Implementing a Digital Repository for the Cultural and Natural Heritage of the Island of Zakynthos.

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Abstract— **The present study discusses the development of a digital repository (ANTETI) for the preservation and dissemination of the Cultural and Natural Heritage of Zakynthos Island. The platform is based on a popular Content Management System (CMS) to provide the core functionality, extended with the use of the CMS's API, to provide additional personalisation functionality for the end-users. Additionally, the system features a web application, oriented mainly on users visiting the island of Zakynthos and developed exclusively with open web technologies and JavaScript frameworks. The web application is an alternative, map-centered, mobile optimised front-end, for the platform's content featured in the CMS. The system also provides a RESTful API, allowing integration with 3rd party systems and web applications, thereby expanding the repository's reach and capabilities. Content delivery is personalized based on user profiles, location, and preferences, enhancing engagement and usability. By integrating these features, the repository effectively preserves and makes accessible the unique cultural and natural heritage of Zakynthos to both local and global audiences.**

Keywords—Cultural Heritage, Natural Heritage, Biodiversity; Content Management Systems; Multimedia Digital Repositories; Web Applications.

I. INTRODUCTION

Preservation, dissemination and promotion of cultural and environmental heritage have been enhanced by the advent of digital repositories and the related information systems. Most of the recent research and development focuses on systems that manage cultural and environmental content. Under this work we developed a system that aims to provide useful knowledge, in the form of a repository/portal, to the culture and nature of Zakynthos.

In this context, a distinction was made on the basis of repository types, Cultural and Environmental, as well as the interdisciplinary development approach. The three types are presented below, together with the most popular deployment methodologies that apply to them.

A. Cultural Repositories

Cultural repositories are designed to store, manage, and provide access to cultural heritage resources. These systems encompass various digital assets, including texts, images, audio, and video, related to history, art, literature, and other cultural artifacts.

- **Metadata Standards and Interoperability:** Effective cultural repositories utilize standardized metadata schemas like Dublin Core, METS, and EAD, which facilitate interoperability and data exchange between systems [1]. The CIDOC Conceptual Reference Model (CRM) is also significant in structuring complex cultural heritage information [2].

- **User-Centered Design**: Recent studies emphasize the importance of user-centered design in cultural repositories. This approach ensures that the repositories are accessible and user-friendly, catering to the needs of diverse user groups, including researchers, educators, and the general public [3].

- **Digitization and Preservation**: Digitization is a crucial process in the creation of cultural repositories. Advanced techniques in image processing and digital restoration help in preserving artifacts in high resolution, making them accessible for future generations [4].

B. Environmental Repositories

Environmental repositories focus on collecting, storing, and disseminating data related to environmental science, including biodiversity, climate change, and ecosystem management.

- **Data Integration and Analysis**: Effective environmental repositories integrate data from various sources, enabling comprehensive analysis and decision-making. Geographic Information Systems (GIS) play a vital role in visualizing and analyzing spatial data related to the environment [5].

- **Sustainability and Conservation**: Environmental repositories contribute to sustainability and conservation efforts by providing critical data that inform policy and management strategies. Repositories like the Global Biodiversity Information Facility (GBIF) offer extensive datasets for biodiversity research [6].

- **Community Involvement**: Engaging local communities in the development and maintenance of environmental repositories enhances data accuracy and relevance. Citizen science initiatives have proven effective in gathering large volumes of environmental data [7].

C. Integrated Cultural and Environmental Repositories

There is a growing trend towards integrating cultural and environmental data into unified repositories, recognizing the interdependence of cultural heritage and natural environments.

- **Holistic Approaches**: Integrated repositories adopt holistic approaches that consider both cultural and natural heritage. Projects like the Europeana Digital Library provide access to millions of digitized items, including cultural and environmental resources [8].

- **Technological Innovations**: Advances in technology, such as semantic web technologies and linked open data, facilitate the integration and interoperability of cultural and environmental datasets [9].

- Case Studies and Best Practices: Successful examples of integrated repositories include the Mediterranean Science Commission (CIESM) and the UNESCO World Heritage Centre, which offer platforms for the combined study and management of cultural and environmental heritage [10].

II. STATE OF THE ART

Creating a repository/portal for the culture and nature of Zakynthos is based on matching the optimal practices and technologies related to both cultural and environmental repositories. Emphasizing interoperability, user-centered design, and community involvement will ensure the repository is comprehensive, accessible, and sustainable. Integrating cultural and environmental data will provide a richer, more holistic understanding of Zakynthos's heritage, supporting both academic research and public engagement. In the following text are presented some recent studies and articles on digital cultural and environmental repositories.

Firstly, the review paper of Zibani et al [11] highlights the importance of digital repositories in preserving and promoting cultural and environmental heritage. Modern digital repositories offer advanced features that support the management, discovery, and reuse of diverse content types. This literature review explores the state-of-the-art in digital repositories, focusing on systems that manage cultural and environmental content. By adopting best practices and leveraging state-of-the-art technologies, repositories dedicated to the culture and nature of Zakynthos can effectively contribute to the preservation and dissemination of the island's unique heritage. This work will not only protect Zakynthos's cultural and environmental assets but also to provide them to a global audience, fostering appreciation and scholarly research.

The study of Ndegwa et al [12] emphasized the importance of organizational preparedness and financial sustainability in digital preservation. Digital preservation is resource-intensive, requiring significant investment in infrastructure, staffing, and technology monitoring. The Kenyan universities' IRs studied were found to be underfunded and lacked specific budgets for digital preservation activities, which poses a significant risk to the longevity and integrity of their digital collections.

More particularly, the findings from the Kenyan universities underscore the necessity for developing comprehensive digital preservation policies and plans. These should be integrated into the universities' strategic plans to ensure proper budgeting and resource allocation. Multi-stakeholder involvement in policy development, including archivists, information technologists, librarians, and university management, is crucial. Moreover, continuous review and adaptation of these policies and plans are essential to keep pace with technological advancements and changing organizational needs.

Furthermore, the development of digital repositories and information systems is crucial for preserving, disseminating, and promoting cultural and environmental heritage. The work by Sarah Lippincott highlights the evolving landscape of research libraries' engagement with emerging technologies to steward the scholarly and cultural record [13]. It emphasizes the necessity for libraries to adopt new approaches to manage the increasing volume and complexity of digital content. This includes advancing open research and publishing practices, ensuring the integrity and trustworthiness of digital records, and addressing the challenges posed by dynamic, networked, and diverse digital artifacts. The report underscores the importance of coordinated, cross-institutional collaboration and the adoption of open standards and technologies to achieve effective digital preservation at scale.

Moreover, the article by Xia and Opperman [14] provides a comprehensive analysis of how institutional repositories (IRs) at master's and baccalaureate institutions in the United States are evolving. The study highlights that these repositories play a significant role in managing diverse types of content, including faculty works, teaching materials, student theses, and special collections. A key finding is the emphasis on student contributions, which aligns with the educational missions of these institutions. The operational styles of these repositories vary, with some relying on consortia or external vendors like bepress for technical support and maintenance. This diversification in content and operational strategies underscores the importance of digital repositories in preserving

and providing access to academic and cultural materials, ensuring their long-term availability and usability.

It is noteworthy that there is a need for a balance between ICT use in DP and environmental sustainability. It introduces the concept of sufficiency, advocating for a sustainable approach that minimizes ICT's environmental footprint while fulfilling preservation goals. Another study by Paschalidou et al. [15] examines the practices of the Finnish Heritage Agency, emphasizing the importance of integrating environmental considerations into digital preservation strategies. The research underscores the importance of collaboration among CHOs to share best practices and develop sustainable solutions. It calls for comprehensive frameworks that address both the preservation of cultural content and the ecological sustainability of digital preservation processes, ensuring that the practices align with broader environmental goals.

In that notion, Nasidi and Jika [16] discuss digital archiving and the establishment of open access digital repositories in selected Nigerian universities. They highlight that despite the abundance of vital information in traditional archives, many researchers struggle to access it due to inadequate digitization and online visibility. The study found that while digital repositories exist in these universities, they are often not well-structured to integrate resources from various departments and faculties, leading to accessibility issues. The repositories contain significant scholarly information, including theses, dissertations, and journals, but face challenges such as inadequate ICT infrastructure and a lack of necessary staff skills for effective maintenance. The paper concludes with recommendations for improving digital repository management, emphasizing the need for robust ICT infrastructure, regular staff training, and a strong maintenance culture to ensure sustainable access to scholarly information.

The development of digital repositories and information systems is critical for preserving, disseminating, and promoting cultural and environmental heritage. The work by Geser et al. [17], focuses on data management policies and practices of digital archaeological repositories, underscores this importance. The survey, conducted under the ARIADNEplus and SEADDA initiatives, highlights the need for repositories to adopt FAIR (Findable, Accessible, Interoperable, and Reusable) principles. The findings reveal that while many repositories are operational, significant gaps exist in policy implementation, particularly regarding data deposition, metadata richness, and long-term preservation strategies. The survey emphasizes the necessity of robust guidelines, regulatory support, and training to enhance the management and sharing of archaeological data.

The COVID-19 pandemic has accelerated the digital transformation in the CH sector, with many institutions establishing their digital presence for the first time. This shift underscores the importance of resilience and the need for CH organizations to integrate environmental sustainability into their digital preservation strategies. Champion and Rahaman [18] point out the lack of systematic discussion on the environmental impacts of DP practices and the need for CH organizations to inform and influence the decision-making standards for DP through their practical insights and

reimagining of their core mission. The increasing reliance on digital archives has led to a significant rise in the production of digital content, which, in turn, demands more resources and energy consumption. This necessitates a sufficiency approach that considers the finitude of natural resources and aims to mitigate the environmental impacts of ICT used in DP.

There is an important work from ISBER [19], which outlines comprehensive best practices for managing repositories, emphasizing the importance of governance, planning, and operational excellence. It highlights the need for clear policies, proper resource allocation, and sustainable practices to ensure the longevity and accessibility of digital collections. The report also stresses the significance of quality management, risk assessment, and ethical considerations in repository management. By adhering to these best practices, repositories can effectively safeguard cultural and environmental artifacts, making them accessible for research and public engagement.

Furthermore, the development of digital repositories and information systems is essential for preserving, disseminating, and promoting cultural and environmental heritage. Lin et al elaborates on the TRUST Principles—Transparency, Responsibility, User focus, Sustainability, and Technology— vital for ensuring the reliability and trustworthiness of digital repositories [20]. These principles guide repositories to maintain high standards in data management and preservation, ensuring long-term accessibility and usability. Their work highlights the importance of clear governance, robust technical infrastructure, and sustainable practices to support digital preservation. It emphasizes that trustworthy digital repositories (TDRs) must transparently communicate their policies and capabilities, responsibly manage data integrity and security, focus on user community needs, ensure long-term sustainability, and leverage appropriate technology. Adopting the TRUST Principles helps repositories earn and maintain the trust of their stakeholders, thereby playing a critical role in safeguarding and promoting cultural and environmental heritage for future generations.

It is therefore obvious that safeguarding the cultural and environmental heritage of a region requires the preservation of digital infrastructure with the ultimate goal of further accessibility to future generations. A balanced approach combining regulatory frameworks with practical, bottom-up improvements in data management practices is therefore preferred.

III. SYSTEM REQUIREMENTS AND ARCHITECTURE

A. Objectives

The main target is the development of a web-based digital repository, for showcasing the cultural and natural heritage of Zakynthos Island, while featuring a generally applicable architecture to preserve the expandability to different thematic areas. The main objectives include:

- **a robust back-end infrastructure**: The platform will feature a CMS at the heart of the back-end infrastructure, providing the core functionality and incorporating a multimedia digital repository, along

with relevant semantic and classification information [20]. User profiling and personalization mechanisms as well as a content contribution, approval and management mechanism, will be featured by the back-end, serving as the central hub for managing the entire system. The functionality will be also "exposed" via an Application Programming Interface [22] (RESTful API), which will allow 3rd party developed applications and systems to leverage the platform's content and features.

- **end-user Web Mobile Application**: A web-based, mobile-friendly application, will serve as an alternative front-end to the main one provided by the CMS. The end-user mobile application will better suit on-site users, allowing them to access relevant information for near-by locations, using geolocation services on their mobile devices.

  • **enhanced user engagement:** The platform will also support digital social features, allowing users to engage, contribute and provide feedback.

B. System Requirements

The main system requirements are:

- A totally web-based user interface, accessible and

- Modular design based on modern open-source technologies and web development paradigms, for cost effectiveness, maintainability and expandability.

- Support for multimedia-rich content and modern media types such as streaming video, 360 panoramic images, 3D content

- Personalization and user feedback and contribution mechanisms that will provide a custom-tailored, participatory and engaging experience to the end-users.

- Expandability and integration with 3rd party platforms through supported APIs.

C. System Architecture

The overall architecture, modules and primary usage scenarios of the proposed system is illustrated in Figure 1. The system is built around a Content Management System (CMS) to provide the core functionality, such as: user management, authentication, profiling, content searching, editing, contribution and management mechanisms. Authors can use the CMS's built-in editor to contribute to the system, providing also relevant metadata (e.g. classification, keywords, geolocation information). After reviewing and approval, the content, is incorporated into the repository and published. Authors and administrators can also design thematic activities /
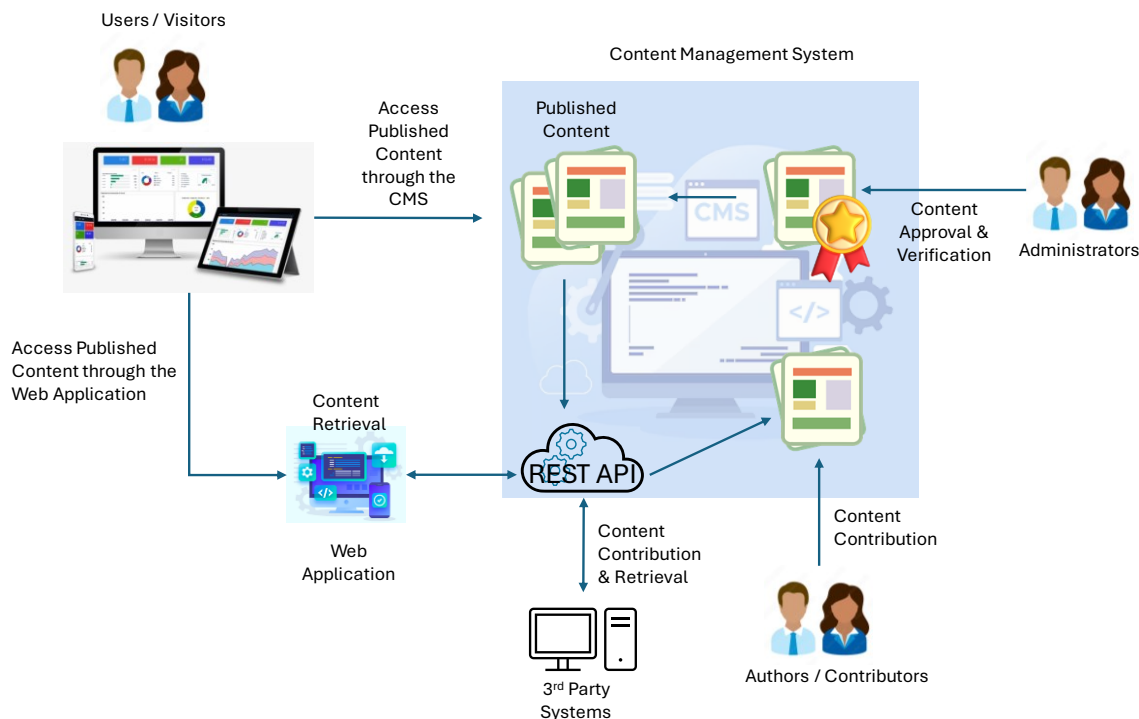

Fig. 1: Overall System Architecture.

compatible with all modern devices and popular web browsers.

pathways, based on relevant content featured in the system and accessible to the end-users.

End users / visitors can access personalized content through the CMS's front-end or via the complementary web application designed primarily for on-site visitors using mobile devices. This application enhances the user experience with map-based geolocation technologies and advanced presentation methods.

Furthermore, a RESTful API will allow integration with third-party systems, such as digital repositories or custom applications, to access the desired system's functionality and content.

IV. System Implementation

In this section we will discuss the implementation of the system's back-end infrastructure, which provides most of the system's functionality, as well as the implementation of the web application as an alternative, mobile oriented, front-end to the system's content.

A. Implementation of the system's back-end services

The back-end infrastructure is built around the Wordpress (V6) [23] Content Management System, a highly versatile, scalable, and user-friendly CMS, suitable for a wide range of websites and web applications. The main reasons for choosing WordPress as the foundation for the system implementation are the - essential for the implementation - features it offers, including:

- Intuitive administration environment and flexibility to accommodate a wide range of needs.

- Extensive library of themes to customize the front-end appearance and plugins to extend the core functionality and features.

- Search Engine Optimisation (SEO) features and plugins.

- Strong community support from users, developers and designers and regular updates to improve security, provide new features and ensure compatibility with the latest web standards.

- Scalability and Extensibility: WordPress is suitable for anything from a simple blog to a full-fledged e-commerce site. The provided native PHP API and web REST API allows for accessing the provided functionality and content from custom web applications.

- Responsive Design supporting all modern computing devices.

- Great content and user management features.

The modules of the back-end infrastructure are depicted in **Figure 2.** Each module implements part of the system's functionality:

Multimedia Content Database / Digital Repository: manages the system's content (mainly articles) and the multimedia repository. All the functionality is inherently provided by the CMS.

User and Content Management: the CMS provides all the functionality required for the user management (registration, authorization, management, profiles, roles and permissions) as well as the Content Management (authoring, editing, metadata and classification, reviewing and approval for publishing by content supervisors/experts).

User Feedback, Metrics and Personalization: end users are able to rate the articles they read as well as provide feedback on their improvement. This functionality was added with the Wordpress Plugin "Rate My Post" byFeedbackWP [24]. Additionally the system keeps track of the articles a user has read, in order to provide relevant/suggested activities on
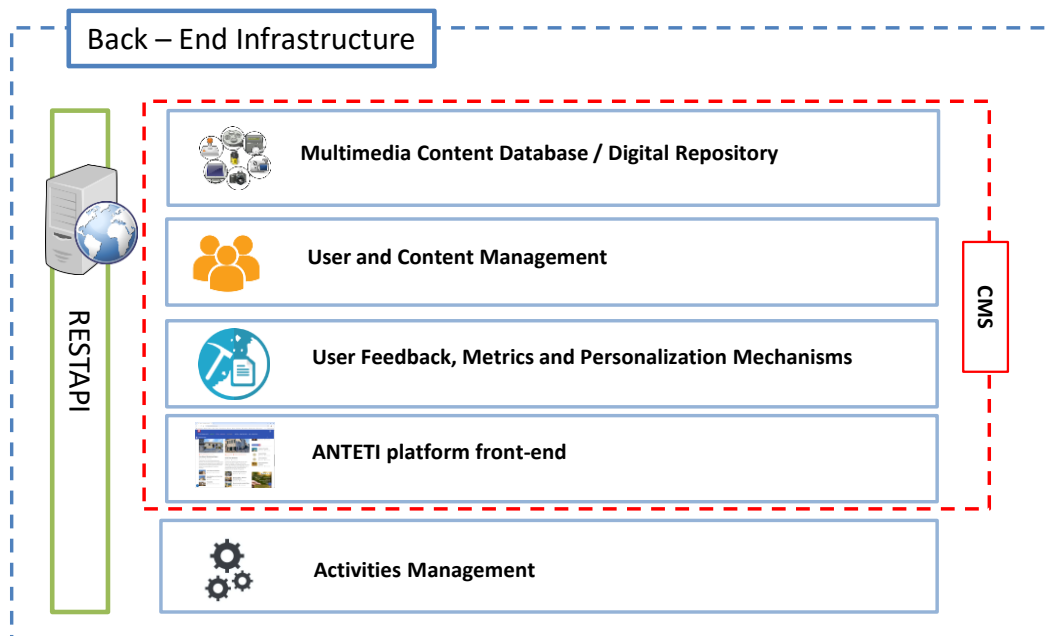

Fig. 2: Back – End Infrastructure Modules.

the web application. This functionality was implemented with the development of a custom WordPress plugin written in PHP programming language in combination with the Wordpress provided PHP functions [25] and the REST API [26].

Platform front-end: The "ZON" Theme [27], by THEMEDREESIA, was installed, to provide an appealing and intuitive "magazine-alike look and feel" on the main platform front end. The home page is split on thematic areas, highlighting important content categories such culture and nature.

explore these featured routes and identify those that best align with their preferences. Upon selecting a route, the application displays relevant information and offers the option to view the featured points of interest on a map. For each point of interest, the application provides basic details along with a link to access the full related article featured on the platform's CMS. Thematic routes incorporating several points of interest where the user has previously read related articles on the platform, are specially marked as recommended for that user.
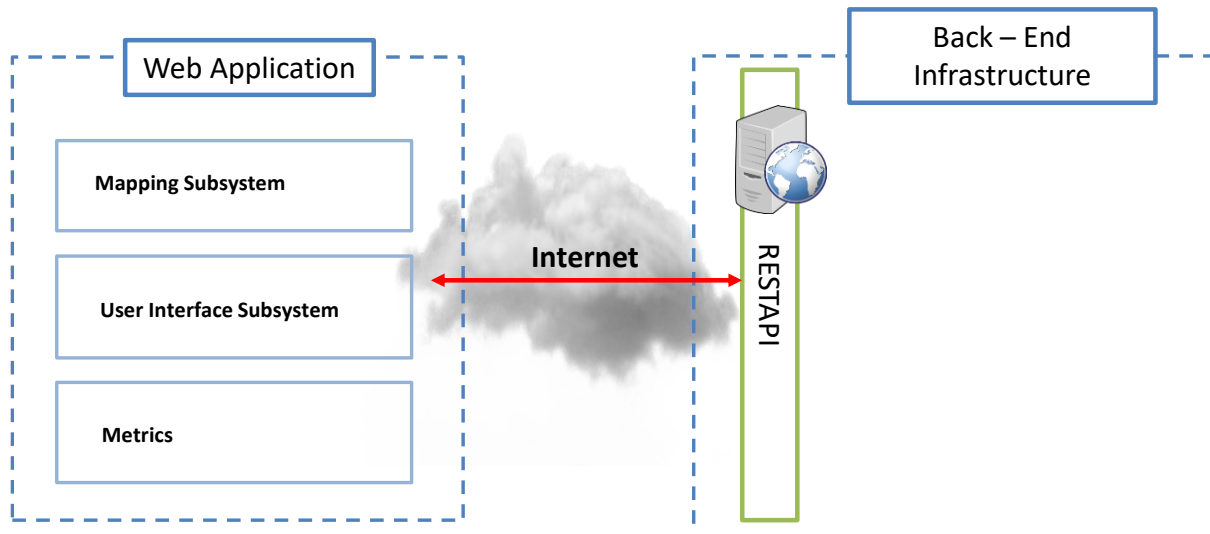
The mobile application was developed as a web-based,

Fig. 3: Web Application Modules

Activities Management: this back-end module provides the ability to administer **thematic routes / activities**, by linking similar and relative points of interests, featured in the platform. A custom web application was developed in PHP programming language and utilising the API provided by Wordpress. By using this custom "Activities Administration Application", content managers of the system can define new and edit existing thematic pathways (e.g. museums of the city), providing essential information (duration, distance, thematic categories, optimal seasons, small description etc) and defining which points of interest, featured in the platform, are involved. These thematic activities are later accessible by the end users using the Web Application.

B. Implementation of the web application

In addition to the main frond-end of the system, provided by the CMS, a web application has been implemented to serve as an alternative, map-cantered, front-end to system, better suited to on-site visitors, accessing the system with mobile devices. The web application utilizes the REST API to exchange data with the back-end services and access the functionality provided by each back-end module.

The web application highlights thematic routes and activities curated by the system's content managers. Users can

mobile-friendly, application, relying solely on web technologies, notably HTML5, CSS, and JavaScript. JavaScript frameworks were used to provide the basis and essential functionality to build upon, during the development of the various modules (Figure 3):

Mapping Subsystem: handles the map-based presentation of the points of interest involved in a selected thematic route, along with user's current position given by the mobile devices geolocation sensors. It is implemented with the LeafletJS [28] and OpenStreetMap [29] mapping service. LeafletJS provides a JavaScript programming interface for the development of interactive maps, while OpenStreetMap provides open-source GIS/Mapping services.

User Interface Subsystem: The OnsenUI V2.0 [30] JavaScript framework has been used for the implementation of the user interface of the web application. OnsenUI provides a javascript framework for the development of web and hybrid mobile applications, with the look-and-feel of native Android and iOS mobile apps.

Metrics Subsystem: Implemented in JavaScript, this subsystem regularly tracks the user's location using the geolocation services of their mobile device and sends important metrics to the system's backend via a REST API.

These metrics help the system maintain statistics, such as the number of physical visits to points of interest highlighted by the system. Furthermore, when the user is physically close to a featured point of interest, the system triggers the display of related content from the digital repository.

V. DISCUSSION

The current study explores the design and implementation of a web-based platform aimed at promoting the cultural and natural heritage of Zakynthos Island, incorporating features to facilitate user contributions and feedback.

Constructed around a popular CMS, the system relies solely on open-source tools and technologies, employing a modular, open architecture to offer a versatile solution for creating digital repositories across various themes. A key goal was to streamline the deployment process and reduce costs.

The system's core back-end services leverage the CMS's inherent functionality, with its API used to enhance the CMS's capabilities as needed. A REST API functions as the "bridge" between the back-end services and the web application. Additionally, JSON has been adopted as an effective method for data exchange between the web application and the system's back-end services.

The development approach for the client/mobile application illustrates how intricate, location-based, multimedia, and augmented reality applications can now be effectively built using only web technologies like HTML, CSS, and JavaScript, alongside advanced browser features like WebGL. Previously, such sophisticated mobile apps required custom SDKs and platform-specific tools. Today, these applications can be deployed as cross-platform, web, or progressive web apps, while still offering platform-specific functionalities and interfaces, such as those for Android.

Modern JavaScript frameworks provide the foundation for creating advanced mobile apps with technologies such as location-based services, interactive maps, AR, 360° videos, and 3D content. However, a major consideration in choosing a framework is its longevity and lifecycle. Factors like community support, popularity, and backing from major companies can be crucial in selecting the right framework for successful application development

Finally, some aspects of the system, such as streaming multimedia content over the internet, necessitate an active connection and involve transferring significant amounts of data, which may incur charges for users from their service providers. However, as mobile internet becomes more accessible and affordable, and with the growing availability of free public Wi-Fi in urban areas, this concern is expected to decrease over time.

VI. ACKNOWLEDGMENT

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