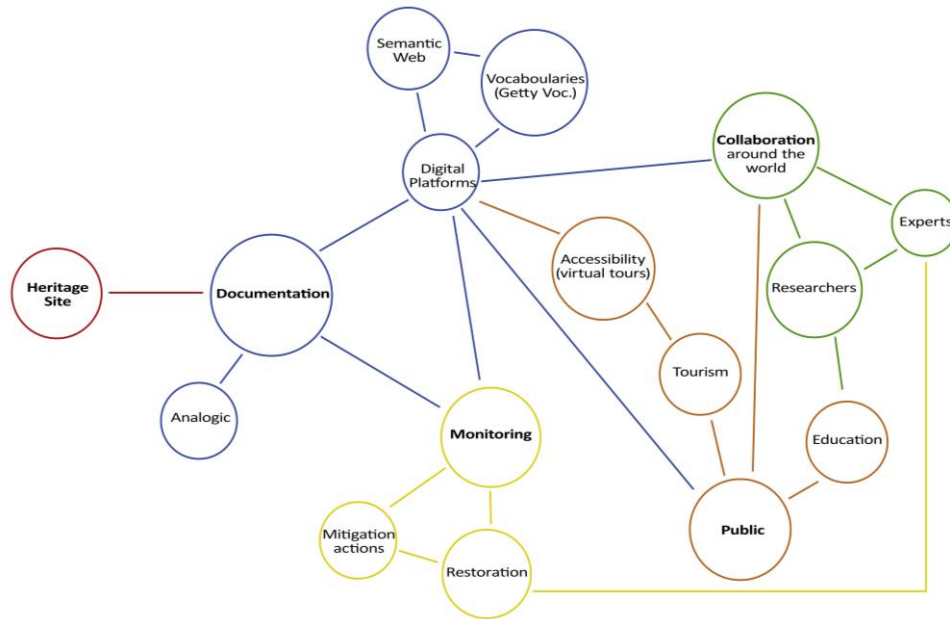

Figure 1. The importance of Digital Documentation in the field of Cultural Heritage (image of the authors).

2. Aims and objective

This research seeks to comprehend the relationships among the natural surroundings, historical architecture, and inhabitants, considering the psycho-physical elements associated with the physical space and people's perception of it. Key areas of research exploration involve devising fresh approaches to accessing, uncovering, and comprehending cultural resources through digital technologies and data management. It also examines applications tailored for smaller cultural sites, with attention to social aspects related to heritage significance, alongside potential novel perspectives on employing digital documentation to manage public usage of heritage sites. Focusing on the case study of the historical city and landscape of Piazzola sul Brenta, in the province of Padua, in the north-east of Italy, this research integrates different analysis methods in order to have a proper base for digital models, which more and more have the capacity to include several data simultaneously (urban, territorial, social, cultural), and since this research is concerned with investigating such a huge subject which interferes with so many factors, this characteristic is a fundamental element. By integrating different datasets into digital models, it is possible to reach a comprehensive understanding of the complex dynamics within urban environments. For example, it is possible to analyse how social factors intersect with spatial configurations to influence community dynamics or assess how Cultural Heritage assets contribute to the overall identity of a city.

Furthermore, the ability to incorporate multiple types of data into digital models enables more holistic assessments and decision-making processes. In the field of urban planning, these complex models can be used to simulate different scenarios and evaluate the potential impacts of various interventions or policies on urban, social, and cultural dynamics. This facilitates more informed and sustainable urban development strategies that take into account a broader range of factors and stakeholders' perspectives.

3. Methods and procedure

Examining the case of Piazzola sul Brenta, a small town in the Veneto region, a territorial examination was developed to explore the interplay between natural and man-made environments.

The historical and naturalistic context of Piazzola sul Brenta represents a particularly significant ensemble of cultural and natural heritage gathered in a small historical centre, making it a representative case study of many settings, not only in Italy, where historical evolution, the most iconic monuments - such as the Villa Camerini-Contarini - and territorial ones, such as the river Brenta, provide an ideal research scenario to investigate the role of digital tools for knowledge and enhancement, and to analyse intangible significances and emotional perceptions.

In this context, where space includes both physical dimensions and the perceptions of those inhabiting it, adopting an interdisciplinary approach is crucial. Consequently, the initial phase of spatial analysis focused on juxtaposing current conditions in the studied area with historical maps. This method of landscape analysis not only facilitates understanding the historical relationships between built and natural surroundings but also sheds light on how human actions have influenced the landscape positively and may continue to do so in the future, rectifying past errors or addressing issues stemming from previous experiences.

Figure 2. Villa Camerini-Contarini and the portici of the square in front of the Villa (images of the authors, from ProLoco Piazzola sul Brenta, from Gallery of the Municipality of Piazzola sul Brenta).

The initial stage of the research started with a comprehensive review of historical maps to gain understanding into the development of both the natural and built landscapes. During this preliminary investigation, particular attention was focused to studying the historical changes of the Brenta riverbed and Villa Camerini-Contarini. The research started by examining historical maps sourced from the State Archive of Venice, specifically focusing on those illustrating the Villa and the interaction between the Villa and the Brenta River's course. By closely analyzing primarily two maps and overlaying them onto the current landscape, noticeable alterations in the Brenta River's curvature were observed. The analysis revealed a deliberate modification in the river's trajectory, characterized by the creation of a diversion intended to facilitate field irrigation.

Exploring the human-made spaces within Piazzola sul Brenta's territorial boundaries, previous studies uncovered the existence of Roman axes traversing the village, although gradually disappearing over time. Additionally, an evaluation of Piazzola's urban layout was conducted, juxtaposing it with the orientation of the Roman axes. However, no correlation was identified between them. This preliminary examination highlighted the historical significance of Villa Contarini, particularly revealing that the village's urban configuration deviates from the Roman axes and, instead, aligns with the grid influenced by the orientation of Villa Contarini. By examining those historical maps, insights were gained into the alterations of the natural landscape and whether these changes were attributed to human activities. Utilizing historical maps as a layered document, the study delved into the evolution of the Brenta River, a pivotal natural feature in this small urban context, and the architectural structure that significantly defines the area's identity. Specifically, this examination emphasized the significant role of Villa

Contarini in shaping Piazzola, revealing that the entire urban structure revolves around the orientation of the Villa. This departure from the ancient Roman axes highlights the substantial influence of Villa Contarini on molding the spatial arrangement of the town.

During the comparison between historical maps and the contemporary state of the area, a significant inquiry emerged concerning its boundaries. Given that Piazzola sul Brenta is a small urban enclave nestled within the Venetian countryside, the demarcation between the city and the rural landscape is ambiguous. As buildings gradually dissipate, blending with the contours of the terrain and reinforcing its forms, the delineation between urban and rural becomes blurred. This issue holds considerable importance in a study focused on the dynamic interplay among human beings, environment, and nature. Indeed, boundaries can be either natural or man-made, yet they can also be perceived subjectively. In his very well known work "The Image of the City," Kevin Lynch explores how individuals perceive urban environments, investigating the processes by which people develop impressions and recollections of a city's layout, encompassing both its tangible and abstract boundaries. A central aspect of his examination is the notion of "boundary perception" and the significance of boundaries in shaping coherent and comprehensible mental representations of the urban landscape. A central topic in this research, individuals construct their cognitive maps of urban spaces through five key components known as "image elements." These elements, comprising paths, edges, districts, nodes, and landmarks, collectively contribute to the cognitive mapping of the city. Specifically, the concept of 'edges' assumes particular importance in the perception of boundaries within this cognitive mapping framework. Therefore, recognizable and clear boundaries influence the orientation that the individual has of the city, avoiding a sense of loss which would interfere with the perception that inhabitants have of the space. While clarity and legibility are not the sole defining features of a visually appealing city, Lynch observes, they become particularly significant when assessing the urban environment in terms of its size, temporality, and intricacy. To comprehend this, we must view the city not merely as an entity but rather through the lens of how its residents perceive it. The recognition of these boundaries, whether tangible or intangible, contributes to the formation of a unified mental representation of the city, impacting individuals' capacity to navigate and engage with their surroundings. This mental image subsequently informs the behaviors and routines adopted by citizens in their everyday interactions within urban environments (Lynch, 1964).

During the research, physical limits and perceived but also natural limits were identified. Furthermore, the boundaries of the city and the municipal one were compared, noting differences and inconsistencies with what is the surrounding natural landscape. The traces drawn on the landscape and the comparison of them with the historical maps were fundamental elements to carry out an in-depth analysis, necessary to understand a place with such a historical stratification.
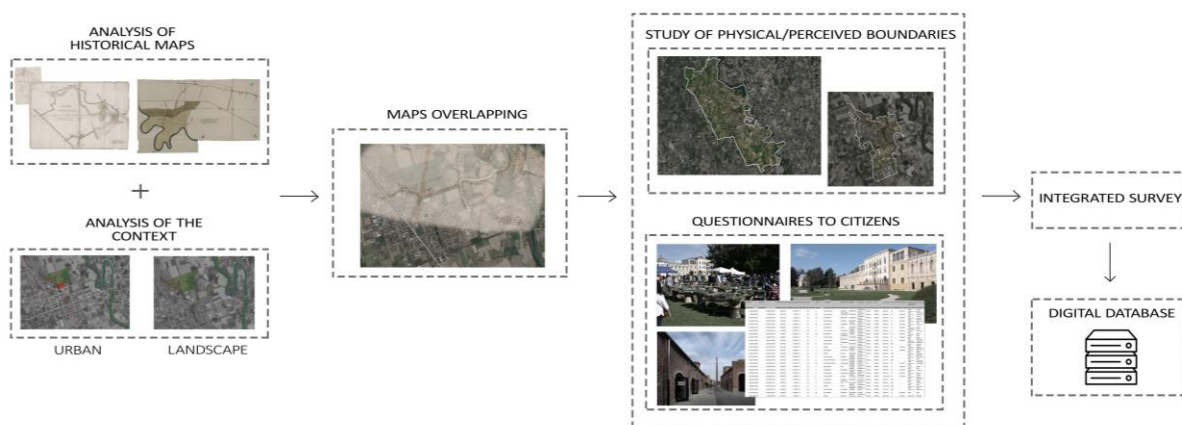

Figure 3. Documentation and analysis are the fundamental first step. Methodology scheme of the research.

4. Results

Preliminary outcomes of the research are a systematisation of direct and indirect sources, the comparison of which aims to search for new perspectives of analysis for knowledge and for the development of new strategies for understanding, awareness and thus conservation of historic centres. The integration of different documentation methodologies highlighs the essential role of merging different "layers" of knowledge, including physical and immaterial elements, using the 2D digitization, and creating the essential basis for the application of 3D surveying tools. Careful survey design and planning, when using "quantitative" surveying technologies such as these tools are, is indeed the core of the critical approach, which must always be applied, particularly when investigating Cultural Heritage. This critical approach opens up new perspectives in the field of digitisation, focusing on which data can be brought into the "system" of knowledge to answer new questions.

In this case, the interdisciplinary iNEST project (iNEST – Interconnected Nord-Est Innovation Ecosystem, s.d.) focuses on the human being and its well-being in experiencing natural and built environments, analysing the relationships between psycho-physical and perceptual elements with places in their current conformation and through the analysis of changes over time. With these intentions, citizens were provided with a questionnaire in which they were asked to identify three places that they thought were significant for the city's identity. Demonstrating the clear legibility of the city, the result of recognizable landmarks and a strong social identity in the place, citizens recognized around ten places (natural and artificial) as identity elements. Among these obviously Villa Contarini-Camerini was listed, as was its Park, the Brenta river, the city's Cathedral, the square in front of Villa Contarini-Camerini (in which various city activities take place) and others.

The next steps of the research involve the digital survey of the most significant contexts of the Piazzola sul Brenta case study in order to develop three-dimensional models that have the ability to collect different data, aggregating intangible perceptual levels to the digital representation of physical places.

5. Conclusions

Finally, digital documentation has the potential to democratise access to knowledge and public participation in urban planning and landscape conservation. Through online platforms and interactive tools, the information collected can be shared and accessible to a wide range of stakeholders, enabling a wider and more inclusive involvement in defining the future of our cities and landscapes. In short, documentation is a vital bridge between the past, present and future of our urban communities and natural environments. Through its role in collecting, storing and using information, documentation helps us understand, protect and responsibly shape the world around us. One of the aims of the research is to achieve effective utilisation of the digital data acquired, moving digital documentation and modeling out of a static and exclusive domain - reserved for those who make digital models or for experts in the field - and pursuing openness towards concrete and practical use.

There already are studies testifying how new technologies have the ability to "revolutionize" research and teaching by implementing collaborative theory and practice in the field of Digital Humanities (Giordano et al., 2022), embracing the analysis of urban systems with a new methodology in the interpretation of cultural sites complexities. An additional challenge for the future concerns data integration, finding new ways for merging information and communication technologies and digitization, with people's well-being, assuming the concept of "care" as pivotal (care for people, for the environment, for heritage assets, and care in managing new tools to guide future transformations of the territory), where citizens have a central role. Nevertheless, from a social point of view, the promotion by digital media of heritage sites not well know but evidence of cultural reality worthy of attention, can arise a social awareness and sense of belonging by local communities.

6. Acknowledgements

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