

Article

Harnessing Vernacular Knowledge for Contemporary Sustainable Design through a Collaborative Digital Platform

Letizia Dipasquale ^{1,*} , Jacopo Ammendola ², Lucia Montoni ^{1,*} , Edoardo Paolo Ferrari ³ and Matteo Zambelli ¹¹ Department of Architecture, University of Florence, 50129 Firenze, Italy; matteo.zambelli@unifi.it² Competence Centre for Sustainability, Free University of Bozen-Bolzano, 39100 Bolzano, Italy; jacopo.ammendola@unibz.it³ School of Architecture, Oxford Brookes University, Oxford OX3 0BP, UK; edoardopaoloferrari@gmail.com

* Correspondence: letizia.dipasquale@unifi.it (L.D.); lucia.montoni@unifi.it (L.M.)

Abstract: Vernacular architecture offers valuable technological and typological solutions rooted in knowledge systems that connect environmental, social, economic, and cultural contexts. This paper introduces the Heritage for People Platform, a collaborative digital tool developed under the VerSus+ project (Creative Europe Program), aimed at organising and disseminating vernacular architectural knowledge with a focus on sustainable practices that are both culturally and environmentally conscious. The platform builds upon lessons learned from similar projects, offering key improvements such as the adoption of a Case-Based Reasoning methodology, which organises examples by geographic location, materials, and intervention types. A structured classification system based on sustainability principles and strategies enables cross-disciplinary research and comparison. The design process was highly participatory, incorporating user feedback at every stage to ensure the platform is accessible to a wide range of users, including designers, scholars, craftspeople, and the general public. A cross-device, user-centered approach further broadens its accessibility. The platform provides a public, web-based geospatial repository where users can create, update, and explore a dynamic collection of artefacts, design models, people, and institutions from across the globe. This tool marks a significant advance in promoting and preserving both physical and intangible heritage, with strong educational and practical applications for sustainable architecture. The paper details the theoretical framework and real-world potential of the platform as a critical resource for promoting sustainability in the built environment.

Keywords: cultural heritage; vernacular architecture; sustainability; knowledge management; web mapping; mobile applications



Citation: Dipasquale, L.; Ammendola, J.; Montoni, L.; Ferrari, E.P.; Zambelli, M. Harnessing Vernacular Knowledge for Contemporary Sustainable Design through a Collaborative Digital Platform. *Heritage* **2024**, *7*, 5251–5267. <https://doi.org/10.3390/heritage7090247>

Academic Editor: Roberto Scopigno

Received: 31 July 2024

Revised: 10 September 2024

Accepted: 15 September 2024

Published: 18 September 2024



Copyright: © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The preservation and promotion of vernacular heritage and architecture have become increasingly critical, particularly in light of their positive contributions to global sustainability goals [1–3]. Vernacular architecture, defined by local traditions, indigenous materials, and traditional building techniques, represents a rich repository of cultural, environmental, and historical knowledge [4]. This knowledge spans multiple disciplines beyond architecture, including engineering, ecology, anthropology, human geography, and physics—specifically, the physics applied to the built environment [2].

As contemporary society faces ecological and social challenges, there is a renewed appreciation for traditional knowledge and vernacular strategies [1,2]. Unlike standardised modern construction methods, vernacular architecture has evolved through generations of trial and error, adapting to local resources, constraints, and risks while being shaped by its natural and socio-economic context [4]. Locally derived-cum-traditional adaptive strategies are considered more and more valuable resources to learn from and are therefore increasingly studied and documented [1,2]. However, in the face of rapid urbanisation,

modernisation, and technological advancements, the expertise of craftspeople and the understanding of sustainable, context-specific practices are at risk of being lost [2]. This presents both a challenge and an opportunity for heritage conservation and the development of sustainable communities.

Research in this field has increasingly emphasised the potential of Natural-Based Solutions (NBS) [5] and Local Resource-Based (LRB) [6] technologies, many of which are embedded in traditional ways of living and interacting with the environment. Vernacular strategies derived from these systems are invaluable resources for addressing contemporary issues, provided they are documented, analysed, and disseminated.

Recent advancements in digital technologies have not only improved the preservation of valuable knowledge but have also facilitated greater collaboration and knowledge exchange among experts, local communities, and professionals from various disciplines [7]. In this context, a collaborative digital tool is crucial for creating an interconnected network that brings together a diverse range of stakeholders—including architects, historians, craftspeople, and sustainability advocates—enabling them to share insights, resources, and best practices.

This paper presents the development of the *Heritage for People Platform* [8], a digital tool specifically designed to foster a knowledge network centered on vernacular heritage, architecture, traditional craftsmanship, and sustainability.

The development of the *Heritage for People Platform* was one of the key activities of the “VerSus+ /Heritage for People” project [9], funded by the Creative Europe Program (2019–2023). The main objective of the VerSus+ project is to disseminate knowledge and raise awareness about the conservation and transmission of both tangible and intangible cultural heritage to promote more sustainable living [10]. VerSus+ builds upon the results of previous research called “VerSus-Lessons from Vernacular Heritage in Sustainable Architecture” [3], whose aim was to understand the lessons of sustainability transmitted by vernacular architecture, which were codified into 15 principles spanning environmental, socio-cultural, and socio-economic dimensions. While the VerSus project innovatively introduced a way to analyse and understand sustainability imbued into vernacular traditions, it became urgent to find a way to more practically learn, adopt, and eventually utilise these principles by involving not only academic communities. In fact, several scientific studies remain isolated, and their valuable content is not accessible outside specialised fields. This seemed to us a relevant gap to address through the development of this project because of the possibilities offered by an online digital tool.

The primary goal of the *Heritage for People Platform* is to establish a dynamic, evolving repository that systematises sustainable strategies, design models, and solutions drawn from vernacular traditions, making them accessible to a wider, non-academic audience through the open-ended capabilities of a digital platform. It serves as a resource for scholars, designers, and craftspeople, promoting more mindful design practices rooted in a respectful relationship with natural, social, and cultural environments. Additionally, the platform fosters global connectivity, enabling stakeholders from diverse regions to collaborate and exchange knowledge.

The creation and initial testing of the platform were carried out as part of the VerSus+ project, which concluded in 2023. Further testing in 2024 is discussed in this article. However, given the platform’s goal of becoming a continuously evolving archive, content creation thus far has focused on a limited number of case studies, with the broader archive to be expanded over time. The project is therefore divided into two phases: Phase 1, which involves the creation and initial testing of the platform, and Phase 2, which will focus on content development and long-term goals.

This paper provides a critical analysis of Phase 1, examining the platform’s functionality and potential, while also initiating a discussion on how content will be developed moving forward. The conclusions primarily revolve around the lessons learned from the design and development process based on user feedback. As the platform evolves, it

will continue addressing the knowledge gap between theory and practice, offering new opportunities for learning, collaboration, and the preservation of vernacular knowledge.

2. Related Works

2.1. Digital Platforms for Managing Cultural Heritage

The documentation, dissemination, understanding, protection, and preservation of cultural heritage, both tangible and intangible, have been significantly enhanced through the utilisation of digital tools such as digital recordings, photography, scanning, BIM, 3D scanning, GIS, and, more recently, IoT, VR, AI, and blockchain technology. The primary advantages of digital technologies, compared to traditional methods, include greater degree of accuracy and detail, as well as the capability to link and search data via databases. Furthermore, digital tools enable broader public engagement in both the construction and consultation of databases, thereby democratising access to cultural assets and raising awareness about their value and the risks they face [11].

Among the possibilities offered by digitalisation, the use of spatial databases to geographically locate resources, known as geographical information systems (GIS), is of particular interest for the disciplines of architecture, landscape architecture, and urban studies. The integration of geographical data with other information and digital media makes possible the exact positioning of resources, the visualisation and analysis of spatial relationships, and the engagement of different kinds of publics interested in specific geographical realms. The use of GIS for assessing and cataloguing historical and cultural heritage assets emerged in the 1990s [11]. The systems were then progressively integrated with emerging web technology during the 2000s, facilitating broader public engagement and the development of collaborative, crowd-sourced geographical databases [12–14]. These early experiments laid the groundwork for Public Participatory GIS (PPGIS), a methodology extensively utilised in historical heritage that enables the active participation of citizens, enthusiasts, underrepresented communities, experts, and institutions [15].

Over the last two decades, numerous collaborative web-based projects have been developed for mapping cultural heritage, with several specifically focusing on vernacular and traditional knowledge. The advantages of these tools over classical catalogues [16] of case studies and best practices can be summarised as follows: precise geolocation of assets; large and expandable catalogue size; advanced search and filtering capabilities; and collaborative data addition and correction involving diverse communities.

Furthermore, the development of an internet-based digital platform functions not only as a means to distribute knowledge but also as a virtual environment that fosters people's networks. This includes integrating social networks, websites of artisans and other specialised professionals or organisations, video-sharing platforms, and other digital media to facilitate connections among those interested in the subject.

The preliminary documentation phase for the creation of the *Heritage for People Platform* involved the reconnaissance and classification of existing collaborative web-based geospatial projects, with a particular focus on both tangible and intangible heritage related to vernacular architecture and traditional building techniques. This research revealed the existence of numerous collaborative projects that, in various ways, aim to create digital geographic databases dedicated to the conservation, enhancement, promotion, and dissemination of both tangible and intangible heritage. A selection of these projects is presented here, categorised into three main types.

The first type comprises databases exclusively dedicated to the collection of tangible heritage objects:

- *SIGECweb* [17,18] is implemented by the Italian government. It is a collaborative tool for cataloguing Italian cultural assets, equipped with a public web client [19];
- *Sosbrutalism* [20] is developed by the Deutsches Architekturmuseum that contains brutalist buildings worldwide, with the goal of promoting their protection and preventing demolitions or alterations [21];

- *Lehmbau im Weinviertel* [22] is created by the *Think Spacial!* project with the goal of cataloguing earthen constructions in the Weinviertel region of Austria. A crucial component of the project is the engagement of Citizen Science, which involves the participation of local individuals in the process of mapping heritage [12].

A second type consists of databases that encompass intangible heritage, including knowledge, expertise, project guidelines or other types of resources:

- *Hiberatlas* [23], a project by the EURAC Research Center, aims at collecting best practices for retrofitting historic buildings [24,25];
- *H-ATLAS.Porto* [26] contains best practices in heritage conservation and redesign practices in Portugal [27];
- *Mapa da Terra*, focused on sharing knowledge on sustainable methods of construction [28,29]. It is a collaborative cartography showcasing building experiences using natural materials. The initiative intends to cultivate a network of individuals who are interested in sustainability and natural construction, with the intention of inspiring them through the platform's content;
- *Mediterrenet* [30] collects and geolocates professionals who are experts in earthen building techniques.

In this category, the *Red Nacional de Maestros de la Construcción Tradicional* [31,32] website is another invaluable resource that emphasises the intangible heritage of technical knowledge and the network of craftsmen. Although it lacks georeferencing, this platform serves as a Spanish network for highly experienced artisans and master craftsmen. It provides a database of exemplary methods in traditional construction and restoration, prioritising the expertise of craftspeople and their areas of origin.

A third category consists of integrated databases, in which the first two types coexist:

- *Cartoterra* [33,34], developed by CRAterre, contains buildings, active projects, conferences, exhibitions, companies, and everything related to earthen architecture;
- *MEA* (Map of Earthen Architectures) [35], a project by Associazione Internazionale Città della Terra Cruda, aims to crowdsource information on earthen architecture, including its network of experts and related events in Italy.

From a technical perspective, most of the examples analysed above utilise the Google Maps platform, though they exhibit varying degrees of customisation and integration. In contrast, [17,22] employ the open-source framework Leaflet. All examples are primarily designed and developed for desktop use. Although some enable visualisation on mobile devices, none guarantee a complete user experience on these platforms. Issues were identified in accessing certain data, activating filters, and, most critically, adding or editing data on mobile devices.

2.2. VerSus Wheel: 15 Sustainable Principles to Codify Lessons from Vernacular Knowledge

The classification system used in the *Heritage for People* Platform is based on the sustainability lessons from vernacular architecture that resulted from the previous VerSus project [3]. The VerSus methodology embraces a comprehensive, cross-cutting approach to sustainability. It categorises sustainability lessons into three levels—environmental, socio-cultural, and socio-economic—each with five guiding principles and an accompanying list of case-based strategies for each principle (Figure 1). The definition of the 15 principles and their related strategies is the result of extensive research initiated through the observation of vernacular architectures. The principles and strategies concerning the environmental aspect of sustainability encompass the integration of habitats with the natural and climatic features of a place. This includes employing natural and climatic resources effectively while minimising pollution, resource consumption, and waste generation. Socio-economic sustainability principles and strategies refer to the ability to generate and maintain income and social welfare within the territory, supporting self-reliance, promoting local activities and saving resources. The list of strategies, as presented in Table 1, is not static; rather, it

can be increased and adjusted based on the preferences and input of the users who will utilise the platform.

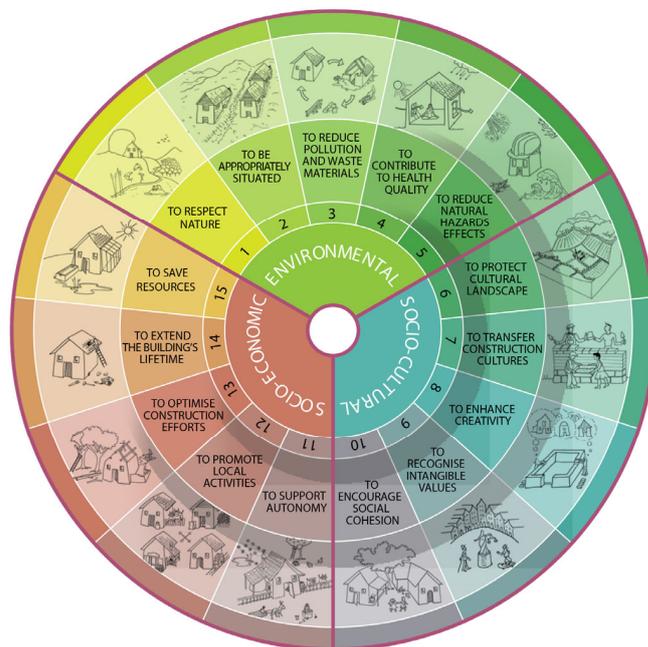


Figure 1. VerSus wheel representing sustainability principles. Source: The project “VerSus-Lessons from Vernacular Heritage in Sustainable Architecture”.

Table 1. List of sustainability principles and strategies.

Sustainability Levels	Sustainability Principles	Sustainability Strategies
Environmental	Respecting nature and landscape	<ul style="list-style-type: none"> • Integrating with the land morphology • Minimising intervention • Ensuring site regeneration • Respecting biodiversity
	Taking benefit from natural and climatic resources	<ul style="list-style-type: none"> • Applying appropriate form and orientation • Managing water resources • Integrating soil inertia • Integrating solar energy • Adapting to dominant winds • Integrating vegetation
	Reducing pollution	<ul style="list-style-type: none"> • Using local materials • Recycling and reusing materials • Using low-processed materials • Reducing transportation
	Ensuring human well-being and comfort	<ul style="list-style-type: none"> • Using materials with high thermal inertia • Using hygroscopic and transpiring materials • Promoting natural lighting and ventilation • Integrating adequate shading systems • Integrating courtyard or buffer spaces • Using non-toxic materials
	Reducing disaster risks	<ul style="list-style-type: none"> • Choosing appropriate sites • Designing robust and flexible structures • Employing compact and aerodynamic shape • Employing seismic-resistant elements • Promoting building adaptation to disasters • Integrating damage mitigation systems

Table 1. Cont.

Sustainability Levels	Sustainability Principles	Sustainability Strategies
Socio-cultural	Preserving the cultural landscape	<ul style="list-style-type: none"> • Respecting values and dynamics of the landscape • Supporting biodiversity • Implementing water collection systems • Implementing erosion protection systems • Enhancing local crops
	Transmitting and sharing building cultures	<ul style="list-style-type: none"> • Fostering constructive experiences and practices • Fostering the application of empirical know-how • Recognising the value of masters and craftspeople • Involving young people in construction processes • Facilitating local community participation • Promoting self-maintenance processes
	Encouraging creativity	<ul style="list-style-type: none"> • Promoting collective intelligence • Encouraging diversity • Integrating other building-cultures' influences • Allowing experimentation with different building techniques • Fostering evolution through experimentation, trial, and error processes
	Recognising intangible values	<ul style="list-style-type: none"> • Expressing collective memory • Representing cultural identity • Enhancing a sense of place • Recognising the value of history and mythology • Expressing peace and well-being
	Encouraging social cohesion	<ul style="list-style-type: none"> • Fostering pedestrian areas • Fostering a shared management approach • Enhancing public spaces • Sharing services and infrastructures • Implementing collective spaces for recreational activities
Socio-economic	Supporting autonomy	<ul style="list-style-type: none"> • Integrating residential and production spaces • Implementing autonomy in food production • Implementing autonomy in water supply • Implementing local systems for goods transformation and conservation
	Promoting local activities	<ul style="list-style-type: none"> • Fostering local production • Fostering a short supply chain • Fostering local labour • Fostering local economy • Fostering the use of local materials
	Optimising construction efforts	<ul style="list-style-type: none"> • Adopting appropriate size • Promoting low-tech techniques • Reducing transportation of goods • Sharing common spaces
	Extending lifetime	<ul style="list-style-type: none"> • Replacing building components when needed • Implementing effective protection systems against weathering • Implementing effective maintenance plans • Fostering flexible systems • Implementing long-lasting structures
	Saving resources	<ul style="list-style-type: none"> • Sharing infrastructure and services • Promoting urban density and building compactness • Integrating renewable energy sources • Reducing embodied energy • Minimising heat losses • Integrating passive systems

3. Materials and Methods

The methodological approach to the platform's development is depicted in Figure 2. It began with a comprehensive analysis of the context and key concepts that shaped the project's core challenges and overall objectives. Existing digital tools for managing vernacular knowledge and Figurecultural heritage based on geographically located resources were examined, focusing on their classification systems, advanced search features, collaborative data input, and user engagement strategies.

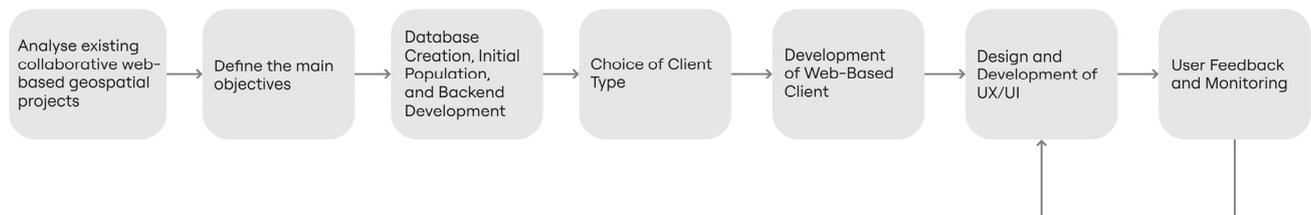


Figure 2. Stages of the *Heritage for People Platform* development.

Based on this analysis, the platform's key objectives and methodological framework were defined. Following this, we advanced through various phases of development, including technical planning, iterative design processes, and user engagement strategies. Each phase was carefully structured to ensure the platform met its functional requirements while delivering an optimal user experience. The following sections provide a detailed account of these development stages.

3.1. Objectives and Methodological Approach

3.1.1. Fostering a Case-Based Reasoning Approach to Integrate Vernacular Lessons into More Conscious Design

The primary objective of the *Heritage for People Platform* is to facilitate the systematisation of exemplary case studies on sustainable techniques, practices, and strategies inspired by traditional knowledge. Its purpose is to surpass the function of a mere archive, catalogue, or map of case studies. It aims to be a resource for scholars and designers, providing outstanding models, examples, and information inspired by vernacular knowledge to facilitate more conscious design based on a respectful relationship with the natural, social, and cultural environments. Following a Case-Based Reasoning approach [36,37], it aims to provide concrete examples of past solutions that can be applied to address current, specific issues. The Case-Based Reasoning approach applied to design is based on the idea that satisfactory architectural solutions can be derived from comparable cases from prior experiences. To resolve a new design problem that originates from similar requirements, past scenarios can be repurposed, recombined, and innovated. Classifying past cases in a clear and accessible manner is essential for utilising them to address new issues [37]. The indexing keys can be dynamic and multiple, as each case contains numerous related items of information. In the case of the *Heritage for People Platform*, sustainability lessons learned from vernacular architecture and codified into principles by the VerSus project [3] were selected as attributes for indexing, archiving, and searching cases related to vernacular and contemporary architecture.

To facilitate searches based on project requirements, the cases are also indexed by their geographical location (viewable on a map), category (landscape; city/country; building; building elements; craftsmen; documentation or dissemination centre), primary materials used, and type of intervention (traditional/vernacular, new, rehabilitation). Thus, the tool facilitates in-depth research using cross-cutting criteria. It enables the cross-referencing of sustainability principles and strategies with various attributes such as material types, locations, categories, and types of interventions.

3.1.2. Enhancing a Network of People Interested in Sustainability and Vernacular Heritage through a Collaborative and Inclusive Tool

Another key objective of the *Heritage for People Platform* is to strengthen a network of individuals who can act as key agents in the revitalisation and innovation processes of vernacular knowledge [38]. The dissemination tool is designed with a collaborative approach, aiming to include a diverse range of users and offer tailored resources for architects, designers, researchers, craftspeople, cultural heritage organisations, students, and policymakers. Architects can access sustainable design strategies from vernacular approaches to develop context-sensitive, eco-friendly designs. Researchers can utilise the platform for interdisciplinary studies, contributing new insights into sustainable architecture. Craftspeople can document and share their expertise while collaborating with professionals to preserve traditional techniques.

Cultural heritage organisations can use the platform to safeguard vernacular practices and integrate sustainability into conservation efforts. Students and educators benefit from the platform as an educational tool, exploring case studies and contributing to the growing repository of knowledge. Policymakers can draw from case studies to promote sustainable development and resource-efficient construction.

In terms of applications, the platform offers examples of vernacular architecture that address environmental and social challenges, supports heritage conservation, and fosters collaboration among stakeholders. It serves as a valuable educational resource and provides tangible references for policy development in sustainable urban and rural planning.

3.1.3. Enhancing User Experience and Usability in the Heritage for People Platform

An additional significant goal of the *Heritage for People Platform* is to enhance user experience and usability, making it the first application of its kind to be fully functional on mobile devices. This objective stems from the recognition of the increasing prevalence of mobile device usage and the need for accessible, on-the-go solutions in today's digital age.

The *Heritage for People Platform* offers itself as a next-generation PPGIS tool for the promotion and dissemination of both tangible and intangible elements related to vernacular heritage, providing valuable resources for scholars and planners. To foster usability and dissemination, the UX design of the application is geared towards enabling users to interact with a complex, geolocated database in the simplest way possible, organised within a highly articulated classification system. Extensive user research and iterative testing were conducted to ensure that the application is intuitive, efficient, and satisfying to use. Adopting a mobile-first strategy, the design prioritises the technological constraints of smartphones and tablets, ensuring seamless functionality and navigation on smaller screens. In addition, responsive design principles were implemented to ensure a consistent and engaging experience across devices and screen sizes. This approach includes flexible layouts, scalable images and adaptive content, ensuring that users can interact with the application effortlessly, whether using a mobile phone, tablet, or desktop computer.

The navigation and user interface were designed to be accessible in both desktop and mobile environments, catering to all types of users and providing different levels of detail for occasional and repeat visitors. Flows, layouts, and icons were selected to ensure the most user-friendly design choices.

Ultimately, the *Heritage for People Platform* aims to provide an accessible and versatile user experience, encouraging greater engagement and participation in the documentation and dissemination of vernacular heritage.

3.2. Technical Development and UX/UI Design

3.2.1. Database Creation, Initial Population, and Backend Development

For database creation, a headless CMS based on SQL was chosen. Initially, the database was populated with data from previous research projects. Subsequently, a mobile-friendly backend interface was developed, allowing new users to register and enabling administrators and collaborators to add entries. Each entry requires geolocation, a brief description,

the year of creation, a gallery of images, and the option to include a link to video resources. The data is hosted on the servers of the University of Florence and is managed in full compliance with GDPR regulations.

3.2.2. Choice of Client Type

A comparative analysis was conducted between a web app, a progressive web app, and a native mobile app. The web app was deemed the best option in terms of resource optimisation and achieved results, as it addresses both mobile and desktop use cases with a single development effort. While native apps provide a superior user experience on mobile devices, they require significant development and maintenance investment, posing sustainability challenges [39]. Progressive web apps, although emerging as an interesting solution, were considered relatively uncommon and exhibited compatibility issues.

3.2.3. Development of Web-Based Client

The database can be accessed in two modes: map or list. The map was created using the open-source Leaflet system, featuring a neutral base map on which entries are represented by icons corresponding to their categories. The list view displays a thumbnail of the main image, the name, and a summary of the associated principles and sustainability strategies. A search interface allows users to filter data based on their preferences and combine searches by characteristics with geographical searches.

3.2.4. Design and Development of UX/UI

The design and development of the User Experience (UX) and User Interface (UI) were preceded by extensive research and adhered to three main principles: user- design (UCD), mobile-first, and responsive design. Human-centred design focuses on the needs, preferences, and limitations of end users at every stage of the design process, involving empathy, user research, and iterative testing to create effective, efficient, and satisfying solutions [40]. The mobile-first approach optimises UX design for the technological constraints of mobile devices, while responsive design ensures a seamless user experience across different devices and screen sizes by using flexible layouts, scalable images, and adaptive content [41]. Consistency between mobile and desktop visualisations, as well as between map-based and list-based presentations of the dataset, was highly prioritised.

3.3. Monitoring, Feedback, and Implementation

The methodological process led us to define the organisational structure of the platform, the interface requirements, and the organisation of the flows, generating an initial prototype interface. In March 2022, a pivotal mapping campaign was conducted during a workshop in Sant'Antioco, Italy, with architecture students from the University of Florence and the University of Cagliari in the framework of the Versus+ project. This educational activity facilitated external user analysis and identification of potential improvements, resulting in significant testing and content enhancement. Building on this positive experience, university seminars have become opportunities for larger mapping campaigns, demonstrating the app's efficacy as an educational tool for case study research, analysis, and classification.

Maintenance and user feedback gathering are crucial aspects in the life cycle of digital services. Following the launch of the final product, these processes become pivotal in ensuring the app's quality, stability, and continuous evolution [42].

To collect feedback from the users of *Heritage for People*, a questionnaire was designed with the objective of: (1) assessing overall user satisfaction; (2) identifying technical or usability issues; (3) gathering suggestions for new features; (4) understanding user needs and expectations.

The questionnaire was designed to be concise and focused. It begins with general questions to identify the user's profile and then proceeds with specific questions about the app's usability. Questions are formulated clearly and directly to avoid ambiguity, and there

is a combination of closed-ended (multiple choice) and open-ended questions to facilitate data analysis and comparison, while also providing more detailed feedback.

The questionnaire is provided in the confirmation email once a user has interacted with a feature. Additionally, it is easily accessible within the platform through a permanent link included in the about section.

User feedback drives a continuous cycle of assessment and improvement. New versions of the application incorporate user suggestions and address reported issues. Once collected, feedback is systematically analysed, which involves categorising the reports, identifying common trends, and prioritising the necessary changes.

During an app use and implementation activity in spring 2024 with architecture students at the University of Florence, an interactive questionnaire was administered to the participants (Table 2). The survey yielded the following insights:

1. All participants found the app useful, particularly valuing its classification, documentation, and mapping features.
2. Some participants encountered issues with uploading images, locating entries, and linking to external material. They also suggested enhancements, such as adding PDF presentations, detailed references for each image, reducing upload times, and improving map functionality.
3. All participants reported that the process of adding a new feature was easy.
4. Most participants expressed a desire to use and consult the app in the future.

Table 2. Results of the interactive questionnaire.

Question	Responses
Do you find the app useful?	Yes: 100% No: 0%
Share with us the most useful aspects	Most popular: Classification; Documentation; Mapping. Also prominent: Case studies; Find examples; Tags; Material section; Project database; References; Information; Knowledge.
Did you find any criticalities?	Most popular: Upload of images. Also prominent: Localisation; Link to extra material.
Any suggestions for improvement?	Most popular: Implementation of the map for localisation. Also prominent: Credits for each picture; expected time for uploading.
How did you find the process of adding features to the database?	Easy: 100% Not that easy: 0%
Are you going use/consult the app again?	Yes: 80% Probably: 20% No: 0%

The criticalities that emerged from the interactive questionnaire were taken into consideration to make improvements and implementations in the tool. This systematic approach to feedback collection and analysis ensures that the *Heritage for People Platform* continually evolves to meet user needs and expectations, thereby maintaining its relevance and effectiveness in promoting and disseminating vernacular heritage.

4. Results

4.1. Description of the Prototype: Flows and Functionality

The final product of the platform is the culmination of an iterative process involving feedback gathering, design review, and technical implementation. Transitioning from prototype to product, the VerSus+ project partners and collaborators conducted user and usability tests to finalise and launch the platform.

The structure of the *Heritage for People Platform* is organised around two primary flows. The first stream focuses on the consultation, research, and comparison of cases, ranging from the cultural landscape to the human scale. This allows users to explore a wide array of examples and draw comparisons that can inform sustainable practices and innovations. The second stream involves the implementation and mapping of both tangible and intangible elements of vernacular heritage, ensuring a comprehensive representation of this valuable knowledge. In the final configuration of the platform (Figure 3), an additional information section was integrated to enhance the user experience. This section includes detailed explanations of the project, providing essential context and supporting materials that deepen users' understanding of sustainability and vernacular knowledge. It also offers insights into the principles and methodologies underpinning the VerSus+ project, further enriching user engagement with the content.

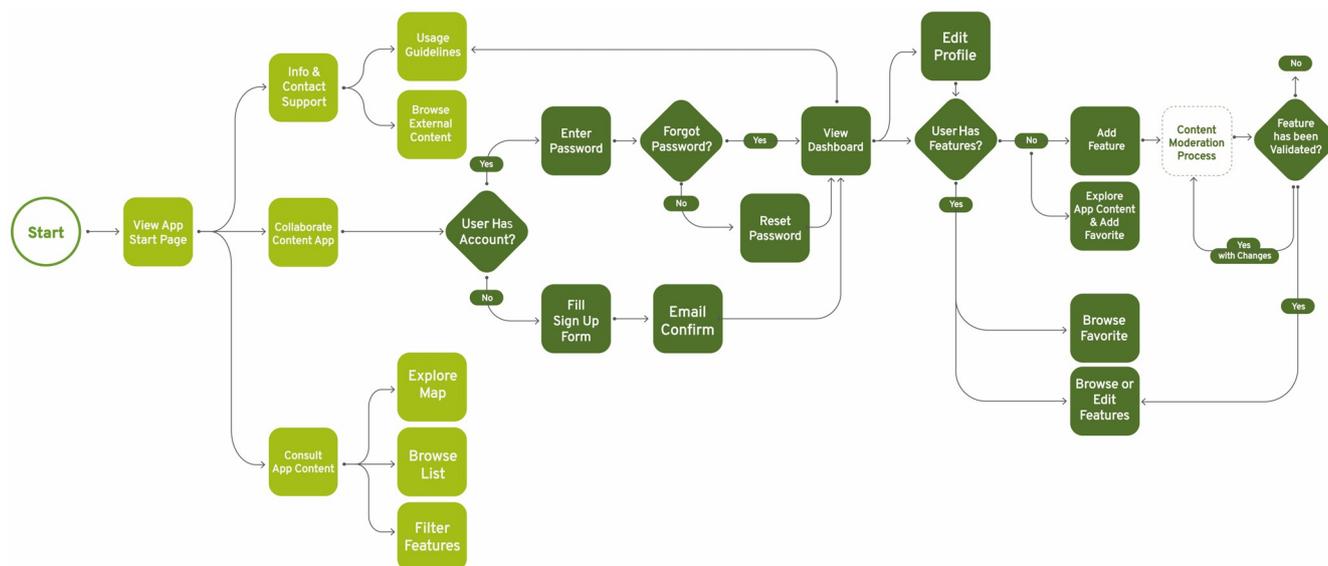


Figure 3. Abstract outline of the user activity flow and functions of the *Heritage for People Platform*. Light green refers to the functions open to everyone (consultation), dark green refers to the activities for registered users (collaboration).

As a consultation tool, the *Heritage for People Platform* allows users to explore content via an interactive map or browse through a comprehensive list (Figure 4a). Users can filter features by categories, types of intervention, materials, and strategies related to the 15 sustainability principles (Figure 4b). This functionality ensures that users can efficiently access the information most relevant to their needs and interests. As a collaboration tool, the platform enables logged-in users to contribute new features, create hyperlinks to external references, and highlight their favourite content (Figure 4c). Users can propose new environmental, socio-cultural, or socio-economic strategies and suggest different materials not included in the provided list. This collaborative aspect ensures that the platform remains a dynamic and evolving resource, enriched by the contributions of its user community.

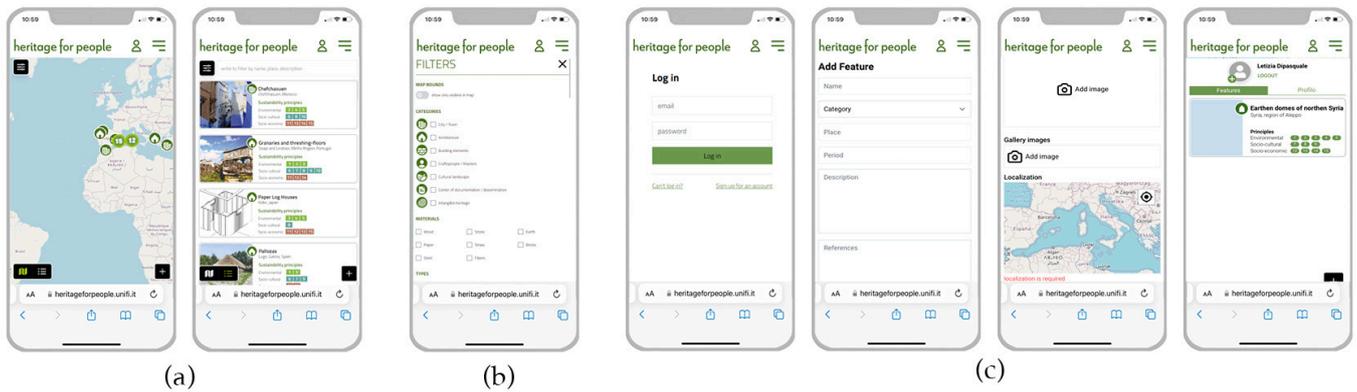


Figure 4. Screenshots of the App, mobile visualisation: (a) Map and list views; (b) Filtering; (c) Backend for adding and managing features.

4.2. Content Moderation Process

Feedback from the initial public presentations of the platform underscored the critical need for robust control, moderation, and validation of user-submitted content. The responses highlighted the importance of maintaining the scientific rigour of a research product, particularly in light of the academic audience attending these presentations.

To maintain the app’s open nature while ensuring the quality and appropriateness of uploaded content, the development team prioritised the integration of a content moderation system. This system is designed to uphold the integrity of the information shared on the platform by preventing the inclusion of irrelevant, inappropriate, or inaccurate content. The moderation process is overseen by an editorial board composed of international researchers with expertise in vernacular and sustainable architecture, primarily drawn from the VerSus+ project partners. Moderators receive notifications whenever a new feature is submitted and can choose to validate, reject, or request revisions from the user (Figure 5). Throughout this moderation process, the content remains visible to other users, marked as “being accepted”, ensuring transparency and allowing for community feedback.

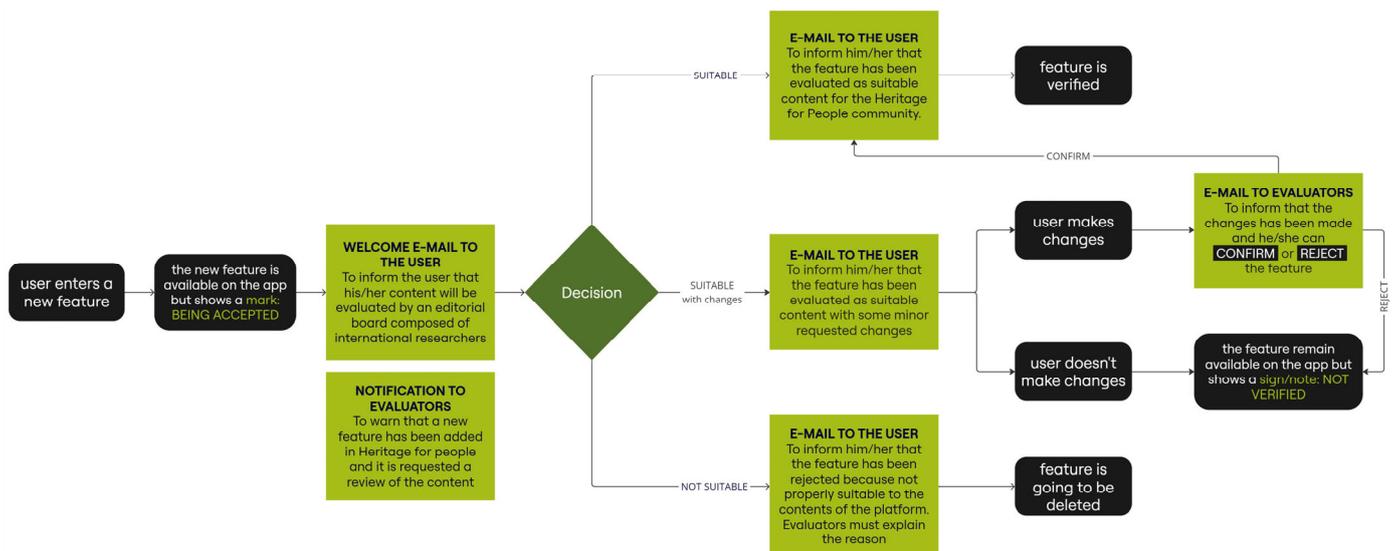


Figure 5. Flowchart of the content moderation process.

5. Discussion

The development and implementation of the *Heritage for People Platform* represents a significant advancement in the dissemination and enhancement of vernacular architecture and traditional knowledge systems. The platform's creation is anchored in the need to address contemporary design challenges by leveraging historical solutions that have evolved in harmony with environmental, social, economic, and cultural contexts. This section critically examines the key aspects of the platform's development, its initial testing, and its future potential, highlighting its impact on the field of sustainable architecture.

5.1. Systematisation of Vernacular Knowledge

The primary objective of the *Heritage for People Platform* is to systematise vernacular knowledge, making it accessible and usable for a wide audience, including scholars, designers, and the general public. By categorising case studies based on sustainability principles derived from vernacular architecture, the tool provides a structured approach to addressing current design challenges with historical solutions. This method aligns with the Case-Based Reasoning approach, which suggests that new design problems can be solved by adapting solutions from similar past scenarios. The categorisation by geographical location, materials used, and type of intervention further enhances the tool's usability, allowing for comprehensive and cross-cutting research. This project is the first to allow researchers to categorise items not only by the characteristics of the artefacts but also based on sustainability principles. The platform integrates both physical heritage elements and intangible aspects, including relevant stakeholders such as artisans and research centers. Although earlier projects included physical and intangible elements, they were often limited to specific technologies [28,33,34] or confined to specific geographical areas [35]. This project represents the first global database that comprehensively includes both physical and intangible items, making it a unique and expansive resource for the preservation and dissemination of vernacular knowledge.

5.2. Knowledge Sharing, Collaborative, and Inclusive Approach

Heritage for People operates within the realm of knowledge sharing and participatory culture. The platform is designed to be collaborative, encouraging contributions from a broad user base. This inclusive approach not only enriches the database with diverse inputs but also fosters a network of individuals and institutions dedicated to the preservation and innovation of vernacular knowledge. By integrating features that allow users to add new information, create hyperlinks, and propose new sustainability strategies, the platform remains dynamic and evolving. This collaborative nature ensures that the platform continues to grow and adapt, reflecting the latest research and user-generated content. While PPGIS and collaborative approaches have been tested in several past projects (see Section 2.1), the present project is the first to permit complete use from mobile platforms, thereby extending opportunities for consultation and participation to a wider audience. By easily accessing the vernacular approaches cataloged on the platform, designers can develop innovative, context-sensitive designs that not only align with sustainability goals but also reduce environmental impact and address local socio-economic challenges. The platform also provides a digital space for craftspeople to showcase their work, collaborate with architects, and contribute to the preservation of their craft while gaining visibility and expanding their professional network.

5.3. User Experience and Accessibility

To maximise accessibility and user-friendliness, the platform's architecture is designed for seamless use on any kind of devices, including smartphones, tablets, and computers. This approach caters to the diverse preferences and needs of users, ensuring easy access and interaction with the content. The responsive design principles implemented guarantee a consistent and engaging user experience across various screen sizes and devices. By enabling mobile accessibility, the app allows users to interact with the platform anytime and anywhere, significantly increasing its reach and usability. Its versatility and intuitive navigation effectively disseminate and preserve vernacular knowledge and sustainable practices, making it a valuable resource for a wide audience. While several other projects attempted to be usable on mobile devices, the Heritage for People Platform is the first designed and developed to target all types of digital devices.

5.4. Engaging Students and Educative Approach

The platform has proven to be an invaluable resource for engaging students in the practical application of their studies, allowing them to actively participate in the mapping and documentation of vernacular heritage. This practical engagement not only enriches the students' learning experience but also contributes to the continuous improvement and expansion of the platform's content. We expect that, when the tool is used within an educational context, content creation can have higher quality and lead to a more critical understanding, so as to furnish higher quality material to be included in the tool for other users. Students and academics can conduct comparative studies, explore sustainability lessons from the past, and contribute new knowledge to the platform, thereby advancing research in the field and bridging the gap between theory and practice.

5.5. Future Perspectives

The *Heritage for People Platform* has the potential to become a significant resource in the field of sustainable architecture, offering a repository of vernacular knowledge that can inform contemporary design practices. The continued development of the platform will focus on expanding its content, improving user experience, and enhancing its functionality based on user feedback. Integration with other cultural heritage platforms could enhance outreach and impact, contribute to platform resilience, and potentially aid in data preservation. The development of native mobile applications would allow for a significant improvement in the user experience by overcoming existing challenges, such as difficulties in uploading and managing images. Future research directions may also include exploring new ways to integrate emerging digital technologies, such as AI and VR, to further enrich the user experience and the depth of information available. All three of these potential research directions have been unexplored in peer projects so far and would represent a significant advancement in the field.

Moreover, the app's potential to foster a global network of individuals and institutions interested in vernacular architecture is immense. By providing a platform for collaboration and knowledge sharing, the platform can contribute to the preservation and innovation of traditional building techniques and sustainable practices.

6. Conclusions

The *Heritage for People Platform* is a cutting-edge digital tool for disseminating knowledge in the field of vernacular architecture and sustainable design. Its creation reflects a broader trend to enhance traditional knowledge systems and adapt them to contemporary challenges. The value of traditional and local knowledge in providing models capable of generating solutions that strengthen community identity and are sustainable over time—socially, environmentally, economically, and culturally—is widely recognised [43,44]. The *Heritage for People Platform* allows users to connect architectural examples and related practical knowledge in a semantic network, where conceptual links are created by the principles of sustainability. This approach enables users to explore and navigate the remarkable

heritage of vernacular knowledge, uncovering sustainable strategies that can be applied to contemporary design challenges.

Overall, the *Heritage for People Platform* marks a significant advancement in the field of PPGIS tools, providing a versatile and powerful platform for preserving, promoting, and disseminating vernacular knowledge in a digitally connected world. It not only safeguards the rich heritage of vernacular architecture but also serves as a practical resource for future sustainable development.

The initial development and testing phase has demonstrated the tool's potential as a comprehensive archive and collaborative platform. Future efforts will focus on expanding the platform's content, enhancing user experience, and ensuring its ongoing relevance and effectiveness in promoting sustainable design practices. The continuous development and refinement of this tool will further amplify its impact, making it an invaluable asset for scholars, designers, and communities committed to vernacular knowledge and sustainable architecture.

Author Contributions: Conceptualization, L.D., L.M., J.A., E.P.F. and M.Z.; methodology, L.D., L.M. and J.A.; software, L.M. and J.A.; validation, L.D., L.M., J.A. and E.P.F.; formal analysis, L.M. and J.A.; investigation, L.D., L.M., J.A. and E.P.F.; resources, L.D., L.M., J.A., E.P.F. and M.Z.; data curation, L.D. and L.M.; writing—original draft preparation, L.D., L.M., J.A. and E.P.F.; writing—review and editing, L.D., L.M., J.A. and E.P.F.; visualization, L.D., L.M., J.A. and E.P.F.; supervision, L.D. and M.Z.; project administration, L.D. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the European Union, under the Creative Europe Culture Programme (2019–2023), Grant Agreement Ref. 607593-CREA-1-2019-1-ES-CULT-COOP.

Data Availability Statement: The original data presented in the study are openly available in the Heritage for People Platform at <https://heritageforpeople.unifi.it/> (accessed on 11 July 2024).

Acknowledgments: The authors would like to thank Nicola Garruccio (University of Florence, Department of Architecture) for technical support in the design, development, and implementation of the Platform and the University of Florence for hosting the Platform's server.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Nguyen, A.T.; Truong, N.S.H.; Rockwood, D.; Tran Le, A.D. Studies on sustainable features of vernacular architecture in different regions across the world: A comprehensive synthesis and evaluation. *Front. Archit. Res.* **2019**, *8*, 535–548. [[CrossRef](#)]
2. García-Esparza, J.A. Vernacular Technologies and Vernacular Architecture. A Tendencies' Review in Scholarly Publication Over the Last Twenty Years. In *Building Engineering Facing the Challenges of the 21st Century. Lecture Notes in Civil Engineering; Bienvenido-Huertas, D., Durán-Álvarez, J., Eds.; Springer Nature: Singapore, 2023; Volume 345*, pp. 215–231. [[CrossRef](#)]
3. Correia, M.; Dipasquale, L.; Mecca, S. *VerSus. Heritage for Tomorrow. Vernacular Knowledge for Sustainable Architecture*; FUP: Firenze, Italy, 2014.
4. Oliver, P. *Encyclopedia of Vernacular Architecture of the World. 3 Volumes*; Cambridge University Press: Cambridge, UK, 1997.
5. Bologna, R.; Hasanaj, G. Advanced Models For The Construction of An Nbs Catalogue For Resilience And Biodiversity. *Agathón Int. J. Archit. Art Des.* **2023**, *13*, 179–190.
6. Omelyanenko, O.; Vitaliy, A.O. Development of Community Infrastructure Based on the Local Resource-Based Approach. *Her. Econ. Sci. Ukr.* **2023**, *1*, 63–69. [[CrossRef](#)]
7. Windhager, F.; Federico, P.; Schreder, G.; Glinka, K.; Dörk, M.; Miksch, S.; Mayr, E. Visualization of Cultural Heritage Collection Data: State of the Art and Future Challenges. *IEEE Trans. Vis. Comput. Graph.* **2019**, *25*, 2311–2330. [[CrossRef](#)] [[PubMed](#)]
8. Heritage for People. Available online: <https://heritageforpeople.unifi.it/> (accessed on 11 July 2024).
9. Mileto, C.; Vegas, F.; Correia, M.; Carlos, G.; Dipasquale, L.; Mecca, S.; Achenza, M.; Rakotomamonjy, B.; Sanchez, N. The European Project VerSus+/Heritage for People. Objectives and Methodology. *Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci.* **2020**, *44*, 645–649. [[CrossRef](#)]
10. Dipasquale, L.; Mecca, S.; Montoni, L. *Heritage for People. Sharing Vernacular Knowledge to Build the Future*; DidaPress: Firenze, Italy, 2023.
11. D'Andrea, A. Modelli GIS nel Cultural Resource Management. *Archeol. E Calc.* **2000**, *11*, 153–170. Available online: <http://www.archcalc.cnr.it/indice/PDF11/1.10%20Dandrea.pdf> (accessed on 11 July 2024).

12. Schuppenlehner, T.; Eder, R.; Ressar, K.; Feiglstorfer, H.; Meingast, R.; Ottner, F. A Citizen Science approach to build a knowledge base and cadastre on earth buildings in the Weinviertel region, Austria. *Heritage* **2021**, *4*, 125–139. [[CrossRef](#)]
13. Evans, A.; Kingston, R.; Carver, S.; Turton, I. Web-based GIS to enhance public democratic involvement. In Proceedings of the Geocomp, Mary Washington College, Fredericksburg, VA, USA, 27–28 July 1999.
14. Rinaudo, F.; Agosto, E.; Ardisson, P. GIS and Web-GIS, Commercial and Open Source Platforms: General Rules for Cultural Heritage Documentation. In Proceedings of the XXI International CIPA Symposium, Athens, Greece, 1–6 October 2007.
15. García-Esparza, J.A.; Tena, P.A. A GIS-based methodology for the appraisal of historical, architectural, and social values in historic urban cores. *Front. Archit. Res.* **2020**, *9*, 900–913. [[CrossRef](#)]
16. Gandreau, D.; Delboy, L. World Heritage: Inventory of Earthen Architecture; CRATerre-ENSAG: Grenoble 2012. Available online: <https://openarchive.icomos.org/id/eprint/2973/> (accessed on 11 July 2024).
17. Sigecweb. Available online: <https://www.sigecweb.beniculturali.it/> (accessed on 11 July 2024).
18. Catalogo Generale dei Beni Culturali. Available online: <https://catalogo.beniculturali.it/> (accessed on 11 July 2024).
19. Desiderio, M.L.; Mancinelli, M.L.; Negri, A.; Plances, E.; Saladini, L. Il SIGECweb nella prospettiva del catalogo nazionale dei beni culturali. *DigItalia* **2013**, *8*, 69–82.
20. Sosbrutalism. Available online: <https://www.sosbrutalism.org/> (accessed on 11 July 2024).
21. Elser, O. SOS Brutalismus Ein Zwischenbericht. *Die Denkmalpfl.* **2019**, *77*, 66–73. [[CrossRef](#)]
22. Lehmbau im Weinviertel. Citizen Science Projekt zu Lehmbau im Weinviertel. Available online: <https://cs-lehmbau.boku.ac.at/> (accessed on 11 July 2024).
23. Hiberatlas. Historic Building Energy Retrofit Atlas. Available online: <https://hiberatlas.eurac.edu/> (accessed on 11 July 2024).
24. Haas, F.; Herrera, D.; Hüttler, W.; Exner, D.; Troi, A. Historic Building Atlas: Sharing best practices to close the gap between research & practice. In Proceedings of the 3rd International Conference on Energy Efficiency in Historic Buildings (EEHB2018), Visby, Sweden, 26–27 September 2018; pp. 236–245. Available online: <https://hdl.handle.net/10863/8802> (accessed on 11 July 2024).
25. Herrera-Avellanosa, D.; Rose, J.; Thomsen, K.E.; Haas, F.; Leijonhufvud, G.; Brostrom, T.; Troi, A. Evaluating the Implementation of Energy Retrofits in Historic Buildings: A Demonstration of the Energy Conservation Potential and Lessons Learned for Upscaling. *Heritage* **2018**, *7*, 997–1013. [[CrossRef](#)]
26. Heritage Atlas Porto. Available online: <https://heritageatlasporto.arq.up.pt/> (accessed on 11 July 2024).
27. Ferreira, T.C.; Ordóñez-Castañón, D.; Fernandes Póvoas, R. Methodological approach for an Atlas of architectural design in built heritage: Contributions of the School of Porto. *J. Cult. Herit. Manag. Sustain. Dev.* **2023**. ahead of online. [[CrossRef](#)]
28. Mapadaterra. Available online: <https://mapadaterra.org/> (accessed on 11 July 2024).
29. Grappi, L.; Guerra, K. Mapadaterra platform. In *Heritage for People*; Dipasquale, L., Mecca, S., Montoni, L., Eds.; Didapress: Florence, Italy, 2023; p. 213.
30. Mediterre Network. Available online: <https://www.kisskissbankbank.com/en/projects/mediterre-un-site-internet-pour-le-reseau-de-la-construction-terre-mediterraneen> (accessed on 11 July 2024).
31. Red Nacional de Maestros de la Construcción Tradicional. Available online: <https://redmaestros.com/> (accessed on 11 July 2024).
32. García Hermida, A. La Red Nacional de Maestros de la Construcción Tradicional. *PH Boletín Del Inst. Andal. Del Patrim. Histórico* **2019**, *27*, 25–26. [[CrossRef](#)]
33. Cartoterra. Available online: www.cartoterra.net (accessed on 11 July 2024).
34. Paccoud, G.; Rakotomanokjy, B. Cartoterra, un atlas en ligne des architectures de terre, Poster #206. In Proceedings of the Terra 2016, XIIe Congrès Mondial Sur Les Architectures de Terre, Lyon, France, 11–14 July 2016. Available online: <https://craterre.hypotheses.org/files/2016/10/206.jpg> (accessed on 11 July 2024).
35. MEA- Map of Earthen Architectures. Available online: <https://www.terracruda.org/it/mappa-mea> (accessed on 11 July 2024).
36. Kolodner, J. *Case-Based Reasoning*; Morgan Kaufmann Publishers Inc.: San Francisco, CA, USA, 1993; p. 668.
37. Zambelli, M. *La Conoscenza per il Progetto Il Case-Based Reasoning Nell'architettura e Nel Design*; FUP: Florence, Italy, 2022; p. 184.
38. Dipasquale, L.; Ammendola, A.; Ferrari, E.P.; Mecca, S.; Montoni, L.; Zambelli, M. A collaborative Web App to foster a knowledge network on vernacular heritage, craftspeople, and sustainability. In Proceedings of the HERITAGE 2022—International Conference on Vernacular Heritage: Culture, People and Sustainability, Valencia, Spain, 15–17 September 2022.
39. Sandesara, M.; Bodkhe, U.; Tanwar, S.; Alshehri, M.D.; Sharma, R.; Neagu, B.-C.; Grigoras, G.; Raboaca, M.S. Design and Experience of Mobile Applications: A Pilot Survey. *Mathematics* **2022**, *10*, 2380. [[CrossRef](#)]
40. Wever, R.; van Kuijk, J.; Boks, C. User-centred design for sustainable behaviour. *Int. J. Sustain. Eng.* **2008**, *1*, 9–20. [[CrossRef](#)]
41. Roth, R.E.; Çöltekin, A.; Delazari, L.; Denney, B.; Mendonça, A.; Ricker, B.A.; Shen, J.; Stachoň, Z.; Wu, M. Making maps & visualizations for mobile devices: A research agenda for mobile-first and responsive cartographic design. *J. Locat. Based Serv.* **2024**, *18*, 1–71. [[CrossRef](#)]
42. Van Oordt, S.; Guzman, E. On the Role of User Feedback in Software Evolution: A Practitioners' Perspective. In Proceedings of the 2021 IEEE 29th International Requirements Engineering Conference (RE), Notre Dame, IN, USA, 20–24 September 2021; pp. 221–232. [[CrossRef](#)]

-
43. Bouchenaki, M. The Interdependency of Tangible and Intangible Cultural Heritage. In Proceedings of the ICOMOS 14th General Assembly and Scientific Symposium, Victoria Falls, Zimbabwe, 27–31 October 2003.
 44. Ginzarly, M.; Teller, J. Online communities and their contribution to local heritage knowledge. *J. Cult. Herit. Manag. Sustain. Dev.* **2021**, *11*, 361–380. [[CrossRef](#)]

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.