A collaborative Web App to foster a knowledge network on vernacular heritage, craftspeople, and sustainability

Jacopo Ammendola[1], Letizia Dipasquale[2], Edoardo Paolo Ferrari[3], Saverio Mecca[4], Lucia Montoni[5], Matteo Zambelli[6]

[1] Department of Architecture, University of Florence, Italy, jacopo.ammendola@unifi.it; [2] DarMed Lab, Department of Architecture, University of Florence, Italy, letizia.dipasquale@unifi.it; [3] Oxford Brookes University, Oxford, England, 18077828@brookes.ed.uk, epferrari@hotmail.it; [4] DarMed Lab, Department of Architecture, University of Florence, Italy, saverio.mecca@unifi.it; [5] DarMed Lab, Department of Architecture, University of Florence, Italy, lucia.montoni@unifi.it; [6] Department of Architecture, University of Florence, Italy, matteo.zambelli@unifi.it.

Topic: T2.4. Creativity and heritage education

Abstract

Vernacular architecture provides extraordinary technological and typological solutions, which are the result of a complex system of knowledge that has evolved through trial and error, in a deep connection to the environmental, social, economic and cultural contexts. The goal of the study presented here is to propose a tool able to organise vernacular knowledge, both tangible and intangible, by systematising principles, strategies, design models and solutions in order to be more easily shared, transmitted and employed in the design of new sustainable architecture. The tool, which is developed as part of the project "VerSus+ / Heritage for People" (Creative Europe Program), is a collaborative Web Application able to map solutions and models from vernacular architecture, and to associate and classify them with sustainable strategies. In addition to physical objects (cultural landscapes, urban, typological and technological solutions), the App will also map the people involved in the knowledge management of vernacular architecture: craftspeople and professionals in the field of vernacular architecture enhancement and conservation. This tool can catalogue solutions and knowledge from different branches of vernacular architecture, and make it available to a large audience, such as professionals, researchers, artisans and citizens, who can also directly contribute to the growth of the vernacular database by adding new information and solutions to the App. The idea is to have a user friendly and easy to consult App, able to suggest new solutions to contemporary design problems, based on the observation of similar past problems, so that sustainable models developed in the past can be adapted to design and construct a more appropriate architecture for the future.

Keywords: cultural heritage; sustainable and vernacular architecture; knowledge management; web mapping and mobile applications.

1. Introduction

1.1. Framework

The scope of this work is to present the design and the development of a collaborative tool that enable users to organise vernacular architecture knowledge, both tangible and intangible, according principles, strategies, design models and solutions, in order to be more easily transmitted, enhanced, and used in the design of new sustainable architecture. This work is part of the project "VerSus+ / Heritage for People" founded by Creative Europe Program during the period 2019-2023. At the core of VerSus+ project there is to foster the conservation of cultural heritage, encouraging a more sustainable approach to

contemporary architecture, by learning from a contemporary interpretation of locally developed-cum-traditional adaptive strategies. The VerSus+ project builds on the outcomes of the earlier project: "VerSus-Lessons from Vernacular Heritage in Sustainable Architecture" funded by the EU's Culture Programme. Starting from VerSus, several principles have been identified in order to find out strategies connected to several aspects linked to the four key levels of sustainability: natural/environmental, social, economic and cultural. Based on these assumptions, the VerSus+ People project is implemented with the aim of disseminating principles, techniques, and solutions of vernacular heritage to different audiences, and to reach a wide and varied public in order to positively impact society for a better and more sustainable development for the future (Mileto et al., 2020).

1.2. A tool based on people

In order to meet the goal of reaching a wide and varied audience, dissemination includes the development of a Web Application that can help people to access and systematize cases of valuable sustainable strategies. The Web App in this sense is collective as it is not merely a virtual catalogue to be consulted, but it becomes a tool for people to contribute to organise the vast repertoire of vernacular architecture knowledge.

The Web App is also guided by other important VerSus+ aims: 1. to strengthen the role of local artisans and craftspeople, as well as companies that work on traditional construction techniques and materials; 2. to promote the study methodology, strategies, activities and principles developed, and share results not only locally or regionally, but on a national scale and possibly even internationally. For this reason, the Web App not only includes material culture examples (e.g. buildings, landscapes, cities, etc.), but also, where possible, links to people and institutions working on vernacular heritage. Thus, it promotes the creation of a network of people that constitute, with their work, an important part of what is intangible heritage and knowledge.

Intangible cultural heritage represented by people is an essential feature of VerSus+ project, as it can be considered the larger framework within which tangible heritage takes on shape and meaning (Bouchenaki, 2003). The inclusion of people, institutions and associations as integral parts of the tool allow them to be key agents in the processes for the revitalization and innovation of local architecture (Mileto et al., 2020). Cultural heritage, as a form of social construction, is related to local knowledge narratives that are co-constructed by the concurrent participation of both narrative agents and active receivers; the latter are also involved in the knowledge making process (Ginzarly & Teller, 2021). Through a digital platform, the co-constructed and participatory nature of the tool can also enable a larger participation which goes beyond localities to become more widespread in space and time.

The dissemination tool is therefore based on including people in two ways: the first is to engage with them so that they can contribute to the Web App contents (inclusive/collaborative approach), the second is to link references to people (professionals, craftspeople, communities of practice, universities etc.) for whatever material heritage examples that have been mapped.

1.3. Why a Web App?

The development of an online digital platform is a powerful mean for dissemination as it provides a 'space' not only for documenting, but also for creating networks of people. Moreover, as compared to non-digital means of dissemination such as print books, a Web App can be constantly updated and integrated with more examples, materials, and links. This emphasis on new technologies is important to also establish a connection with other digital platforms that can be associated with the tool, for example: social networks, specialised craftspeople websites, websites for video sharing, and so on. It is also important to remember that among digital platforms, the use of social media for crowdsourcing grassroots initiatives aimed at the co-production of knowledge on heritage is still limited and not yet very explored

Name	Source	Theme and objective	InfoVis methods
mapadaterra	*www.mapadaterra.org*	Collaborative map about earthen architecture.	Map
Lehmbau im Wienviertel	*http://thinkspatial.boku.ac.at/app/?init=1&auth=ASZ5HRMPYNKTG8N1YL5W*	Web App to survey and analyse clay buildings in the Weinviertel (Austria). Through digital tools, the project aims to reach a wider audience and spread the knowledge of the local architectural heritage.	Map + mosaic
Red de Maestros	*www.redmaestros.com*	National directory of good practices in the fields of traditional construction and its restoration.	Grid
Europeana	*www.europeana.eu/en*	Europeana is the EU digital platform for cultural heritage. It works with thousands of European archives, libraries and museums to share cultural heritage for enjoyment, education and research.	Grid
Atlante Architettura Contemporanea	*www.atlantearchitetture.beniculturali.it*	The atlas is a project endorsed by the Directorate-General for Contemporary Creativity of the Ministry of Culture that proposes to prompt a more effective "network" perception of modern and contemporary Italian architectural heritage combining several architectures in thematic itineraries.	Map + grid
Cultural Gems	*https://culturalgems.jrc.ec.europa.eu/*	Cultural gems, founded by JRC, is a free open source and collaborative app to map the cultural and creative places of European cities. It is a guide for tourists but also residents, city administrators, and cultural third sector representatives.	Map + grid
Cultural Heritage Interactive Map	*http://arcg.is/0TjSai*	The project invites the general public, as well as cultural heritage experts, to browse cultural initiatives and events across Europe using interactive story maps online. More than just an information source, the web tool serves as an outreach effort to increase the public's involvement in their own cultural heritage.	Map + list
Inventing Abstraction 1910-1925	*https://www.moma.org/interactives/exhibitions/2012/inventingabstraction/?page=home*	The digital diagrams allows users to explore the relationships among the abstract artists represented in *Inventing Abstraction* (an exposition presented by MoMa in 2012-2013) all of whom played a significant role in the development of a new modern language for the arts.	Network

Table 1. Benchmarking on Web Apps and Platforms

(Ginzarly & Teller, 2021). Thus, linking the Web App to other digital 'spaces', which are constantly updated and which foster more public participation, is a way to expand the limits of the tool itself.

2. Methodology: approach and design

2.1. Benchmarking on Web Apps and Platforms on Traditional knowledge

Since cultures are constantly changing, the ways in which cultural heritage aspects are transmitted should also follow these dynamics. The phenomenon of digitization has made sharing easier and extended the meaning of representation and dissemination of cultural contents, making them available to a potentially much wider audience (Windhager et al., 2019).

Already in recent decades, there is a growing interest in the dissemination of cultural heritage through digital systems and there are now many platforms which work as public repositories of digital artefacts from museums, archives and libraries, such as the well-known experience of Europeana or the Digital Public Library of America. Windhager et al. (2019) collected and assessed some recent developments of interfaces and different methods of Information Visualization (infoVis) to enhance access to cultural collections.

For the development of the VerSus plus App we analyzed other similar examples as reference. The benchmarking has been mainly focused on platforms and Web Apps that use maps as visual encoding techniques for the collection of cultural data.

A key reference is *Lehmbau im Weinviertel* platform, which was developed by the project *Think Spacial!* for the knowledge and enhancement of earthen architecture in the Region of Weinviertel, Austria (Schauppenlehner et al., 2020). An essential aspect of the project is the interaction with Citizen Science through the involvement of locals in the mapping of heritage as well as the organization and dissemination of different kinds of materials that can be downloaded.

2022, Editorial Universitat Politècnica de València

Another valuable map-based project aimed at the dissemination of information on more sustainable ways to build is *mapadaterra*, which presents a collaborative cartography of building experiences with natural materials. One of the aims of the project is the development of a network of people interested in sustainability and natural construction that can communicate inspired by the platform's contents.

One more significant reference is the website *Red Nacional de Maestros de la Construcción Tradicional*, which is a Spanish network of artisans and masters in local know-how and a directory of good practises in the fields of traditional construction and restoration (Garcia, 2019). Its importace is the emphasis on people, therefore on their knowledge (immaterial heritage) and the involvement of craftspeople and experts in the field of vernacular heritage.

VerSus plus App, like all these projects, tries to make the best of all opportunities offered by digital technologies for documentation and dissemination of traditional knowledge. The community engagement component in this project is fundamental for two main reasons: the first one is that it helps to increase the social dimension and the feeling of being part of a group, even if virtual, and therefore contributes to the development of an awareness towards vernacular heritage; the second one is that through the production and sharing of contents, new meanings of cultural heritage can emerge (Calcagni et al., 2019).

2.2. A Case-Based Reasoning approach

The design of the Web App starts from the need to create something more than an archive, a catalogue or a map of case studies of buildings, vernacular techniques or craftspeople. VerSus plus Web App wants to be a tool to provide scholars and designers with models, examples, information to create innovative solutions, for a sustainable architecture for the future. By adopting a Case-Based Reasoning approach, the information of the app wants to provide concrete examples of past solutions, in order to use them to solve a particular issue or to better understand it

today. Both Christopher K. Riesbeck, computer scientist, and Roger Schank, cognitive psychologist, are experts in artificial intelligence and focus their studies on "dynamic memory". This concept underpins the theory of CBR. At the core of this theory there is the fact that whatever experience from the past is available to us, it is likely that people will employ it as a model for future decision making (Kolodner, 1993; Riesbeck et al., 1989).

The CBR approach applied to design is based on the idea that a licit architectural solution can be drawn from similar cases from past experiences. Past scenarios can be re-used, recombined and partly revised, to satisfactorily solve a new design problem that starts from similar needs.

In order to employ suitable cases from the past to solve new problems, it is necessary to classify them in a clear and accessible way. Only by making its accessibility easier to a wider and newer audience, will guarantee that past experience will be employed (Oxman, 2003).

Indexing keys can be multiple and dynamic, as each case contains many related pieces of information. In the case of the VerSus plus App, the main reading key that we have identified for the research and resolution of design problems refers to the VerSus methodology (Correia et al., 2014). That is, the sustainability lessons learned from vernacular architecture have been chosen as attributes for indexing, archiving and researching cases and people related to both vernacular and contemporary architecture.

Furthermore, the cases were indexed taking into consideration their geographical position (they can be viewed on a map); the category (Landscape; City / town: Building; Building elements; Craftspeople; Center of documentation or dissemination); the main material or materials from which they were made of; and the type of intervention (traditional / vernacular, new, rehabilitation).

Table 2. The sustainability principles and related strategies

ENVIRONMENTAL SUSTAINABILITY

1 RESPECTING NATURE AND LANDSCAPE
1.1 Integrating with the land morphology
1.2 Minimizing intervention
1.3 Ensuring site regeneration
1.4 Respecting biodiversity

2 TAKING BENEFIT FROM NATURAL AND CLIMATIC RESOURCES
2.1 Applying appropriate form and
2.2 orientation
2.3 Managing water resources
2.4 Integrating soil inertia
2.5 Integrating solar energy
2.6 Adapting to dominant winds
Integrating vegetation

3 REDUCING POLLUTION
3.1 Using local materials
3.2 Recycling and reusing materials
3.3 Using low processed materials
3.4 Reducing transportation

4 ENSURING HUMAN WELL-BEING AND COMFORT
4.1 Using materials with high thermal inertia
4.2 Using hygroscopic and transpiring
4.3 materials
4.4 Promoting natural lighting and ventilation
4.5 Integrating adequate shading systems
4.6 Integrating courtyard or buffer-spaces
Using non-toxic materials

5 REDUCING DISASTER RISKS
5.1 Choosing appropriate sites
5.2 Designing robust and flexible structures
5.3 Employing compact and aerodynamic shape
5.4 Employing seismic resistant elements
5.5 Promoting building adaptation to disasters
5.6 Integrating damage mitigation systems

SOCIO-CULTURAL SUSTAINABILITY

6 PRESERVING THE CULTURAL LANDSCAPE
6.1 Respecting values and dynamics of the landscape
6.2 Supporting bio-diversity
6.3 Implementing water collection systems
6.4 Implementing erosion protection systems
6.5 Enhancing local crops

7 TRANSMITTING AND SHARING BUILDING CULTURES
7.1 Fostering constructive experiences and practices
7.2 Fostering the application of empirical know-how
7.3 Recognizing the value of masters and craftspeople
7.4 Involving young people in construction processes
7.5 Facilitating local community participation
7.6 Promoting self-maintenance processes

8 ENCOURAGING CREATIVITY
8.1 Promoting collective intelligence
8.2 Encouraging diversity
8.3 Integrating other building-cultures' influences
8.4 Allowing experimentation of different building techniques
8.5 Fostering evolution through experimentation, trial and error processes

9 RECOGNIZING INTANGIBLE VALUES
9.1 Expressing collective memory
9.2 Representing cultural identity
9.3 Enhancing a sense of place
9.4 Recognizing the value of history and mythology
9.5 Expressing peace and well-being

10 ENCOURAGING SOCIAL COHESION
10.1 Fostering pedestrian areas
10.2 Fostering a shared management ap-
10.3 proach
10.4 Enhancing public spaces
10.5 Sharing services and infrastructures
Implementing collective spaces for recreational activities

SOCIO-ECONOMIC SUSTAINABILITY

11 SUPPORTING AUTONOMY
11.1 Integrating residential and production spaces
11.2 Implementing autonomy in food produc-
11.3 tion
11.4 Implementing autonomy in water supply
Implementing local systems for goods transformation and conservation

12 PROMOTING LOCAL ACTIVITIES
12.1 Fostering local production
12.2 Fostering a short supply chain
12.3 Fostering local labour
12.4 Fostering local economy
12.5 Fostering the use of local materials

13 OPTIMIZING CONSTRUCTION EFFORTS
13.1 Adopting appropriate size
13.2 Promoting low-tech techniques
13.3 Reducing transportation of goods
13.4 Sharing common spaces

14 EXTENDING LIFETIME
14.1 Replacing building components when
14.2 needed
14.3 Implementing effective protection systems against weathering
14.4 Implementing effective maintenance plans
14.5 Implementing flexible systems
Implementing long-lasting structures

15 SAVING RESOURCES
15.1 Sharing infrastructure and services
15.2 Promoting urban density and building compactness
15.3 Integrating renewable energy sources
15.4 Reducing embodied energy
15.5 Minimizing heat losses
15.6 Integrating passive systems

2.2. VerSus principles and strategies for indexing, archiving and researching cases

VerSus methodology approaches the concept of sustainability from a transversal, holistic and multidisciplinary perspective. The methodology is based on three main levels of reading: 1. Three sustainable scopes: environmental, socio-cultural and socio-economic; 2. Five principles/aims or key questions related to each sustainable scope; 3. For each principle a list of strategies learnt from vernacular heritage for the design of a more sustainable architecture.

The definition of the 15 principles and related strategies is the result of a deep research work that started from the observation of vernacular architectures, which unlike standardised solutions of modern architecture, have adapted over time to local resources, to the limits and the risks defined by the natural as well as the socio-economic context.

Principles and strategies related to the environmental dimension of sustainability refer to the capacity to integrate a settlement, a building, and their related crafts with the environmental characteristics of a place, benefitting both from

natural and climatic resources, and by limiting pollution and waste. Principles and strategies related to socio-cultural sustainability refer to the capacity to guarantee and strengthen the sense of belonging, cultural diversity, local knowledge and know-how, personal and community well-being, social cohesion, the recognition of tangible and intangible cultural values. Socio-economic sustainability principles and strategies refer to the capacity to produce and maintain income and social well-being within the territory, supporting autonomy, promoting local activities, and saving resources.

Indexing through the VerSus strategies and principles listed in Table 1.2 is aimed at archiving vernacular knowledge to be used in the context of problem-solving, where 360-degree sustainability is a priority for the definition of new design ideas. The list of strategies is not fixed but it can be expanded and adapted according to the choices and the entries of the users who will use the App.

3. Implementation: a collaborative and cognitive Web App

3.1. Designing VerSus plus App: concept

The VerSus plus App is a multifarious disseminating tool that brings together different aspects: documenting and mapping tangible and intangible elements coming from vernacular heritage; looking for references of architectures, landscapes, understanding people knowledge where sustainable strategies are applied; understanding the sustainability degree of a case; and creating a network where all users can contribute to the construction of this database.

The Web App came out firstly as a tool for mobile devices, emphasizing the immediacy of the use and the accessibility to anyone from everywhere. It can be used as a map where the icons suggest the category of the entries, or by browsing the list of all of them (Fig 1). In this way, it is possible to customise the experience using filters, so that the users can visualise the features they need. Users can select according to their personal interests choosing between different

categories (from cultural landscape to human scale), materials, types of intervention, sustainability principle and strategies.

By logging in the app, people can insert new entries contributing to the growth of the available database. As shown in the last image of the Fig 1, the sheet of the entries contains some generic information (category, address/place, materials, period), a brief description, a gallery with images and videos, and some references that user could simply fill in together with the attribution of tags that correspond to sustainability strategies and principles of the feature.

A basic profile of the users could be a way to connect people that are members of this network. The possibility of sharing references, links, contacts goes with the idea of creating synergies and connections with similar realities. For a better understanding of the sustainability principles or a deeper investigation on the thematic field, visitors or members can find supportive materials.

The first mapping campaign of the various features has been done for the two case studies of Sant'Antioco (Italy) and Formentera (Spain) and then opened to the other inter-project experiences. The cases already documented in the previous projects (VerSus, 3d Past) are loaded. The app will be subsequently implemented by students and researchers involved in the activities that apply the VerSus methodology (Muñoz et al., 2022) and by all people that become aware of it and recognize its values. Existing networks among scholars and professionals in the fields of sustainability and vernacular knowledge will be the main channels to disseminate the VerSus plus App.

3.2. UI/UX design tools applied to the project

The design and development of User eXperience (UX) / User Interface (UI) design of the Web App has been preceded by extensive research and followed three main principles: User-Centered Design (UCD); mobile first approach; "map-first" approach in data presentation. The three principles can be considered, for this project, strongly correlated.
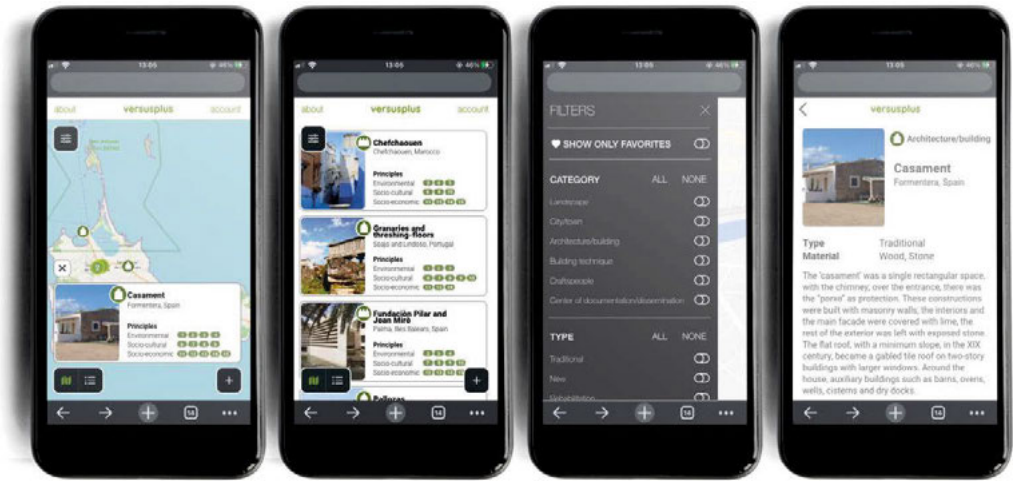
Fig. 1. Versus+ Web App interface

Mobile web cartography is a relatively recent field that in the last years has seen a significant development. Nevertheless, most of real applications are still in the commercial sector, and research-based projects are still rare or in development (Wang et al., 2017). The present case can be included according to Tsou (2013) classification in the fifth generation of apps, primarily regarding crowdsourcing of data. Mobile-first approach was applied to the design of visual elements and interactions. High value has been given to consistency between mobile and desktop versions, as well as between map-based and list-based presentation of the dataset. The preeminence of the former over the latter, as the main user interaction model, has guided the whole process of design.

The UCD, a widespread design model, was interpreted in this particular case mostly as an attentive research about current patterns and practices in largely used design of mobile and desktop geographical applications, primarily navigation apps such as Google Maps or Apple Maps (Ricker & Roth, 2018). A more specific analysis came from the research of real estate websites, whose dataset share many common aspects with the current use case. The reproduction of patterns of behviour found in existing and widely used digital tools has the specific

aim of improving the ability to interact with the interface for first time users. The UX design of the application is oriented in enable users to interact in easiest way with a complex geolocalized database, organized in a highly articulated classification system. The navigation and UI is studied to be accessible in desktop and mobile environments to all kind of users, granting different levels of detail to both occasional and recurring visitors. Layouts and icons were chosen among a series of options following usability tests on a sample of potential users.

4. Conclusions: expected positive outcomes

The value of traditional and local knowledge in providing models capable of generating solutions that strengthen the identity of the community are sustainable over time from a social, environmental, economic, and undoubtedly cultural point of view is widely recognized.

VerSus plus Web App allows to connect architectural examples and related practical knowledge in a semantic network, where conceptual links are created by the principles of sustainability, through which we intend to interrogate and navigate the remarkable heritage of vernacular knowledge.

2022, Editorial Universitat Politècnica de València

The use of the tool over time will give us feedback on the usability of the Web App, so that we can work on its strengths and weaknesses. Moreover, periodic considerations on the system provide an analysis of the citizens' approach/trends and interests in the vernacular heritage and could provide an outlook on where we are standing in terms of learning from sustainability strategies. This is also useful to bridge the gap between experts and users in order to allow decision making processes about urban heritage capable of engaging both experts and civil society (Ginzarly & Teller, 2021; European Commission, 2017).

References

Bouchenaki, M. (2003). The Interdependency of Tangible and Intangible Cultural Heritage. In *ICOMOS 14th General Assembly and Sci- en-tific Symposium (Victoria Falls, Zimbabwe, 27-31 October 2003)*. 5 pp.

Calcagni, F., Maia, A., Connolly, J., & Langemeyer, J. (2019). Digital co-construction of relational values: understanding the role of social media for sustainability. In *Sustainability Science.* Vol. 14. 40 pp. doi.org/10.1007/s11625-019-00672-1.

Correia, M., Dipasquale, L., & Mecca, S. (eds.) (2014). *VerSus. Heritage for tomorrow. Vernacular knowledge for sustainable architecture*. FUP. 288 pp.

European Commission (2017). *Mapping of Cultural Heritage actions in European Union policies, pro-grammes and activities*. 34 pp.

García Hermida, A. (2019). La Red Nacional de Maestros de la Construcción Tradicional. In *Revista PH.* 2 pp. doi.org/10.33349/2019.96.4259.

Ginzarly, M., Pereira Roders, A., & Teller, J. (2019). Mapping historic urban landscape values through social media. In *Journal of Cultural Heritage*. Vol. 36. 24 pp. doi.org/10.1016/j.culher.2018.10.002.

Ginzarly, M., & Teller, J. (2021). Online communities and their contribution to local heritage knowledge. In *Journal of Cultural Heritage Management and Sustainable Development.* Vol. 11(4). 28 pp. doi.org/10.1108/JCHMSD-02-2020-0023.

Kolodner, J. (1993). *Case-Based Reasoning.* Morgan Kaufmann Publishers Inc. 668 pp.

Mileto, C., Vegas, F., Correia, M., Carlos, G., Dipasquale, L., Mecca, S., Achenza, M., Rakotomamonjy, B., & Sanchez, N. (2020). The European Project VerSus+ / Heritage for People. Ob-jectives and Methodology. In *The International Archives of Photogrammetry, Re-mote Sensing and Spatial Information Sciences*. XLIV-M-1-2020. 5 pp.

Oxman, R. (2003). Think-Maps: Teaching design thinking in design education. In *Design Studies,* vol. 25(1). 29 pp. doi.org/10.1016/S0142-694X(03)00033-4.

Ricker, B. A., & Roth, R. E. (2018). Mobile maps and responsive design. In *Geographic Information Science & Technology Body of Knowledge*. CV-40. doi.org/10.22224/gistbok/2018.2.5.

Riesbeck, C. K., & Schank, R. C. (1989). *Inside Case-Based Reasoning*. Psychology Press. New Jersey. 448 pp. doi.org/10.4324/9780203781821.

Sánchez Muñoz, N., Moriset, S., Mecca, S., Dipasquale, L., Achenza, M., Mileto, C., Vegas López-Manzanares, F., Correia, M., & Carlos G. (2022). Transmission de la méthode VerSus "From Vernacular to Sustainable" aux étudiants et enseignants d'architecture : retour d'expérience. In *Proceedings of the congress Terra Education III 4-5 Juin 2018*.

Schauppenlehner, T., Eder, R., Ressar, K., Feiglstorfer, H., Meingast, R., & Ottner F. (2021). A Citizen Science approach to build a knowledge base and cadastre on earth buildings in the Weinviertel region, Austria. In *Heritage 2021*. Vol. 4(1). 15 pp. doi.org/10.3390/heritage4010007.

Tsou, M. H. (2011). Revisiting web cartography in the United States: The rise of user-centered design. In *Cartography and Geographic Information Science*. Vol. 38(3). 8 pp.

Wang, X., Van Elzakker, C. P., & Kraak, M. J. (2017). *Conceptual design of a mobile application for geography fieldwork learning*. ISPRS International Journal of Geo-Information. Vol. 6(11). 17 pp.

Windhager, F., Federico, P., Schreder, G., Glinka, K., Dörk, M., Miksch, S., & Mayr, E. (2019). Visualization of Cultural Heritage Collection Data: State of the Art and Future Challenges. In *IEEE Trans Vis Comput Graph. 2019 Jun.* Vol. 25(6). 20 pp. doi: 10.1109/TVCG.2018.2830759.