

The Underground for Value Platform

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Abstract — The paper discusses the challenges and architectural solutions applied in the Underground for Value (U4V) platform. The U4V platform has been released a year ago, but the corresponding project is still under development in close cooperation with the members of COST Action CA18110 “Underground Built Heritage as catalyser for Community Valorisation”. The U4V platform spreads information and facilitates access to the underground heritage. The main target user groups are: tourists, local businesses, and authorities. The U4V platform is developed as a fork and functional enhancement of the CycleAdvisor - a cloud platform that adopts the community-driven principle for creating personalized flexible services for tourists. The U4V platform provides an easy and cozy tool for packaging and promoting products and services of local SMEs and micro-businesses to tourists. It allows converting knowledge about local attractions (historical, cultural, archaeological, natural sites, and services) into attractive package offerings for the tourists, which leads to more active use of the local services by the tourists. It results in a win-win scenario for tourists and the local community. Also, the local authorities benefit by getting valuable statistics that help identify potential weaknesses of the local hospitality services.

I. INTRODUCTION

There are several systems that can provide tourist information about underground heritage objects. Such systems use several technologies and their combination to best present the underground heritage sites to the visitors. Overall, these systems are designed to enhance visitors' understanding and appreciation of underground heritage objects, while also providing practical information about how to access and navigate these sites, and entertaining the user. The existing systems can be clustered based on the primary technology, as well as a format of content packaging and delivery to the tourists. The tourists' solutions for underground heritage sites can be clustered into the following groups based on the applied primary technology:

- Mobile apps - provides visitors with information about underground heritage sites, including maps, audio guides, and other multimedia content. These apps can be downloaded onto a smartphone or tablet and can be used to enhance the visitor experience. Majority of the mobile apps are done around the audio guide functional, and tools for sharing experience via Internet. Visitors can use their own device or borrow a device provided by the site. Usually, the mobile apps are localized to multiple languages and allow good personalization of the experience.
- Interactive displays – provide visitors with a visual representation of underground heritage objects, their history, significance, and context. These touch-screens

can be installed directly on the site or in other appropriate place, e.g., in the nearby museum building. The interactive displays deliver message in the format of video presentations, images, text, and using other advanced interactive features.

- Augmented Reality (AR) – is a technology that overlays digital information onto a real-world view using a smartphone or tablet. This can provide visitors with a more immersive and interactive experience, allowing them to explore underground heritage sites in a unique and engaging way.
- Virtual Reality (VR) – is a technology that creates a simulated environment that allows visitors to explore underground heritage sites in a virtual setting. This technology can provide visitors with a unique and immersive experience that can be used to supplement their in-person visit or as a standalone experience.
- 3D modeling – is a technology to create detailed digital models of underground heritage sites. These models can be used to provide visitors with a virtual tour of the site. It is especially important for dangerous and hardly accessible sites, as well as for many categories of tourists, e.g., people with disabilities, claustrophobes, etc.
- Lighting – is used to enhance the visitor experience at underground heritage sites. By strategically placing lights and using color and other effects, visitors can be guided through the site and provided with a more immersive and engaging experience.
- Signage – is used to provide visitors with information about underground heritage sites, including historical context, important features, and safety information. Well-designed signage can help visitors navigate the site and enhance their understanding of its significance.

There are also several good projects that provide advanced web-based platforms to present the underground sites to the tourists. These systems are designed to provide a range of information about underground heritage objects, including their historical significance, cultural context, architectural features, and more. They can also include information about practical matters, such as how to navigate the site and where to find amenities like restrooms and gift shops.

Overall, these systems and technologies can provide tourists with a wealth of information about underground heritage objects, helping to enhance their understanding and appreciation of these important historical sites.

For example, the “Subterranean London” project, developed by the Museum of London [1]. This project provides an interactive web site, plus uses virtual reality and interactive

onsite displays to provide visitors with an immersive experience of London's underground heritage, including historical sewers, tunnels, and subways.

But all existing solutions are focused on a certain underground site or agglomeration of sites in a limited geographical area.

The underground heritage form a large own cluster of the cultural heritage that requires deep analysis of commonalities, development of proper classification and applying start analytics. By this paper the author summarizes the motivation and main design principles of the U4V platform [2], which was developed for managing the underground heritage content.

The U4V is a universal platform for delivering information about the underground heritage. The platform is developed in close cooperation with the expert team of the COST Action CA18110 "Underground Built Heritage as catalyser for Community Valorisation" [3], which is the largest community of the underground heritage experts in the Europe and Mediterranean region. The platform provides advanced functional and services for various groups of users, including, tourists, the hospitality industry businesses, authorities, and the field experts. In addition to the core service of the platform, each user category gets access to a set of additional services designed specifically to best meet needs of this category. As a result the author is targeted to create a well-organized smart knowledge base that:

- improves visibility and facilitate accessibility of the underground heritage sites by the tourists;
- offers new service opportunities to the local business and increases their revenue from the tourist flow;
- provides local authorities with a deep understanding of the tourist flows in the region and the most demanded services (including transport);
- helps the field experts to classify and digitalize the underground heritage content.

Moreover, the author and the FRUCT team are working to integrate the U4V content into the Europeana database [4].

The rest of the paper is organized as follows. Chapter 2 provides a comprehensive understanding of the driving factors and philosophical principles that underpin platform's development. It explores the needs and motivation of the main stakeholders of the platform and highlights the guiding principles that shaped its design. Chapter 3 offers a detailed examination of the platform's architecture, including its core components, underlying technologies, and the development process. The author discusses the key design decisions and technical considerations that were taken into account to ensure the platform's effectiveness and scalability. In Chapter 4, the author elaborates on the additional services and features integrated into the U4V platform to enhance its functionality and adaptability. The author discusses the roadmap for future developments and outlines the plans for expanding the platform's capabilities to meet evolving user needs. Additionally, he explores potential collaborations and partnerships that can contribute to the platform's growth and sustainability. Chapter 5 presents the outcomes and findings

obtained so far. The author discusses the impact of these results, their implications for relevant stakeholders, and the broader significance of the platform's contributions. Finally, the author draws conclusions based on our analysis and provides insights for future research and development of the U4V platform.

The final chapters of this paper encompass the Acknowledgments, where the author expresses gratitude to those who have contributed to the realization of the project, and the References, which provide a comprehensive list of the works cited throughout the paper.

II. MOTIVATION AND PHILOSOPHY OF THE U4V PLATFORM

Tourism destinations are constantly seeking new strategies to attract visitors and provide unique experiences. The U4V platform is a novel tool that offers access to a rich repository of underground heritage attractions, which have remained largely untapped in the tourism industry.

The U4V platform was developed with the needs and motivations of several various stakeholders in mind. The platform aims to provide an easy and cozy tool for packaging and promoting products and services of local SMEs and micro-businesses to tourists. In particular, it combines information about the underground sites with locally available services to generate attractive tourist routes that captivate the interests of travelers.

The primary beneficiaries of the U4V platform are the small regional businesses. These include not only traditional establishments such as hotels, restaurants, and cafeterias, but also local guides, farms, wine producers, and other providers of the hospitality services. These businesses often struggle to gain visibility and reach potential customers, especially in the highly competitive tourism industry. The platform facilitates the process of converting knowledge about local attractions in the package offerings for the tourists. Moreover, the U4V platform offers them a convenient means to showcase their offerings to tourists, thereby increasing their chances of attracting customers and generating revenue. By utilizing the platform, these businesses can tap into the growing market of eco-tourists seeking unique and sustainable experiences.

In addition to supporting small businesses, the U4V platform also benefits the local authorities. The platform provides valuable statistics and insights that enable local authorities to gain a comprehensive understanding of the tourism industry in their region. By analyzing the data collected through the platform, they can identify potential weaknesses in the local hospitality services and make informed decisions to address them. This helps in enhancing the overall quality of tourism offerings, ensuring a positive experience for both tourists and local businesses.

Furthermore, the U4V platform caters to the needs of tourists themselves. By using U4V tourists can discover and explore the unique offerings of the region, and experiencing the cultural and natural heritage in a sustainable and most comfortable manner, supported by the service offerings of the various local service providers.

The guiding principles that shaped the design of the U4V platform revolve around simplicity, inclusivity, and sustainability. The platform was designed to be user-friendly, ensuring a seamless experience for both local businesses and tourists. It provides easy-to-use interface and allows businesses to create appealing packages, while tourists can effortlessly search and use these offerings. The platform also emphasizes inclusivity by providing opportunities for various types of businesses, ranging from traditional accommodations to niche service providers like local guides and wine producers.

Moreover, the U4V platform aligns with the principles of sustainability. Particularly the U4V is optimizing service offering for eco-tourists and promoting activities that have minimal impact on the environment. By encouraging tourists to engage in biking, hiking, and kayaking, the platform supports sustainable tourism practices that minimize carbon footprints and preserve the natural beauty of the region. This approach benefits not only the environment but also the long-term viability of the tourism industry itself.

In summary, the U4V platform serves the needs of multiple stakeholders. It empowers small regional businesses by increasing their visibility, provides valuable insights to local authorities, and offers tourists an easy and sustainable way to discover and enjoy the local underground heritage attractions. Also, U4V offers a good set of tools for the professionals in the area of underground heritage study, preservation and management, but we will discuss it more in the section on supporting services and future plans.

III. U4V PLATFORM ARCHITECTURE AND DEVELOPMENT

The U4V platform encompasses various components, including a web client, a mobile application, a set of auxiliary web tools, and a server. The primary function of the web client module revolves around engaging with key user groups such as tourists, underground site managers, and local businesses. It processes user commands, identifies explicit and implicit requirements, and delivers the desired services. The web client serves as the principal tool for content management, trip planning, and memory administration. Fig. 1 shows an example of the U4V web client interface.

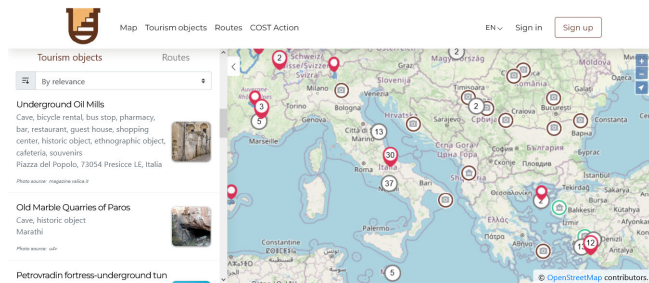


Fig. 1. Screenshot of the U4V web-client

The mobile application offers on-site assistance to users during their trips. It simplifies access to preferred data and enables offline usage of U4V without an internet connection. This includes accessing information about preferred routes and

objects. The mobile app doesn't create all required functional inside instead it integrates popular third-party navigation services, providing users with an efficient and comfortable solution. The app provides detailed instructions regarding the installation of additional apps and their usage. The mobile app requires user registration to access the user's preference profile in the system.

The supporting services provide several supplementary functions, such as community-driven localization to other languages. Additionally, they offer tools tailored to special requirements, such as a professional interface for underground heritage professionals. In the future, there are plans to incorporate a gateway to the Europeana system [4].

The server side of the platform fulfills several key responsibilities, including retrieving relevant information from the database, intelligent data processing, and transmitting it to the client side. Communication between the client and server components occurs through the designated API. The current technological implementation is depicted in Fig. 2.

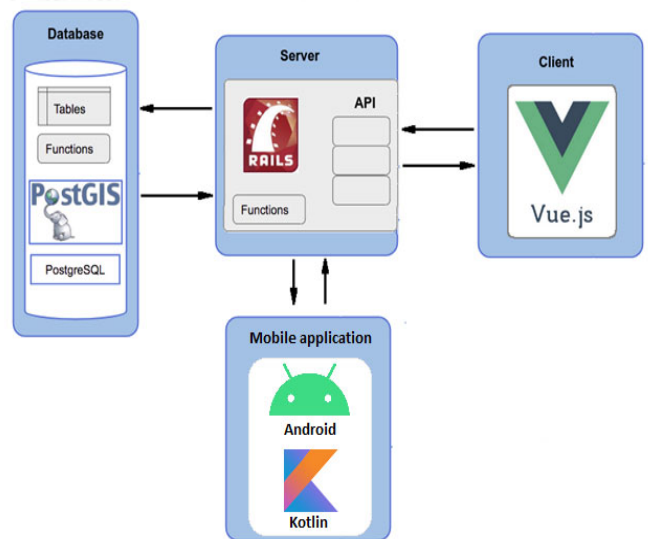


Fig. 2. The U4V platform set of technologies

The U4V server is developed using the Ruby on Rails framework, which facilitates a user-friendly interface for interaction between the platform's components. The PostgreSQL database is utilized for information storage, while the PostGIS extension is employed for handling geo-data.

The U4V platform has been designed as a derivative or an alternative UI for the CycleAdvisor platform. The scientific ground of the CycleAdvisor platform is based on the referenced works [5-7], and its development has received partial support from the ENI CBC BizCycle project [8]. CycleAdvisor represents a cloud-based platform that embraces the community-driven approach in order to facilitate the creation of personalized and adaptable tourist services.

Both systems operate using a shared database, resulting in mutual advantages for users of both platforms, specifically

expediting the generation of a substantial volume of user content. Moreover, this approach enhances the cost-effectiveness of the corresponding development efforts.

The database diagram specification of the U4V platform is presented in Fig.3.



Fig. 3. The U4V database diagram specification

Presently, the U4V platform is publicly available for free usage at www.u4v.org. The development process is ongoing and regular platform updates are published every three weeks. The new functional is continuously added based on requests of the COST expert community and the service users. It is an ongoing endeavor closely tied to comprehending and constructing the comprehensive ontology of the target system. Moreover, the process is influenced by additional requirements expressed by the primary stakeholders and by updates added to the CycleAdvisor platform.

IV. SUPPORTING SERVICES AND FUTURE PLANS

In addition to the set of core services discussed before, the U4V platform offers several supplementary tools within its framework. These additional services encompass the U4V administration console, a community-driven localization tool, and an advanced data management tool tailored to the needs of underground heritage experts, among others.

A. U4V administration console

The U4V platform exhibits remarkable flexibility owing to a comprehensive suite of administration tools that enable efficient configuration and management of multiple platform settings. As illustrated in Fig. 4, the U4V administration tool provides a user-friendly interface, empowering users to dynamically create and modify several characteristics of the platform, including, for example, the object classification categories.

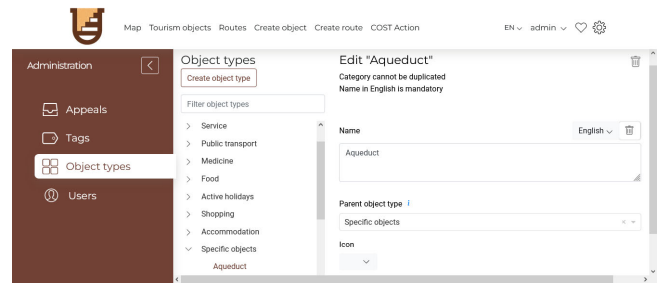


Fig. 4. Screenshot of the U4V administration UI

The current set of U4V categories was developed with the help of the COST Action CA18110 expert team and based on a long term studies in the field [9].

The same admin tool enables the dynamic definition of tags for specifying a set of additional services offered by an object, managing user rights, as well as a mechanism to taking and processing users' appeals and suggestions. The administrative tool is available in all supported languages and allows defining and managing content in all languages used by the system.

B. Community-driven localization tool

The availability of the U4V platform in multiple languages is a crucial aspect that enhances its usability. The U4V platform enables users to input information regarding points of interest in over hundred different languages. Furthermore, the community has been provided with a localization tool to facilitate the customization, improvement [10], and expansion of the platform's localization capabilities to accommodate any language to the U4V UI. Therefore, all verified users of the U4V platform have the opportunity to actively contribute to the localization process for their respective languages. Refer to Fig. 5 for an illustration of the localization tool example UI.

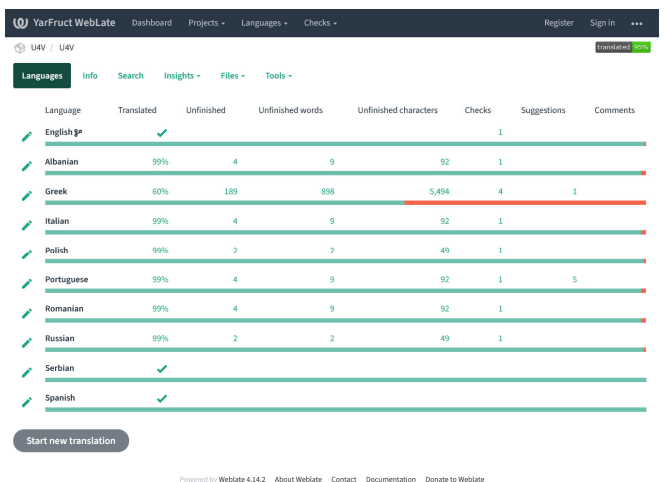


Fig. 5. Screenshot of the U4V community-driven localization tool

C. U4V professional toolkit

The U4V platform has garnered certain level of interest and active involvement from underground heritage experts associated with the COST Action CA18110. These experts

form the most dynamic group of content providers within the U4V ecosystem. The underground heritage experts become a highly influencing user group and the key stakeholder in the project. In addition to fulfilling needs of the tourists, the U4V expert team has expressed their desire to utilize the platform as a comprehensive repository and classifier of relevant content for professional purposes. This inclination stems from their intention to streamline their workflow and eliminate duplicative data entry efforts across different tools.

Recognizing the distinct requirements of professionals, which necessitate a more expansive definition of object content, we have initiated the development of the U4V professional toolkit. This specialized toolkit aims to meet the demands of underground heritage experts by providing advanced functionalities tailored to their specific needs. Currently, the project is actively progressing, and we anticipate the release of the initial version of the U4V professional toolkit in autumn 2023.

The U4V professional toolkit represents a significant step towards empowering professionals in the field of underground heritage. By offering enhanced capabilities for content storage, classification, and management, this toolkit seeks to optimize their workflow, minimize redundant efforts, and consolidate their expertise within the U4V platform. The forthcoming release of the professional toolkit marks a crucial milestone in expanding the scope and utility of the U4V platform to cater to the diverse requirements of both tourists and professionals alike.

D. Europeana integration gateway

The preservation and dissemination of cultural heritage has gained paramount importance in the digital era. As Europe continues to cherish its rich cultural diversity, it becomes imperative for cultural heritage service providers to embrace modern technologies and platforms that facilitate effective access, collaboration, and preservation of cultural artifacts. In this context, integration with the Europeana system emerges as a pivotal step for any cultural heritage service provider operating within Europe.

The Europeana system is the European Union's flagship digital platform for cultural heritage, has established itself as a central hub for accessing Europe's vast cultural wealth. The Europeana system serves as a gateway, consolidating digitized collections from numerous cultural institutions across Europe, ranging from museums and libraries to archives and galleries. By integrating with Europeana, cultural heritage service providers gain unparalleled visibility, access, and collaboration opportunities within the European cultural landscape.

One of the primary advantages of integration with the Europeana system is the expanded reach and exposure it offers. By becoming part of the Europeana network, cultural heritage service providers can seamlessly connect with a wide audience that extends beyond their individual platforms. This increased visibility significantly enhances the discoverability and accessibility of cultural artifacts, attracting a diverse range of users including researchers, scholars, educators, and the

general public. Integration with Europeana enables cultural heritage service providers to contribute to the collective digital representation of European cultural heritage, fostering cross-cultural understanding and appreciation.

Furthermore, integration with the Europeana system empowers cultural heritage service providers with advanced tools and resources for preservation and conservation. Europeana has established robust frameworks and standards for metadata, digitization, and data management, ensuring the long-term preservation and integrity of cultural artifacts. By aligning with these standards, service providers can leverage Europeana's expertise and infrastructure, safeguarding their digital collections for future generations. The Europeana system also offers sophisticated search functionalities and multilingual support, enabling users to explore and interpret cultural heritage in their preferred language, contributing to inclusivity and accessibility.

Collaboration and knowledge exchange are essential components of any thriving cultural ecosystem. Integration with the Europeana system facilitates meaningful collaboration among cultural heritage service providers, fostering partnerships, and encouraging the sharing of resources and expertise. Through Europeana, service providers can participate in joint projects, research initiatives, and exhibitions, amplifying the impact of their cultural collections and generating new insights and discoveries. The Europeana community serves as a vibrant network, stimulating dialogue, innovation, and cooperation, ultimately enriching the European cultural heritage landscape.

Integration with the Europeana system presents numerous compelling reasons for cultural heritage service providers in Europe to embrace this collaboration. By connecting with Europeana, the U4V service can benefit from enhanced visibility, preservation standards, accessibility, and collaboration opportunities. Through integration, it will become active contributor to the broader European cultural heritage narrative, ensuring the conservation and promotion of diverse cultural treasures for current and future generations. The Europeana system stands as a cornerstone for the digital transformation of cultural heritage, fostering a connected and inclusive cultural landscape throughout Europe, and U4V targets to be part of this process. Because of this, our team is actively working to setup relations with the Europeana team and developed a designated Europeana gateway specifically for the underground heritage content.

V. MAIN RESULTS AND CONCLUSION

This paper introduces the U4V platform, which is a universal platform designed to deliver information about underground heritage sites to various user groups, including tourists, businesses, local authorities, and field experts. The platform is developed in collaboration with the expert team of the COST Action CA18110, which is the largest community of underground heritage experts in Europe and the Mediterranean region.

The U4V platform aims to improve the visibility and accessibility of underground heritage sites for tourists. It offers new service opportunities for local businesses, provides local

authorities with insights into tourist flows, visualizes the demand for services, and help field experts to classify and digitize underground heritage content.

The motivation and philosophy behind the U4V platform revolve around simplicity, inclusivity, and sustainability. The platform is designed to be user-friendly, inclusive of various types of businesses, and aligned with sustainable tourism practices. It aims to empower small regional businesses by increasing their visibility, provide valuable insights to local authorities, and offer tourists an easy and sustainable way to discover and enjoy underground heritage attractions.

The architecture of the U4V platform includes components such as a web client, a mobile application, auxiliary web tools, and a server. The web client serves as the main tool for content management, trip planning, and memory administration, while the mobile application provides on-site assistance to users, even if the user doesn't have internet connection. The server is responsible for retrieving relevant information, processing data, and transmitting it to the client side. The platform is developed using the Ruby on Rails framework and utilizes the PostgreSQL database with the PostGIS extension for handling geo-data.

In addition to the core services, the U4V platform offers supporting services such as an administration console for efficient configuration and management, a community-driven localization tool to accommodate multiple languages, and a professional toolkit tailored to the needs of underground heritage experts. The platform is continuously updated based on user feedback and requirements from the expert community.

Overall, the U4V platform aims to harness the potential of underground heritage sites in the tourism industry, benefitting small businesses, local authorities, and tourists alike. The paper discusses the motivation, philosophy, architecture, supporting services, and future plans of the U4V platform, highlighting its contributions and potential for further research and development. The U4V platform is a developing project, but you already can try it using the link [2].

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