Journal of Computer System and Informatics (JoSYC)
ISSN 2714-8912 (media online), ISSN 2714-7150 (media cetak)
Volume 5, No. 4, August 2024, Page 1001-1013
https://ejurnal.seminar-id.com/index.php/josyc
DOI 10.47065/josyc.v5i4.5776

Prototype Design for Education and Heritage Tourism through Rapid Application Development

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Submitted: 12/08/2024; Accepted: 25/08/2024; Published: 26/08/2024

Abstract−This research explores the development of a prototype for the Sangiran Information System, utilizing the Rapid Application Development (RAD) framework to meet the specific needs of researchers, destination managers, and tourists. The study emphasizes the importance of user-centric design, facilitated by iterative refinement, which ensures the system effectively supports data management and access related to the Sangiran heritage site. The coding results from content analysis were instrumental in shaping the system, particularly in digital technology integration, educational roles, museum management, and tourism impact. Despite these advancements, the research identifies a critical limitation: the lack of integration with the museum's internal systems and databases. This gap highlights the necessity for further development to achieve a more cohesive and comprehensive information system. The findings underscore the significant progress made in enhancing the educational and management functions of the Sangiran site while also pointing to the need for ongoing improvements to fully support heritage preservation and tourism objectives.

Keywords: Prototype; Education; Heritage; Tourism; RAD

1. INTRODUCTION

Tourism and museums serve a crucial function in preserving historical evidence and cultural heritage, which are integral to the collective identity of societies and civilizations. By facilitating the conservation of artifacts, records, and monuments, these institutions safeguard the tangible and intangible remnants of the past, thereby ensuring the continuity of cultural memory [1]–[3]. The interplay between tourism and museum institutions enhances public awareness of historical significance and fosters a deeper understanding of the intricate connections between cultural identity and historical legacy [4]–[7]. Thus, the role of tourism and museums transcends mere preservation, acting as a bridge between the past and the present, ultimately enriching the cultural consciousness of future generations.

Within the museum context, tourism and educational activities play a pivotal role in disseminating historical relics as evidence of civilization while clarifying identity and significant events from the past. These institutions serve as platforms for immersive learning experiences, allowing visitors to engage with artifacts that embody cultural and historical narratives [8], [9]. Such interactions deepen the understanding of historical continuity and reinforce the connections between past events and contemporary identity. Consequently, museums are essential for education and cultural preservation, fostering a more informed and reflective society.

In the Sangiran area, museums and fossil excavation activities exemplify the potential of research endeavors and museum institutions to stimulate local community engagement while encouraging scholarly collaboration. These interactions involve residents' participation in the preservation and exhibition of fossils and attract experts to collaborate in excavation efforts, aiming to collect, identify, and comprehensively analyze fossil data. This dynamic fosters a symbiotic relationship between the community and the academic field, enhancing the understanding of paleontological heritage and the region's socio-economic development.

A synergistic relationship exists between tourism, museums, education, and heritage, wherein each component mutually reinforces the others. Museums act as custodians of heritage, preserving artifacts and narratives that form the foundation for educational initiatives to deepen public understanding of cultural and historical significance [10]–[12]. Tourism, in turn, facilitates the dissemination of this knowledge, enabling broader access to heritage sites and museum collections, thereby enriching the educational experience [13]–[15]. This interconnectedness elevates the appreciation of cultural heritage and ensures its transmission to future generations, solidifying its role in shaping collective identity.

This study aims to design a prototype for education and heritage tourism using Rapid Application Development (RAD), which can store data related to fossils, discovery locations, exhibition activities, and relevant journal publications. The development process involves iterative cycles that prioritize user feedback, ensuring the prototype effectively meets the needs of its intended audience. Such a system not only enhances the management and accessibility of information but also supports the broader goals of heritage preservation and

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educational outreach. The integration of these elements underscores the significance of innovative digital solutions in heritage tourism.

The urgency of this research lies in its potential to address critical gaps in the management and dissemination of heritage and educational resources. As the digital age demands more efficient and accessible means of preserving and sharing cultural knowledge, developing a specialized system becomes increasingly imperative. Such a system streamlines the organization and retrieval of essential data and enhances public engagement with heritage through interactive and user-friendly platforms. Therefore, this research is essential for advancing both the preservation of cultural heritage and the effectiveness of educational outreach in contemporary society.

This research's theoretical and practical implications are significant for academic inquiry and real-world application in heritage management and educational technology. Theoretically, the study contributes to a deeper understanding of how digital tools and methodologies, such as Rapid Application Development, can be effectively utilized to enhance the preservation and dissemination of cultural knowledge [16]. The research offers a blueprint for creating robust systems that facilitate the organization, retrieval, and public engagement with heritage-related data. These dual contributions highlight the study's value in advancing scholarly discourse and practical solutions, ultimately bridging the gap between theory and practice in heritage tourism and education.

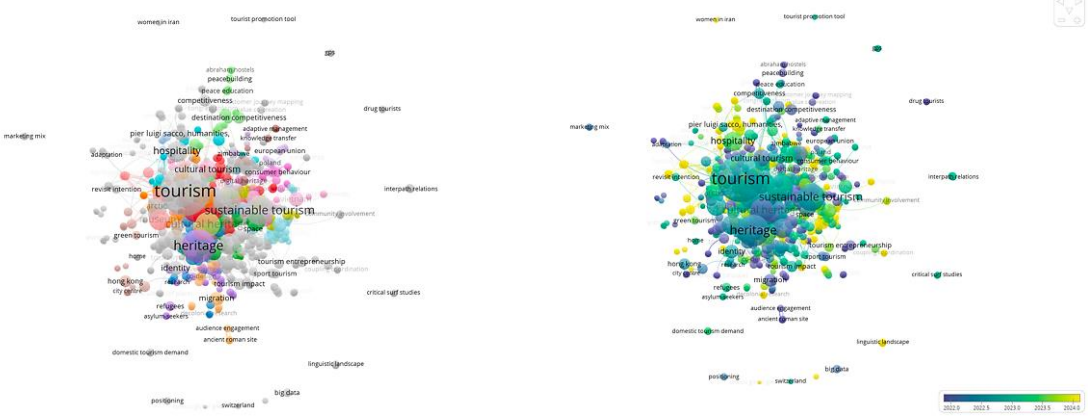
Similar research has explored the integration of digital technologies in heritage preservation and education, highlighting the transformative potential of such innovations. Various studies have demonstrated the effectiveness of these technologies in enhancing the accessibility and engagement of cultural resources, thereby contributing to a more interactive and informed public [17]–[19]. These findings underscore the importance of continuing to develop and refine digital tools for heritage management, as they play a critical role in bridging the gap between historical knowledge and contemporary audiences. Thus, the ongoing exploration in this field is essential for ensuring cultural heritage's sustained relevance and impact in the digital age.

The limitation of this research lies primarily in its scope, which may not fully encompass the diverse complexities of heritage preservation and educational technology integration. While the study offers valuable insights into the application of digital tools, it may not address the varying contextual factors that influence the effectiveness of these tools across different cultural and educational settings. Additionally, the reliance on specific technological frameworks could restrict the generalizability of the findings to other methodologies or platforms. Therefore, acknowledging these limitations is crucial for guiding future research that seeks to expand and refine the application of digital innovations in heritage and education.

2. RESEARCH METHODOLOGY

2.1 Gap Analysis

The novelty of this research is evidenced by its innovative approach to integrating Rapid Application Development with heritage and educational tourism. Unlike traditional methods, this study emphasizes the rapid and iterative creation of a digital prototype that stores and organizes fossil-related data and facilitates public access and scholarly dissemination through exhibitions and publications [20], [21]. This approach represents a significant advancement in the field, as it combines efficiency with comprehensive data management in a way that has not been extensively explored. Consequently, this research introduces a fresh perspective on the intersection of technology, heritage, and education, offering new possibilities for academic and practical applications.



(a) (b)

Figure 1. Network and Overlay Visualization (a dan b)

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Figure 1 shows network visualization using Vosviewer. Based on the results of the network visualization, studies focusing on the topics of tourism, heritage, education, and museums are interconnected, with significant emphasis on sustainable tourism and cultural heritage. The visualization reveals that these themes are central to a broader discourse that includes hospitality, identity, and community engagement, highlighting the integral role that educational initiatives and museum management play in promoting sustainable tourism practices. This interconnectedness suggests that future research should continue to explore these relationships, particularly in how they contribute to preserving heritage sites and promoting responsible tourism. Ultimately, these insights underscore the importance of a multidisciplinary approach in understanding and addressing the challenges and opportunities within these fields.

Based on the results of the overlay visualization of studies focusing on tourism, heritage, education, and museums from 2020 to 2024, there is a clear progression toward integrating sustainable tourism practices with the preservation of cultural heritage. The visualization highlights the increasing emphasis on educational approaches within museum contexts, reflecting a growing trend in utilizing museums as learning and heritage conservation platforms. This trend indicates a broader shift towards multidisciplinary research that addresses tourism and heritage and seeks to educate and engage the public in these efforts. Consequently, the findings suggest that future research and practice should continue to explore and strengthen the synergy between tourism, education, and heritage to foster sustainable development in these sectors.

The contributions of this research to the body of knowledge are significant, particularly in advancing our understanding of the integration between digital technology and heritage management within the context of educational tourism. By exploring the development and application of the Sangiran Information System prototype, this study provides new insights into how digital tools can enhance the preservation, education, and dissemination of cultural heritage. Furthermore, the findings highlight the importance of aligning technological innovations with the specific needs of diverse user groups, including researchers, destination managers, and tourists. These contributions enrich the academic discourse on heritage tourism and offer practical implications for the design and implementation of similar systems in other heritage sites globally.

2.2 Rapid Application Development (RAD): Sangiran Information System Prototype Design

The Rapid Application Development (RAD) framework is employed to design a prototype through the stages of requirement planning, user design, construction, and Cutover. Each stage is meticulously executed, beginning with identifying and prioritizing system requirements, followed by an interactive user design phase that ensures alignment with end-user needs. The construction phase then facilitates the rapid development of functional components, culminating in the cutover phase, where the system is deployed and integrated into its operational environment. This approach underscores the efficacy of RAD in delivering a high-quality prototype that meets user expectations within a compressed timeline.

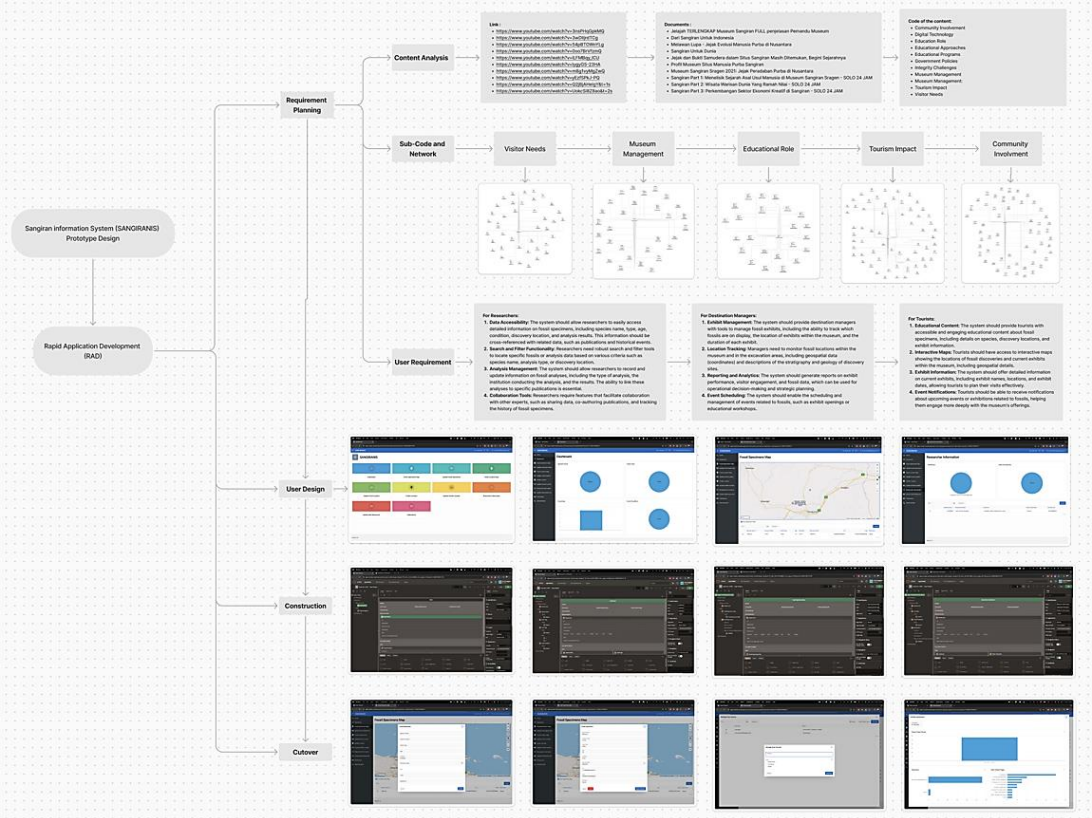

Figure 2. Rapid Application Development (RAD) Framework

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Figure 2 shows the implementation of the Rapid Application Development (RAD) framework to design the prototype of the Sangiran Information System (SANGIRANIS). This framework prioritizes iterative feedback loops, enabling continuous refinement of user requirements and ensuring that the system aligns with the needs of researchers, destination managers, and tourists. By emphasizing rapid prototyping and user-centered design, RAD facilitates the creation of a flexible and responsive system architecture that adapts to evolving demands. Consequently, deploying RAD to develop SANGIRANIS accelerates the development process and enhances the system's usability and effectiveness in managing and disseminating critical information about Sangiran's heritage.

The stages within the Rapid Application Development (RAD) framework for prototype design are meticulously structured to ensure an efficient and user-focused development process. Beginning with the Requirement Planning phase, where a comprehensive analysis of content and user needs is conducted, the process transitions into User Design, involving the creation of interfaces and functionalities that directly reflect the identified requirements. The subsequent Construction phase facilitates the rapid development of these components, allowing for iterative testing and refinement. Finally, the Cutover phase focuses on deployment and integration, ensuring the system is fully operational and meeting all user expectations. This structured approach underscores the importance of iterative development in achieving a high-quality prototype that effectively aligns with user demands.

2.2.1 User Requirement

In the user requirement phase, a systematic identification of users and their needs was conducted within the context of tourism, education, heritage, and museum management at Sangiran. This process involved analyzing the distinct roles of researchers, destination managers, and tourists, ensuring the specific requirements were thoroughly understood and addressed. The objective was to capture diverse user perspectives, guiding the development of functionalities catering to educational and heritage preservation goals. Consequently, this meticulous approach to user requirement identification ensures that the system's design aligns with its stakeholders' varied and complex needs, ultimately enhancing the effectiveness and usability of the Sangiran Information System.

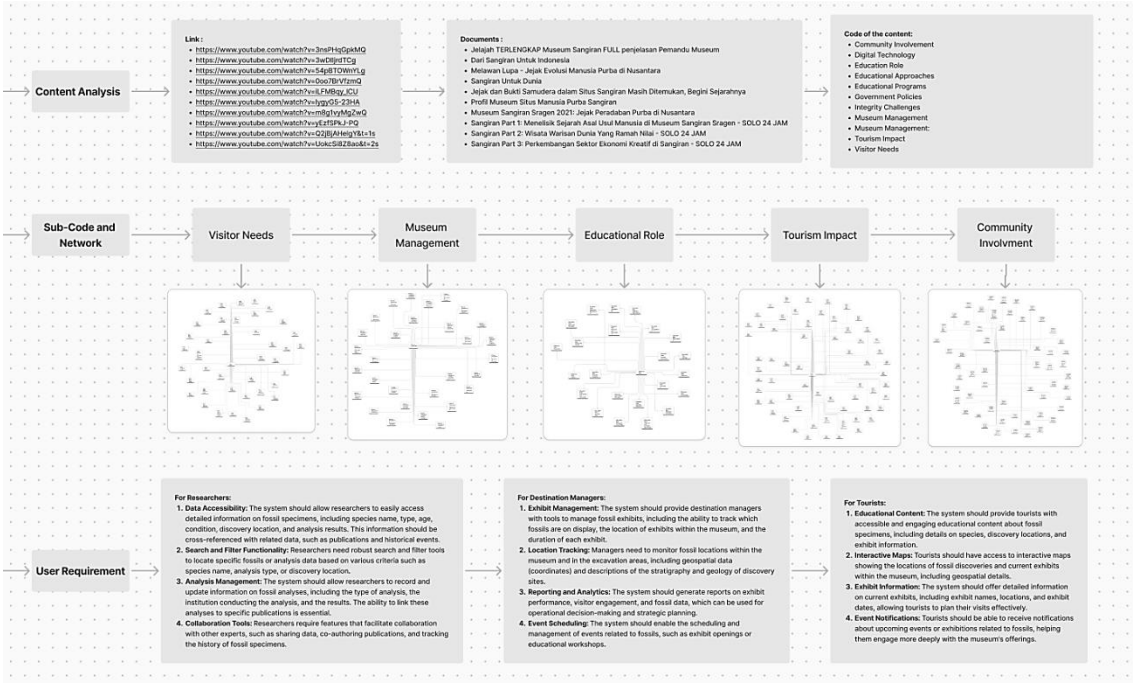

Figure 3. User Requirement Phase

Figure 3 shows the user requirement phase. Content analysis of the video materials on Sangiran is essential for generating codes related to tourism, heritage, museums, and education based on the narratives provided. This analytical process systematically examines the themes and messages conveyed in the videos to identify key concepts aligning with heritage preservation and educational tourism objectives. By extracting relevant codes from the narratives, the analysis facilitates a deeper understanding of how these elements interact within the context of Sangiran, thereby informing the development of more targeted and effective strategies. Ultimately, this approach ensures the content is accurately represented and utilized to enhance the Sangiran Information System's alignment with its educational and cultural preservation goals.

The generated narrative has produced the following codes: Community Involvement, Digital Technology, Education Role, Educational Approaches, Educational Programs, Government Policies, Integrity Challenges,

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Museum Management, Tourism Impact, and Visitor Needs. These codes encapsulate the critical aspects of managing heritage sites like Sangiran, where the intersection of education, tourism, and technology plays a pivotal role. Including these codes highlights the complex interplay between preserving cultural integrity and meeting the needs of various stakeholders, including the government, local communities, and visitors. This coding framework provides a robust foundation for further analysis and development of strategies to enhance the educational and cultural value of the Sangiran site.

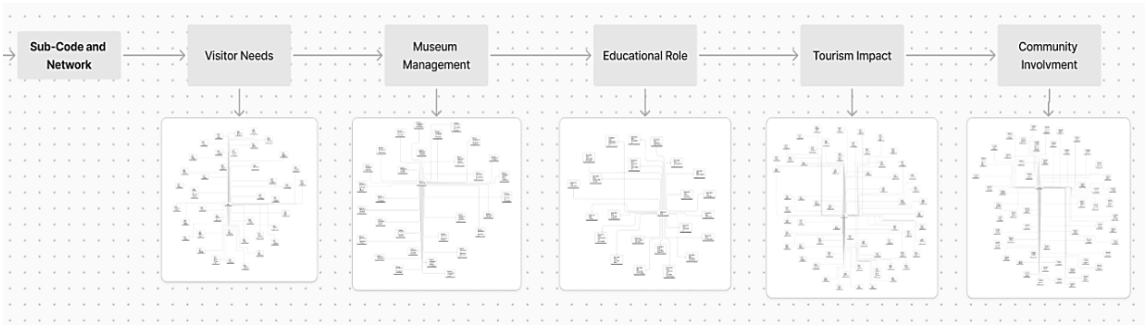

Figure 4. Sub-Code and Network

Figure 4 shows the sub-code and network. The generated codes reveal a complex network of interconnected sub-codes, highlighting the necessity of mapping them according to user needs to ensure the development of an ideal system. This complexity underscores the diverse requirements of stakeholders, including museum management, educational roles, tourism impact, visitor needs, and community involvement, each demanding tailored functionalities within the system. By systematically organizing these sub-codes, the design process can more effectively address the specific demands of each user group, thereby enhancing the overall efficiency and effectiveness of the system. Consequently, this approach will facilitate the creation of a comprehensive system that aligns with the multifaceted needs of its users.

Based on the classification of user requirements derived from textual data, the need for a system that specifically caters to the preferences of researchers, destination managers, and tourists has been identified. Each user group exhibits distinct requirements, with researchers prioritizing access to detailed data and analytical tools, destination managers focusing on operational management and visitor engagement, and tourists seeking informative and interactive experiences. These differentiated needs necessitate the development of a tailored system architecture that accommodates the unique demands of each group. Therefore, this classification process is crucial in ensuring that the system is both functional and responsive to the diverse expectations of its users.

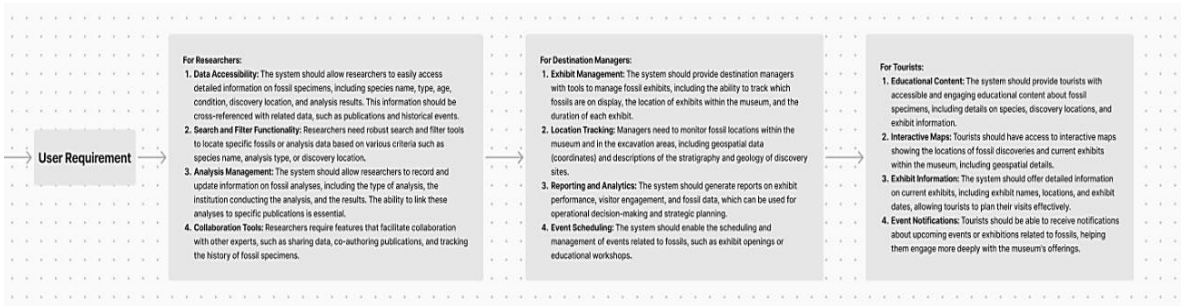

Figure 5. User Requirement

Figure 5 shows the researcher, destination manager, and tourist user requirements. Based on the classification of researcher user requirements, the system must be designed with specific criteria to meet their advanced needs. These criteria include comprehensive data accessibility, enabling researchers to retrieve detailed information on fossil specimens and cross-reference it with related publications and historical events. Additionally, the system should incorporate robust search and filter functionality, allowing users to locate fossils or analyze data based on various parameters efficiently. Effective analysis management is also crucial, providing the capability to record, update, and link fossil analyses to relevant publications. Furthermore, including collaboration tools is essential, facilitating data sharing, co-authoring, and tracking the historical trajectory of fossil specimens. This targeted approach ensures that the system supports the complex and collaborative nature of research activities in the field.

Based on the classification of user requirements for Destination Managers, the system must be equipped with specific functionalities tailored to their operational needs. These include robust exhibit management tools that allow managers to track fossil displays, monitor exhibit locations within the museum, and manage the duration of each exhibit. Additionally, precise location tracking is essential, enabling monitoring of fossil locations within museum and excavation areas, supported by geospatial data and site-specific geological

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descriptions. The system should also generate comprehensive reports and analytics on exhibit performance, visitor engagement, and fossil data, providing valuable insights for operational decision-making and strategic planning. Furthermore, an event scheduling feature is necessary to facilitate organizing and managing fossils-related events, such as exhibit openings and educational workshops. This comprehensive approach ensures that the system effectively supports the multifaceted responsibilities of Destination Managers.

Based on the classification of user requirements for tourists, the system must incorporate specific features that enhance their experience and engagement. First, the system should provide accessible and engaging educational content about fossil specimens, including comprehensive details on species, discovery locations, and exhibit information. Additionally, interactive maps are essential, enabling tourists to view the locations of fossil discoveries and current exhibits within the museum, complete with geospatial details. The system should also offer detailed information on current exhibits, including names, locations, and dates, allowing tourists to plan their visits effectively. Furthermore, event notifications should be integrated, enabling tourists to receive timely updates about upcoming events or exhibitions related to fossils, thereby fostering a deeper connection with the museum's offerings. This tailored approach ensures that the system meets the diverse needs of tourists while enhancing their educational and interactive experiences.

2.2.2 User Design

The identified user requirements can be effectively accommodated in the prototype design. However, it is crucial to recognize that not all needs can be fully facilitated, as careful consideration must be given to the relevance and coherence of the edu-tourism concept centered on prehistoric artifacts in Sangiran. This selective integration ensures that the system remains focused on its core educational and cultural objectives while maintaining a balanced and sustainable approach. Consequently, the prototype is designed to meet the most critical needs of users while aligning with the overarching goals of heritage preservation and educational enrichment at the Sangiran site.

A significant challenge in application development is the incorporation of new users with increasingly complex requirements. Consequently, the current user design prototype emphasizes the core conceptual framework, allowing for adaptability in the application's development to accommodate evolving needs in the field. This approach ensures that the foundational design remains flexible, enabling the system to integrate additional functionalities as user demands grow and diversify. By focusing on the essential idea in the initial prototype, the development process remains agile and responsive to the dynamic environment in which the application will operate.

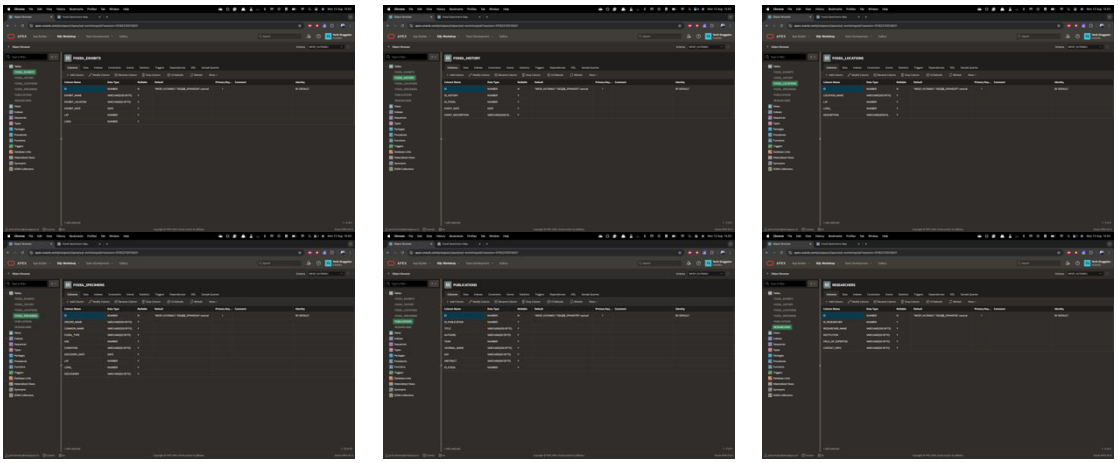

Figure 6. Database of the Prototype

Figure 6 shows the prototype database. The designed database prototype is meticulously structured to meet the diverse needs of its users, encompassing researchers, destination managers, and tourists. The prototype includes interconnected tables storing and managing crucial data, such as fossil specimens, locations, analyses, exhibits, and related publications. Each table is carefully designed for efficient data retrieval and management, ensuring users can access and utilize the information relevant to their roles. The relational structure of the database supports seamless integration and cross-referencing of data, thereby enhancing the overall functionality and usability of the system. Ultimately, this prototype lays the foundation for a robust and comprehensive information management system tailored to the unique requirements of the Sangiran site.

Each table is synchronized with the application's interface to ensure that the data inputted by users is accurately stored and can be effectively utilized to analyze tourism development in Sangiran. This synchronization enables seamless user and database interaction, allowing real-time data entry, retrieval, and analysis. By integrating the tables with the application interface, the system ensures data integrity and provides a robust platform for generating insights into the trends and impacts of tourism at the site. Consequently, this

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design approach enhances the system's capacity to support informed decision-making and strategic planning in managing Sangiran's heritage and tourism resources.

2.2.3 Construction

During the construction phase, interface configuration is meticulously carried out to ensure seamless integration with the database. This process involves aligning the user interface elements with the underlying data structures, enabling efficient data flow between the front-end and the back-end systems. Such integration is crucial for maintaining data integrity and ensuring that user inputs are accurately reflected in the database, facilitating reliable data retrieval and analysis. The focus on thorough interface configuration at this stage is essential for the system's overall functionality and user experience, laying a solid foundation for subsequent stages of application development.

The primary challenge during the construction phase lies in accommodating the diverse needs of researchers, destination managers, and tourists by designing an interactive and user-friendly system. This phase requires the integration of complex functionalities that cater to the specific requirements of each user group while ensuring that the overall interface remains intuitive and accessible. Balancing the depth of information and features necessary for researchers with the operational and experiential needs of destination managers and tourists presents a significant design challenge. Addressing this complexity is crucial for developing a functional and easy-to-navigate system, ensuring all users can effectively engage with the platform.

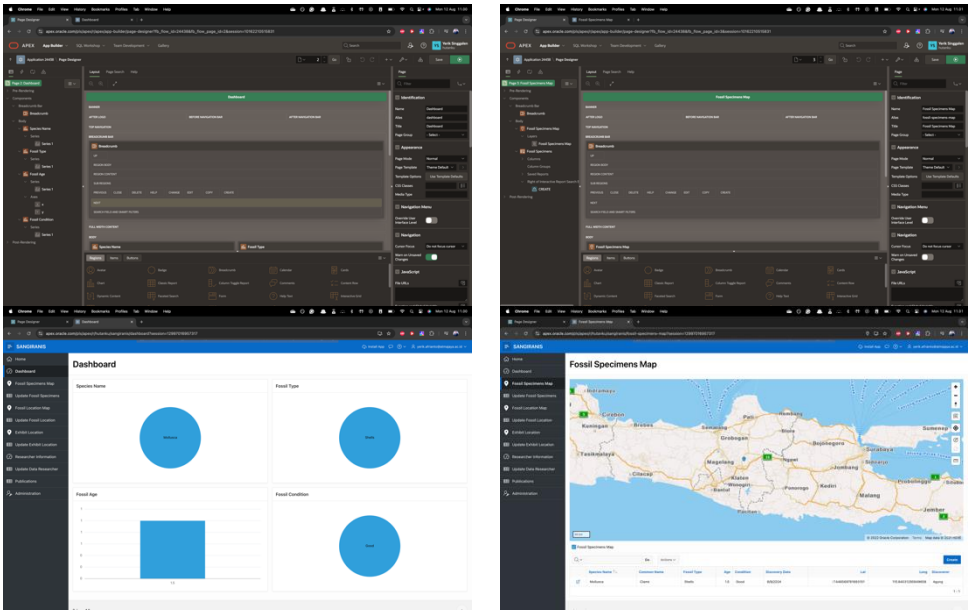

Figure 7. Configuration and Interface Design

Figure 7 shows the configuration and interface design. During the construction phase, the configuration and design of the prototype's interface were meticulously executed. It involved developing an intuitive and user-friendly interface that seamlessly integrates with the underlying database, ensuring that data input, retrieval, and visualization are efficient and accurate. The interface design was guided by the need to facilitate user interaction with the system, enhancing the overall user experience while maintaining the integrity of data management processes. This strategic interface configuration and design approach ensures the prototype meets current user requirements and is adaptable to future enhancements.

The configuration process is tailored to align with the user requirements, ensuring that the system meets the essential needs of its users. However, not all user demands could be fully accommodated within the current prototype design due to constraints related to scope and complexity. This selective integration was necessary to maintain a focused and manageable development process while delivering a functional and practical system. Consequently, the prototype represents a foundational step, with the potential for future enhancements to address the more complex requirements not included in the initial design.

2.2.4 Cutover

During the cutover phase, the design and interface configuration of the SangiranIS prototype are rigorously evaluated based on CRUD (Create, Read, Update, Delete) functionality and the performance of each page, as indicated by the error log. This evaluation ensures that all system operations function correctly and efficiently, identifying issues in data management processes or interface responsiveness. By systematically analyzing the error logs, potential flaws or inefficiencies can be addressed, enhancing the system's reliability and usability. This thorough evaluation ensures that the prototype meets the required standards before full deployment.

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The challenge at this stage lies in users' difficulty in understanding the system's workflow or the functionality of its CRUD (Create, Read, Update, Delete) operations, leading to discomfort and frustration when using the application. This issue arises from the complexity of the system's design, which may not be immediately intuitive for all users, particularly those less familiar with such interfaces. As a result, the user experience is negatively impacted, potentially hindering the system's adoption and effectiveness. Addressing these usability challenges is critical to ensuring that the application is both accessible and user-friendly, thereby enhancing overall satisfaction and efficiency.

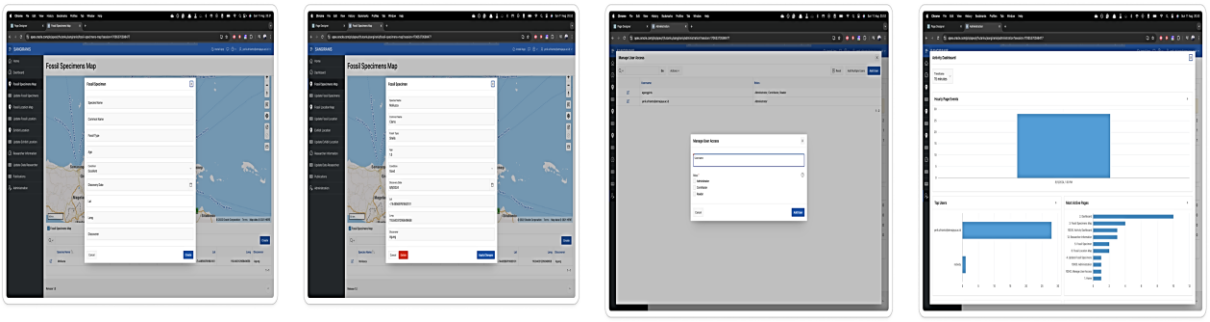

Figure 8. Page Performance

Figure 8 shows the system's page performance. The cutover results indicate that the system executes all CRUD (Create, Read, Update, Delete) functions without issues. Each operation was tested extensively, demonstrating the system's capability to manage data effectively and efficiently. This smooth performance across all CRUD functionalities reflects the robustness of the system's design and configuration. Consequently, the system is deemed reliable for deployment, meeting the operational standards required for effective data management.

Thus, the Sangiran Information System prototype, within the contexts of tourism, education, heritage, and museum management, can be comprehensively analyzed in alignment with the challenges of tourism development in Sangiran. The system is designed to address the multifaceted needs of various stakeholders, enabling a thorough examination of its effectiveness in promoting and preserving cultural heritage while supporting educational initiatives. This holistic approach ensures that the prototype meets immediate operational requirements and contributes to the long-term sustainability and growth of Sangiran's tourism sector. Consequently, the prototype is a crucial tool in navigating and overcoming the complexities associated with tourism development in this culturally significant area.

3. RESULT AND DISCUSSION

The discussion in this study is divided into two key sections: the initial concept development for the design of the Sangiran Information System and the subsequent discussion that examines this system from the perspectives of heritage tourism, education, and sustainability. The first section focuses on the foundational ideas and design principles that guided the creation of the system, emphasizing its role in addressing specific user needs. The second section critically analyzes how the system contributes to the preservation of cultural heritage, enhances educational outcomes, and supports sustainable tourism practices. This dual approach ensures a comprehensive understanding of the system's design and broader implications for heritage tourism and education.

3.1 Foundational Ideas and Design Principles of Sangiran Information System Based on Content Analysis

The Foundational Ideas and Design Principles of the Sangiran Information System are intrinsically linked to the identified needs of users, including researchers, destination managers, and tourists at Sangiran. This design process involved a meticulous analysis of each user group's requirements, ensuring that the system is tailored to support their specific objectives, whether in data management, operational efficiency, or visitor engagement. By grounding the system's development in these user-centric insights, the design not only addresses the diverse needs of its stakeholders but also enhances the overall functionality and user experience. Consequently, the system's architecture reflects a well-integrated approach that aligns with its varied user base's distinct roles and expectations.

Based on the content analysis, several intriguing aspects of digital technology and the educational role at the Sangiran heritage tourism destination have emerged. The integration of digital technology plays a significant role in enhancing visitor engagement through interactive exhibits and virtual experiences, offering an immersive learning environment. Additionally, the educational role at Sangiran is pivotal in raising awareness about the historical and cultural significance of the site, with a focus on making heritage accessible and understandable to a broader audience. These findings underscore the importance of leveraging digital tools and educational initiatives to enrich the visitor experience and promote the preservation of cultural heritage at Sangiran.

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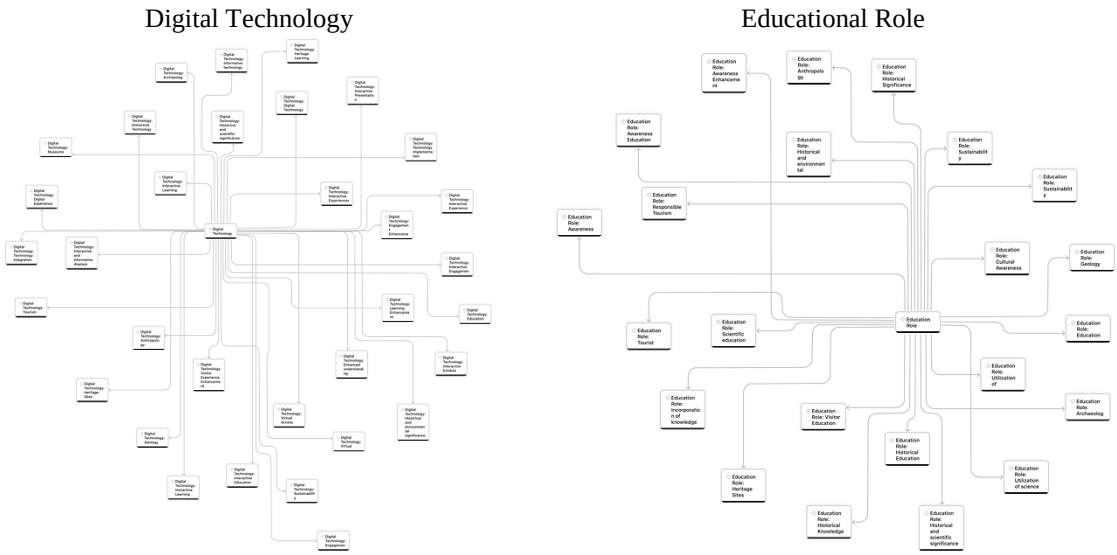

Figure 9. Digital Technology and Educational Role Network

Figure 9 shows the role of digital technology in education. Technology is crucial in supporting activities related to the significant fossil findings at the Sangiran site, ranging from ancient human remains and stone tools culture to ocean life from millions of years ago. The site, with its diverse collections housed in museums like Kerikilan and Ngebung, provides valuable insights into the life and evolution of early humans, including Homo erectus and other ancient human species found in Indonesia, such as Homo floresiensis. Integrating advanced technological tools in these activities enhances the ability to preserve, study, and present these artifacts, contributing significantly to global knowledge of human evolution and ancient life forms. It highlights the essential function of technology in bridging the past and present, ensuring that the rich history encapsulated in Sangiran is accessible and comprehensible to researchers and the general public.

In the context of its educational role, the Sangiran site in Indonesia holds immense significance for studying human evolution, mainly through the discovery of fossils such as Homo erectus. These findings offer valuable insights into ancient human life and its interaction with the natural environment, contributing to a deeper understanding of human evolution and environmental changes over millions of years. The discovery of other significant fossils, including Homo floresiensis on Flores Island, further underscores the importance of Sangiran as a critical location for the study of ancient humans. Through ongoing excavations and the preservation of cultural artifacts, Sangiran continues to be a vital site for education and research, ensuring that the history of life on Earth is accessible and comprehensible to both scholars and the broader public.

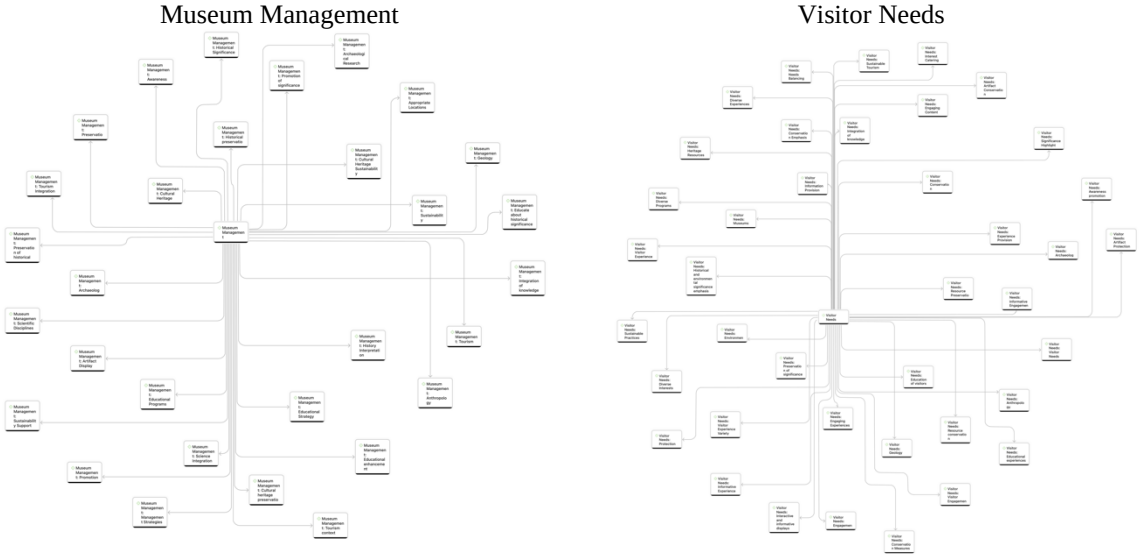

Figure 10. Museum Management and Visitor Needs Network

Figure 10 shows the museum management and visitor needs. In the context of museum management, the Sangiran site in Indonesia plays a crucial role in preserving and showcasing the rich archaeological heritage uncovered by researchers like Von Koenigswald, who discovered ancient human fossils in the region. These

Journal of Computer System and Informatics (JoSYC)
ISSN 2714-8912 (media online), ISSN 2714-7150 (media cetak)
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https://ejurnal.seminar-id.com/index.php/josyc
DOI 10.47065/josyc.v5i4.5776

discoveries, including various species such as Pithecanthropus erectus and Homo sapiens, provide valuable insights into the evolutionary journey of humans in Java over hundreds of thousands of years. The site has since been developed into a world heritage destination, featuring museums that house around 500 collections, each dedicated to different periods and artifacts, enhancing public understanding of human evolution and ancient life. The ongoing research, preservation efforts, and active involvement of the local community further solidify Sangiran's status as a vital hub for education and tourism, emphasizing the importance of maintaining and managing such sites to safeguard our shared history.

In the context of museum visitor needs, the Sangiran site in Indonesia is a pivotal location for understanding human evolution by discovering ancient human fossils and artifacts. The site has yielded significant finds, including fossils of Homo erectus and Homo floresiensis, which illuminate the diversity of early human species in the region. With over 500 collections housed in the Sangiran Museum, visitors have access to a comprehensive array of archaeological and paleontological information, providing deep insights into the history of life on Earth. Additionally, the text highlights the critical importance of conservation efforts and community involvement in preserving these invaluable archaeological sites, ensuring that the rich history of the Sangiran area, which dates back millions of years, remains accessible and educational for future generations.

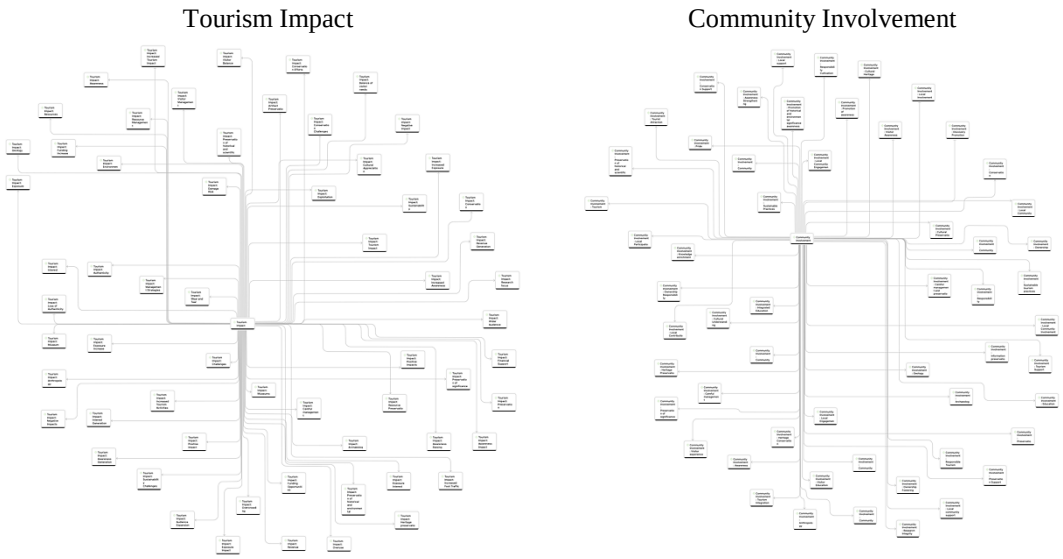

Figure 11. Tourism Impact and Community Involvement Network

Figure 11 shows the tourism impact and community involvement network. In the context of tourism impact, the ongoing research and conservation efforts at Sangiran, a site pivotal for understanding human evolution, have led to significant discoveries such as the Homo erectus, offering profound insights into human history. The Sangiran Museum is a critical educational hub, presenting these findings and highlighting the region's rich cultural heritage. The geological significance of the site, combined with its diverse collections and innovative exhibits, makes it an invaluable resource for comprehending ancient human life and natural history in Indonesia. As exploration continues and discoveries emerge, Sangiran's role in scientific research and heritage tourism becomes increasingly essential, underscoring its global importance in studying human evolution.

In the context of community involvement, the ancient Javanese humans, who lived hundreds of thousands of years ago, relied on group living, travel, and technologies such as stone axes and fire for survival, as evidenced by artifacts discovered at the Sangiran site. These artifacts offer valuable insights into these early humans' lives and evolutionary journeys. The Sangiran site has also played a crucial role in uncovering human and oceanic remains, providing a broader understanding of ancient life in the region. Moreover, the discovery of Homo erectus fossils in various parts of the world has prompted further investigation into their origins and evolution. The Sangiran Museum, with its diverse collection of artifacts, serves as a critical resource for educating the public and enhancing our understanding of prehistoric life in Indonesia. This involvement of the local community in preserving and interpreting such heritage not only enriches cultural knowledge but also fosters a deeper connection between the past and present.

The limitation of this study lies in the prototype of the Sangiran Information System, designed to address the needs of users such as researchers, destination managers, and tourists. However, the museum operates with its distinct system and database, which are not fully integrated into this prototype. This separation may result in challenges when attempting to unify or cross-reference data between the museum's internal system and the broader Sangiran Information System. As a result, while the prototype serves its intended purpose for external users, it does not fully encapsulate the museum's internal data management needs, highlighting an area for potential future development.

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ISSN 2714-8912 (media online), ISSN 2714-7150 (media cetak)
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https://ejurnal.seminar-id.com/index.php/josyc
DOI 10.47065/josyc.v5i4.5776

3.2 Discussion: Tourism, Heritage, Education, and Technology

Sangiran, as a tourist destination, has the potential to be developed into both an edu-tourism and heritage tourism site, attracting a wide range of visitors. This dual approach enhances its appeal and provides multiple avenues for analysis, encompassing tourism, education, and heritage preservation [22]–[24]. The site's rich historical and cultural significance offers opportunities to explore these topics from various perspectives, allowing for a comprehensive understanding of its role as a destination [25]–[27]. Consequently, developing Sangiran as a multifaceted tourism destination highlights its value in preserving cultural heritage and promoting educational tourism.

Digital technology can be developed and utilized as a practical learning medium that aligns with the activities at Sangiran. By integrating advanced digital tools, the educational experience can be significantly enhanced, allowing for interactive and immersive learning opportunities that bring the rich history and cultural heritage of Sangiran to life. This approach makes the learning process more engaging for visitors and supports preserving and disseminating knowledge of evolution and ancient civilizations [28]–[30]. Ultimately, the strategic use of digital technology in educational initiatives at Sangiran can foster a deeper understanding and appreciation of the site's historical significance.

Education related to the activities of local communities, from fossil excavation to museum exhibitions, can be effectively supported by digital technology. Implementing digital tools can enhance the learning experience by providing interactive and detailed insights into each stage of the process, from the discovery of fossils to their preservation and display [31]. This technological integration not only facilitates greater public engagement but also ensures that the knowledge and expertise of local communities are preserved and shared more broadly [32]–[35]. Consequently, digital technology is a powerful medium for bridging the gap between traditional practices and modern educational methods, thereby enriching the overall educational framework associated with Sangiran.

Educational tourism has become a significant attraction for domestic and international tourists, mainly through participatory actions in educational activities related to museum operations involving local communities. This form of tourism allows visitors to engage directly with the cultural and historical context of the destination, enhancing their understanding and appreciation of the site [36]–[38]. The involvement of residents in these educational activities not only enriches the visitor experience but also fosters a deeper connection between the community and the preservation of their heritage. As a result, educational tourism serves as a powerful tool for cultural exchange and sustainable tourism development.

Technology serves primarily as an informational medium for documenting and even marketing educational tourism packages related to heritage in Sangiran. By leveraging digital platforms, the rich cultural and historical narratives of Sangiran can be effectively communicated to a global audience, enhancing awareness and interest in the site. Moreover, these technological tools facilitate the creation of comprehensive and engaging content that showcases the unique aspects of Sangiran's heritage, thereby attracting a broader range of tourists. In this capacity, technology plays a crucial role in bridging the gap between heritage preservation and modern tourism marketing strategies, ensuring that Sangiran remains a relevant and accessible destination.

Future research is recommended to focus on integrating the Sangiran Information System prototype with the existing museum databases and systems. This integration would enhance data coherence and accessibility, providing internal and external users with a unified platform. Additionally, exploring advanced digital tools and technologies could further improve the system's functionality, offering more comprehensive support for researchers, destination managers, and tourists. By addressing these areas, future studies can contribute to developing a more robust and interconnected heritage management system that aligns with the evolving needs of all stakeholders.

4. CONCLUSION

The research concludes that the Sangiran Information System prototype, developed using the Rapid Application Development (RAD) framework, effectively meets the primary needs of researchers, destination managers, and tourists by providing a user-centric platform for managing and accessing data related to the Sangiran site. The RAD approach facilitated the prototype's rapid development and iterative refinement, ensuring alignment with user requirements. Additionally, the coding results from the content analysis further informed the design, highlighting key areas such as digital technology integration, educational roles, museum management, and tourism impact. However, the study also identifies limitations, particularly the lack of integration with the museum's internal systems and databases. This separation underscores the need for further development to create a more cohesive and comprehensive system. Overall, while the RAD-driven prototype and the insights gained from coding analysis represent significant advancements in enhancing the management and educational potential of the Sangiran site, ongoing improvements are necessary to fully realize its potential in supporting heritage preservation and tourism.

ISSN 2714-8912 (media online), ISSN 2714-7150 (media cetak)
Volume 5, No. 4, August 2024, Page 1001-1013
https://ejurnal.seminar-id.com/index.php/josyc
DOI 10.47065/josyc.v5i4.5776

ACKNOWLEDGMENT

We want to express sincere gratitude to Satya Wacana Christian University and Cendrawasih University. Also, the Tourism Department, Faculty of Business Administration and Communication, Atma Jaya Catholic University of Indonesia, PUSDIPAR, and the LPPM (*Lembaga Penelitian dan Pengabdian kepada Masyarakat*).

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