

Westernization and preservation: an appropriated edutourism application as educational media for archaeological sites in Bedulu, Bali

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ABSTRACT

The commercialization of tourism developing in West Bali poses risks that can damage the cultural identity not only of the island but, more crucially, of archaeological sites of cultural value. This research aims to develop a glocal educational tourism application for the Bedulu archaeological sites that offers a cultural alternative to the homogenization of the island's tourism culture. The novelty of this research lies in the combination of integrated digital storytelling for social media (IDSMS) and advanced interactive digital storytelling (A-IDS), with a design approach that eliminates colonization and is community-centered. Using the Borg and Gall model, which is limited to the planning stage, data for this research were collected through literature review, field observation, surveys of 30 subjects, and semi-structured interviews with 5 purposively selected key informants (site managers, archaeologists, and user interface (UI)/user experience (UX) designers), as well as community co-design workshops. This research resulted in a cultural content map and a prototype application, which is the first in the world, and serves as an operational glocalization model, the first in the world to become a model for intergenerational educational digital heritage literature, for inclusive community development, and sustainable Balinese cultural heritage.

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1. INTRODUCTION

Tourism in Bali, characterized by mass tourism and Westernization, has led to the commodification of local cultures, stripping historical landmarks of their identity and significance [1]–[4]. This trend conflicts with the urgent need for cultural preservation, particularly at archaeological sites such as Samuan Tiga Temple, Yeh Pulu Relief, Goa Gajah, Pengastulan Temple, and Gedong Arca Museum in the Bedulu region, Gianyar. These sites preserve shared memory of ancient civilization but currently rely on static communication methods (information panels and short guided tours) that fail to engage younger, digitally inclined generations [5], [6]. More recent scholarship has called for community-led digital heritage design and decolonial practices to address knowledge inequality [7]–[9]. Integrated digital storytelling for social media (IDSMS) [10] and advanced interactive digital storytelling (A-IDS) [11] are frameworks that emphasize multimedia involvement, user control, and narrative consistency. Simultaneously, decolonial tourism studies

advance the community-based ownership and protection of intangible cultural knowledge [12]. However, there are no existing edutourism apps of Balinese archaeological sites that bring together these participatory, decolonial, and glocalization principles in one digital product.

Recent scholarship in digital heritage ethics emphasizes moving beyond mere digitization towards community-centered design and decolonial practices. Pawana *et al.* [11] argue that digital heritage design in Southeast Asia should adopt a participatory approach to avoid a top-down approach that replicates knowledge inequality. See and Wong [12] presents the IDSM. For the contemporary audience, it emphasizes the significance of community engagement and cultural authenticity, alongside multimedia and cultural engagement, as critical for audience engagement. Meanwhile, Chevalier and Yanthy [13] advocate for decolonialism tourism practices that prioritize community-based ownership and cultural heritage protection. This study engages with this body of literature by developing an edutourism app that acts as more than an informational tool, but rather as a glocal intervention that culturally hands in tech. culturally hand in tech. integrated participatory design principles and authentic digital narratives.

Located in the Bedulu region of Gianyar, Bali, the Samuan Tiga Temple, Yeh Pulu Relief, Goa Gajah, Pengastulan Temple, and Gedong Arca Archaeological Museum are archaeological sites that are not merely tourist centers [14]. They preserve the shared memory of ancient advanced civilizations and offer rich sources of history, religion, and philosophy [15]. Sadly, the means of communicating and teaching the visitors about these places remain largely static, often limited to information panels or short guided tours. Such approaches overlook the significance and meaning of each artifact or structure, as well as the multiple layers of understanding that can be appreciated [16]. Engaging and interactive narratives designed to capture the attention of younger, digitally inclined generations are essential for stimulating curiosity and embracing their history and culture [17]. The new edutourism paradigm offers an opportunity for an enjoyable, constructive experience. It contributes to advancing education, culture, and the environment by empowering travelers to protect resources [18]. Edutourism transforms archaeological sites into interactive laboratories, allowing visitors to experience the Balinese culture, history, art, and spirituality [13]. However, innovations in information delivery media and diverse audiences are necessary for the efficient management of edutourism [14]. The progression of information and communication technologies, especially mobile apps, has transformed both the education and tourism industries. With geolocation services and mobile app interactives, historical sites can be dynamically presented to mobile users [15]. Through personalized engagement, complex information can be broken down and presented via interactive narratives. Such applications would enrich the visitor experience, bridging local wisdom and modern technology while connecting past and present [16]. Engaging and interactive narratives designed to capture the attention of younger, digitally inclined generations are essential for stimulating curiosity and embracing their history and culture [8]–[10], [17]. As explained by Rizvic *et al.* [18], A-IDS provides a structure for developing immersive edutainment experiences that go beyond the 'narrative paradox' concerning the balance between the users' freedom to explore and the cultural narratives' integrity.

The aim of this study is to fill this gap by designing a glocal edutourism application for Bedulu archaeological sites. The innovation is a three-fold integrated framework: i) integration of IDSM and A-IDS models for immersive, non-linear learning experience; ii) adoption of decolonial, community-centred co-design approach where local stakeholders co-create a narrative; and iii) development of a glocal counter-narrative tool that utilizes global digital technology to preserve local Balinese values (e.g., Tri Hita Karana, Balinese language as the primary interface).

2. METHOD

2.1. Theoretical framework and design principles

Recent studies from 2020 to 2025 outline the relevance of participatory and ethically driven techniques in cultural heritage informatics. For example, Wong suggests the IDSM, which highlights the essential role of community, culture, and multimedia integration, along with the social media component, in heritage storytelling for effective cultural preservation [9]. It aligns with Purnamawati's research on the development of the Indonesian virtual museum. Purnamawati [16] emphasizes the need for community participation in the design process to achieve sustainability and cultural preservation goals. Furthermore, Wang *et al.* [15], in the context of Cambodian archaeology, show how participatory mapping and digital co-curation can empower local communities and challenge colonial power relations in knowledge production. This research adopts this insight by involving site managers and local stakeholders not only as subjects, but as partners in designing the application's narrative flow.

Decolonial discourse in tourism has gained significant traction. There has been a significant increase in the use of decolonial discourse in tourism. Chevalier and Yanthy [13] break down decolonial tourism practices and how they may reshape power relations through community-based ownership and the

safeguarding of cultural heritage. It also includes a shift from a commodified view of culture to the positive recognition and strengthening of local knowledge systems. The concept of glocalization, as applied in this study, operates as a decolonial strategy using global technology (the application framework) to amplify and preserve local values and narratives [19]. As such, the application is designed not as a neutral tourism product, but as a tool for counter narration to homogenizing Westernization.

In the realm of heritage education, Wang *et al.* [15] introduce the concept of A-IDS, which combines traditional narrative elements with game mechanics (gameplay) and high user agency. This approach overcomes the limitations of linear, static presentations, creating an immersive, personalized edutainment experience. The reward-based quizzes, immersive virtual tours, and interactive timelines in this app design are inspired by the A-IDS framework, which aims to increase knowledge retention and emotional engagement of young users with their heritage.

2.2. Research and development design

This strategy emphasizes building a solid conceptual, cultural, and architectural base. This phase is conducted before moving on to more advanced stages of functionality and empirical testing [20], [21]. Rather than an operational application, the main deliverables of this phase are a detailed design specification and a high-fidelity, clickable prototype.

2.3. Stakeholder involvement and co-design process

Approaching this research from a community-based design (CCD) perspective, the team involved key stakeholders not only as data sources but also as fully engaged co-design collaborators. Engagement occurred in several distinct and sequential phases. In-depth expert interviews: during this research, five semi-structured interviews with key informants were conducted to capture the main components of the context and to identify available resources and potential barriers. Two site managers (from the Goa Gajah complex and Gedong Arca Museum) provided insights on visitor management, site significance, and practical challenges. The archaeologist team employed by the Cultural Heritage Preservation Office (BPCB), Bali, verifies historical and archaeological data. Two professional user interface (UI)/user experience (UX) designers focus on modern usability, interaction, and technical design for the intended audience. User needs analysis: an online survey was conducted with 30 respondents, a sample comprising domestic and foreign tourists, local tour guides, academics, and students. The survey was designed to assess needs and quantify respondents' expected preferences (e.g., virtual tours and audio guides), as well as information needs regarding the Bedulu site. Community co-design workshop: together with core cultural experts, a Hindu Balinese spiritual practitioner (*Pemangku*) and a local historian from Bedulu Village, a semi-structured focus group discussion (FGD) was conducted. Their contributions went beyond mere validation. They actively contributed to the prioritization of narratives and the selection of fundamental philosophical themes, and to the design review (*Tri Hita Karana*) of colors, patterns, and motifs in coral iconography, as well as the symbols chosen for the design.

2.4. Application architecture and content curation logic

To ensure the sustainability of the application and the separation of interests, a three-layer (3-layer) model will be adopted, as it allows. The UI design intentionally incorporates elements of Balinese culture. This design features a natural color palette of earthy browns and leafy greens to mirror the island's landscape. Inspired by the Balinese script, the UI features custom typography. The design further includes a custom graphical and iconographic collection featuring motifs from Balinese culture, such as the Karang Goak (monster head) and Patra (floral). Navigation that follows global UX conventions (e.g., bottom tab bar) but organizes content based on a Balinese cosmological hierarchy (historical timeline and spiritual significance) rather than mere geography.

Business logic layer (back-end): core application functionality is managed by a Node.js server, with data persisted in a MongoDB database. This layer supports the following key content modules. Interactive geospatial map: uses the Google Maps API and custom pins printed with Balinese motifs for the five sites. Multimedia historical timeline: a chronological interactive for each site from prehistory to the present. Digital artifact catalogue: an assemblage from the Gedong Arca Museum that users can browse, for which each artifact is documented with high-resolution (zoomable) images and notes from the curator. Multilingual audio guide and oral histories: audio records in Balinese, Indonesian, and English (three). The Balinese version is edited by the native speaker and blended with oral histories of local community elders. Immersive virtual tour: 360-degree images or videos that users can navigate to explore significant parts of the sites. Educational gamified quiz: users receive digital badges that symbolize Balinese philosophical concepts (e.g., *Palemahan* for environmental awareness) and are named after them when they complete certain tasks.

Data layer: all content (texts, images, and audio/video), user profiles, and user interactions (quiz scores and user preferences) are housed in a structured database. Logic of curation and validation of content:

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content creation is complex and involves several steps. Sourcing: at this primary level, content is obtained from primary sources (expert interviews, oral histories, and inscriptions) and secondary sources that have been validated (peer-reviewed archaeological reports relevant to Balinese history and academic writings). Drafting and cultural translation: drafts of the initial narratives are prepared, and translations into Indonesian and English are conducted by certified translators with knowledge of the relevant cultural nuances. Validation loop: each content module undergoes a minimum of 3 reviews by different panels of local historians and spiritual practitioners. Their feedback ensures cultural accuracy, contextual appropriateness, and respectful representation before final integration into the database.

2.5. Planned evaluation strategy

As this study concludes at the prototype stage, a comprehensive evaluation strategy is proposed for the subsequent development phase. Usability testing: a think-aloud protocol will be administered to 15-20 users (a mix of domestic/international tourists and local community members) using the clickable prototype. Their interactions will be observed to identify navigation issues and cognitive hurdles. Subsequently, users will complete the standardized system usability scale (SUS) questionnaire to yield a quantifiable usability score. Educational impact assessment: a pre-test/post-test design will be implemented with a group of student users ($n = 30-50$). Before using the app's core modules, and after, users will need to demonstrate their knowledge of the history, architecture, and philosophy of the Bedulu site. The degree of users' knowledge will be assessed using paired-sample t-tests. In-app quizzes will be subject to qualitative analysis for additional insights. Re-assessment of stakeholder feedback: following the launch of a functional beta version, site managers, tour guides, and cultural experts will be subjected to structured interviews for a second time to assess the app's real-world effects, the practical accuracy of the app's content, and the app's social acceptance in the community.

2.6. Ethical safeguards and data sovereignty

Design blueprints proactively incorporate ethical considerations. Sacred site representation: at temples with high ritual functions (e.g., Pura Samuan Tiga and Pura Pengastulan), the focus is on publicly available historical data and accessible architectural descriptions. Information and visual descriptions of esoteric rituals are intentionally left out. Photography of the innermost Sanctums (*Pelinggih*) is prohibited, as per the guidance of stakeholders. Community data sovereignty: all cultural data, narratives, and curated media are explicitly recognized as the intellectual property of the Bedulu Village community. The research team proposes establishing a memorandum of understanding (MoU) with the village council (Desa Adat Bedulu). This MoU will cover community consent, data ownership, access rights, and mechanisms for sharing benefits and will be required for any future commercial use or dissemination of the application's content.

Anti-commodification stance: the application functions as an educational and preservation tool rather than a direct revenue-generating product. Narrative content and quiz questions emphasize intrinsic cultural and philosophical values. Quiz questions steer users away from a consumptive mindset towards one of appreciation and understanding.

3. RESULTS AND DISCUSSION

3.1. User needs analysis and foundational requirements

The first stage of research and information collection developed a valuable understanding of user needs and the challenges of heritage interpretation in Bedulu. Using data from 30 survey respondents (tourists, guides, academics, and students) and 5 experts, 3 main themes were developed. Digital gap: almost all (95%) respondents reported a strong lack of accessible, interactive digital educational resources about the archaeological sites, and characterized current resources (information boards and quick tours) as insufficient for education. Need for engaging media: roughly 80% of respondents wanted engaging media, such as photo collections and videos, especially those showcasing aspects not visible during a regular site visit, such as detailed relief close-ups and 360-degree views of the site. Essential user needs: more than anything else, respondents articulated a need for information organized in a clear, straightforward structure, thematically organized content, and, most critically, content that incorporates local wisdom and real stories rather than mere historical accounts. These align with and strengthen recent academic literature that emphasizes the need for cultural and community-based authenticity, especially in the digital heritage context [9]. Cultural and community-based authenticity in digital heritage user requests for culturally relevant materials also meshes with contemporary tourism studies [10], decolonization, and tourism. It shows that the proposed solution has the potential to fill a significant gap in both the literature and the market.

3.2. Core application design and feature rationale

In response to the identified needs, the core feature set of the application was designed to balance pedagogical effectiveness, cultural integrity, and user involvement. For example, the virtual tour and audio guide features prioritize local narratives and the Balinese language to promote cultural authenticity without sacrificing educational value. Table 1 summarizes these key features, their descriptions, and the underlying cultural or decolonial rationale for each design choice.

Table 1. Core feature design of the Bedulu edutourism application

Features	Description	Cultural integration and decolonial or pedagogical rationale
Virtual tour	Immersive 360° exploration of site key points.	Narration employs Balinese folklore and oral histories. [Rationale: adopts IDSM's multimedia engagement principle [9] and positions local perspective as primary knowledge authority, countering external archaeological narration].
Audio guide	Multilingual guide (Balinese, Indonesian, and English).	The Balinese version uses native speakers and the local dialect for the historical narrative. [Rationale: a strategic decolonial act to decolonize language in heritage interpretation, asserting the epistemological validity of Balinese] [15].
Interactive map	Navigation to the five sites with custom markers.	Cartographic symbols are based on Balinese motifs (e.g., kala head for temples). [Rationale: implements participatory mapping ethos [22] by using a local symbolic system, subtly challenging Western cartographic conventions].
Educational quiz	Reward system with cultural badges.	Questions and badge themes are based on Tri Hita Karana values. [Rationale: employs A-IDS gameplay mechanics [18] to reinforce learning of local philosophy, not isolated facts, fostering intrinsic cultural value recognition].

3.3. Comparative benchmarking with regional edutourism applications

To justify the design decisions and briefly situate the Bedulu application, we conducted a competitive benchmarking study of edutourism apps in Southeast Asia. This research analyzed the content focus of individual apps, the degree of interactivity, and the cultural elements. The study discussed in Table 2 outlines major regional deficits in depth of content, interactivity, and cultural perspective, which provide our design with a competitive advantage.

The comparative analysis shows that Bedulu has located a distinct niche for itself. While some apps are strong in certain areas, such as Angkor and architectural documentation, Borobudur and religious symbolism, or Ayutthaya and world heritage branding, they tend to overlook local philosophies and profound community authorship. The Bedulu app aims to address this gap and positions Balinese cosmology (Tri Hita Karana) as the primary focus, rather than an ancillary topic. It represents a move from a heritage-as-artifact paradigm to a heritage-as-a-living-knowledge paradigm.

3.4. Projected user engagement metrics

Based on user needs analyses, comparative benchmarking, and projections from the A-IDS framework [18], we determined key performance indicators (KPIs) to define parameters for future assessments. These metrics evaluate the application's impact from an educational and user engagement standpoint. The projected targets and the methods for their post-development measurement are outlined in Table 3.

Table 2. Comparative analysis of Southeast Asian edutourism applications

Application/site (region)	Content focus	Key interactive features	Approach culture	Identified deficiencies
Application Bedulu (This study)	History, philosophy (Tri Hita Karana), Architecture, Community Narrative	Virtual tour, quiz culture, audio guide in 3 languages (including Balinese), community-sourced content (planned)	Decolonial design; Community-led narrative; Spiritual value integration	Conceptual prototype; not yet empirically tested.
Angkor guide (Cambodia)	History of Kingdoms, Temple architecture	Interactive map, 360° photos, timeline	Standardized historical narrative; Multi - language translation	Limited deepening of local philosophy and minimal community participation in narrative curation.
Borobudur official app (Indonesia)	Archaeology, Buddhist symbolism	Audio tour, photo collection, augmented reality (AR)	Focus on Buddhist narratives and conservation; "Digital museum" approach	Less contextualization within living Javanese culture; limited emphasis on contemporary community connections.
Ayutthaya historical park (Thailand)	History, sculpture, Royal legacy	Self-guided tours, maps, and quizzes simple	Emphasis on UNESCO World Heritage aesthetics and global significance	Lacks advanced gamification and deep emotional or philosophical engagement mechanisms.

Table 3. Projected user engagement metrics and measurement plan

Metric	Expected target	Measurement method (post-development plan)
Average session duration	>15 minutes per session	Analytics dashboard (e.g., Firebase and Google Analytics) tracking user activity.
Content completion rate per site	>70% (via quiz completion and virtual tour progress)	In-app progress tracking for core modules (timeline, audio guide, and quiz).
User feedback score (SUS)	>4.0/5.0 (equivalent to >80 in SUS scale)	Post-use SUS questionnaire administered to a sample of users.
Quiz completion and badge acquisition rate	>60% of users completing at least one quiz	Backend tracking of quiz attempts and badge awards.

3.5. Critical reflection on glocalizing UX: tensions and resolutions

The interface integrates a global bottom tab bar and hamburger menu in line with global UX practices. Striking a balance between integrating UX practices and local Balinese epistemological and aesthetic traditions is critical to the design process and the app's glocalization strategy. The underlying information architecture, however, disregards any purely geographical or popularity-based ordering. Sites are structured around Balinese historical and cosmological periods. In contrast, the content of each site is organized around the philosophical pillars of Tri Hita Karana (harmony with God, other humans, and nature). It integrates a regionally focused cognitive model with a model oriented towards global integration. Although in Western contexts quizzes and badge systems are often treated as forms of gamification, this is not the case here. Badges are not merely indicators of 'completion'. They are inscribed and symbolically communicate mastery of concepts such as '*Palemahan*' (environmental stewardship) and '*Pawongan*' (social harmony). Thus, a Western engagement mechanism is adapted to promote indigenous value systems. The audio guides and text-based interfaces of the tourism application present a unique case, since unlike other applications that usually prioritize English and the respective national language, Balinese is the primary language. It is a case of linguistic defiance, challenging the myriad of globalized linguistic tourism flows, thus localizing the Balinese language as a legitimate, meaningful, and culturally rich heritage container. In the face of the prevailing global UX trend towards extreme minimalism, the app is richly illustrated with Balinese (Patra and Karang Goak) designs. It is not mere 'decorative noise' but rather an assertion that complex cultures do not have to be simplified for the sake of Western design. The overall design of the application interface functions as an educational site. The application overtly changes the provenance of the narratives from an anonymous, usually Western-oriented, institutional voice to a clear local voice. The Balinese audio guide includes specialists and elders from the community. With the "user contribution" module, community members will capture and share their individual stories and images, further defending the right to interpret heritage and enhancing the community's collective ownership and democracy.

3.6. Visual prototype and user experience flow

Figures 1 to 7 show the completed visual prototype. The design principles mentioned earlier in this document are incorporated into this prototype. Figure 1 designates the five locations as more than destinations—they are portals to different philosophical stories. The interface showcases a grid layout of the five archaeological sites (Samuan Tiga Temple, Yeh Pulu Relief, Goa Gajah, Pengastulan Temple, and Gedong Arca Museum) with illustrative thumbnails and brief descriptions. The design integrates Balinese cultural aesthetics, including a natural color palette and traditional motifs, to create an engaging entry point that balances visual appeal with intuitive navigation. Figure 2 allows users to choose one of the five archaeological sites for detailed exploration. Each site is represented with a culturally resonant icon and title, emphasizing the application's commitment to presenting heritage through a localized lens. The clean layout and clear typography are designed for ease of use, particularly for diverse user groups, including international tourists.

The dashboards for each site (Figures 3 to 7) use the same structure for the information across the four layers: history, architecture, philosophy, and ritual (see the user flow diagram in Figure 8 for an example of a dashboard's tab system). Figure 3 is tailored to provide structured access to historical narratives, architectural details, and information on ceremonial significance. The tab-based interface organizes content into thematic categories (e.g., history, architecture, and philosophy), enabling non-linear exploration while maintaining narrative coherence, in line with the A-IDS framework. Figure 4 focuses on the narrative and historical significance of the relief, offering users an in-depth look at its iconography and cultural context. Features include high-resolution zoomable images, audio descriptions, and thematic annotations that decode the visual storytelling, enhancing both educational value and visitor engagement. Figure 5 presents the site's history, cave architecture, and functional evolution over time. Interactive elements, such as a swipeable gallery of interior photographs and a 360-degree virtual tour, aim to recreate the immersive experience of an on-site visit, addressing the user-expressed need for detailed visual content. Figure 6 screen acts as a digital

catalog, summarizing the museum's artifact collection and its historical context. The design emphasizes discoverability, with filterable categories and detailed artifact views that include provenance data and cultural significance, supporting both casual learning and academic inquiry. Figure 7 outlines the temple's structure, history, and preservation processes. By highlighting the temple's architectural elements and ongoing conservation efforts, this section of the application underscores the study's theme of balancing cultural preservation with the pressures of modernization and tourism.



Figure 1. Homepage design of the Bedulu edutourism application prototype



Figure 2. Site selection page of the Bedulu edutourism application

The cultural content map (Figure 9) is a strategically important artifact that outlines how individual pieces of content (e.g., the image of the relief, the historical date, and the description of the ritual) distributed across the five locations are tied together under the Tri Hita Karana framework. It illustrates that although the app offers a non-linear, user-directed exploration, the experience is designed to lead to a culturally rich and cohesive understanding of Balinese cosmology, addressing the A-IDS Framework's "narrative paradox" [18]. The user flow diagram (Figure 8) maps the journey from application launch, through site selection and content exploration (text, audio, and video), to the completion of an educational quiz. This visual representation clarifies the application's information architecture and UX design, demonstrating how the glocal strategy is operationalized through intuitive navigation.

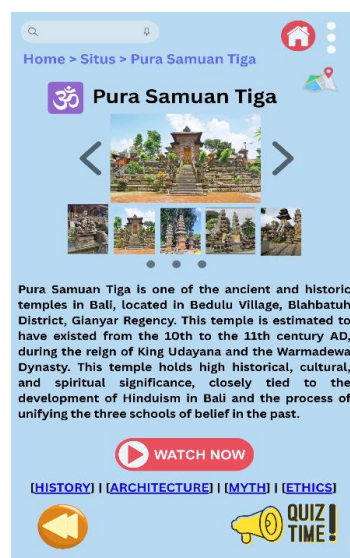


Figure 3. Dashboard for Samuan Tiga Temple within the application

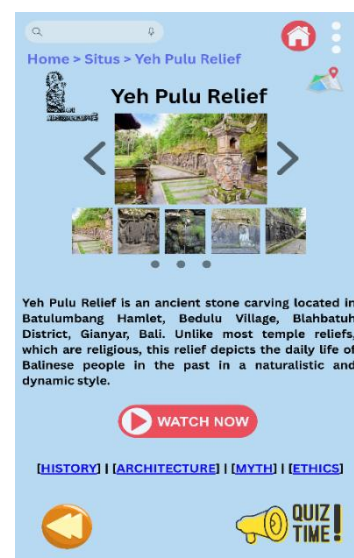


Figure 4. Dashboard for Yeh Pulu Relief



Figure 5. Dashboard for Goa Gajah (Elephant Cave)

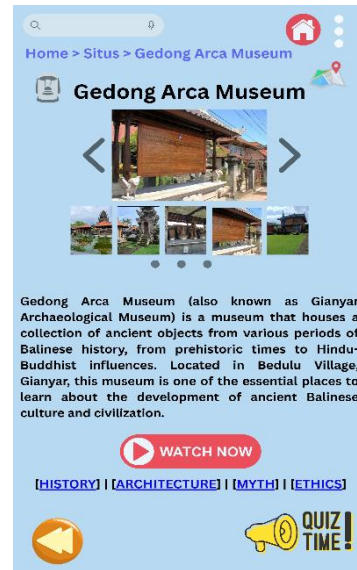


Figure 6. Dashboard for the Gedong Arca Archaeological Museum



Figure 7. Dashboard for Pengastulan Temple

The user needs analysis showed high acceptance of the proposed application (importance: 4.6/5.0; intended use: 4.4/5.0). Satisfaction with the information in existing media was low (2.3/5.0). Regarding quality, 95% of respondents had limited exposure to contemporary digital educational tools, and 80% had a strong demand for photo visual content and local wisdom narratives rather than generic historical content. The most important user requirements were information well-organized (90%), easy navigation (85%), and locality-based content (88%). In this matter, the application design emphasizes the values of Tri Hita Karana and balances accessibility for tourists and depth for academics. It prioritizes the Balinese as the primary interface language and traditional visual motifs.

The concept and UI design for the application titled "Between Westernization and preservation" were created in the first design development educational phase. Information for the recovery of anthropology and world civilization for children needed to be both informative and engaging, user-friendly, and advocate cultural preservation [20]. Its design provides simple navigation to intercultural sites [23]. The main menu,

located downtown in Baligu Figueras, records the marked sites. The Samuan Tiga Temple dashboard is tailored to provide information on the historical, architectural, and ceremonial significance that illustrates the historical processes. The Yeh Pulu Relief dashboard describes and demonstrates the relief, its narrative, and its historical significance. The Goa Gajah dashboard summarizes the site's history, cave architecture, and functional aspects. The saddles present the temple outline, structure, and explain the temple, along with its history and the process of preservation. The Gedong Arca Archaeological Museum dashboard summarizes the collection of artifacts and their scanning history during the museum's construction.

Every archaeological site has its own page, where users can learn specific details about each one. To promote active learning, the history, mythology, architecture, and philosophical significance of each site are presented in descriptive text, along with various other forms. This approach is aligned with A-IDS, which allows for non-linear exploration while maintaining the integrity of a coherent cultural narrative [18]. The "Between Westernization and preservation" is explicitly designed to address the educational gap regarding Westernization. The cultural awareness module, in particular, serves as a decolonial pedagogical tool, encouraging users to reflect on the impacts of cultural homogenization and the value of community participation in preservation, which is a central theme in recent decolonial literature [10]. The text is tailored to the needs of multiple users [24]. Visually, the photo and video galleries are presented in a way that captures the site from different perspectives, including vital microscopic details [25]. Short clips demonstrating the site's history and the cultural practices related to its work are also included. Table 4 presents a detailed breakdown of the user needs analysis results, including respondent profiles, primary needs, and most desired features across each category.

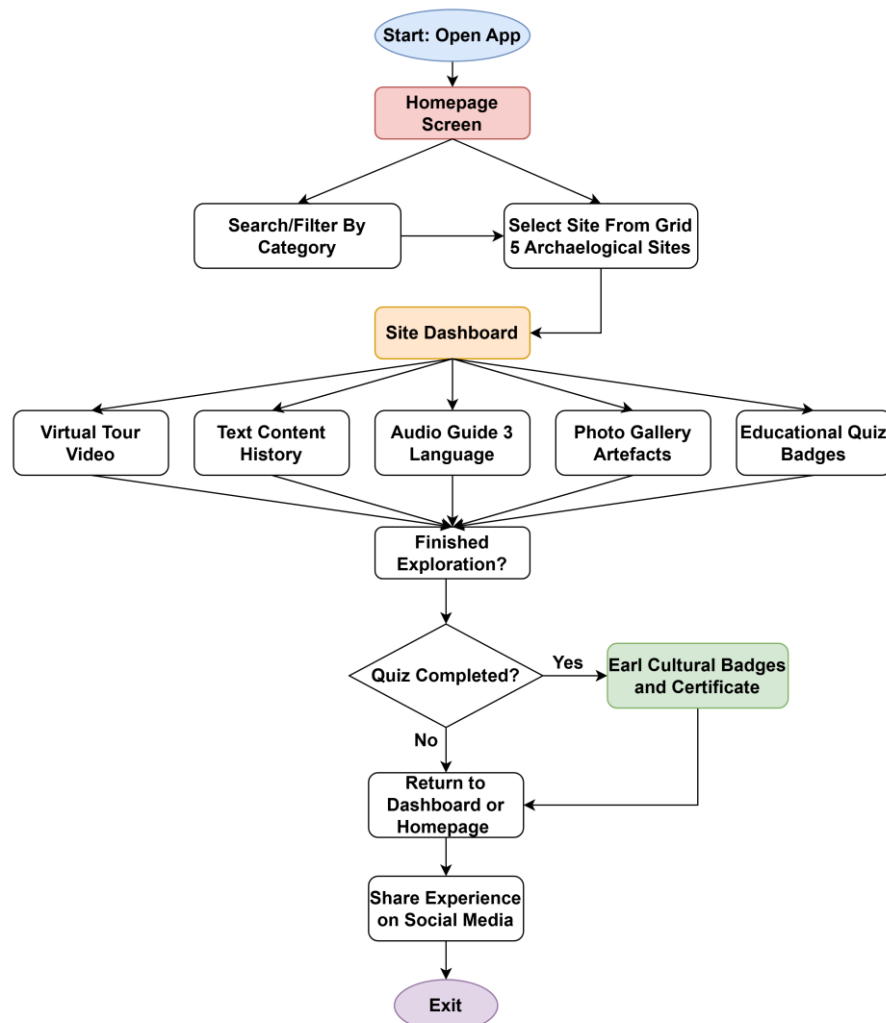


Figure 8. User flow diagram illustrating a typical interaction path within the Bedulu edutourism application

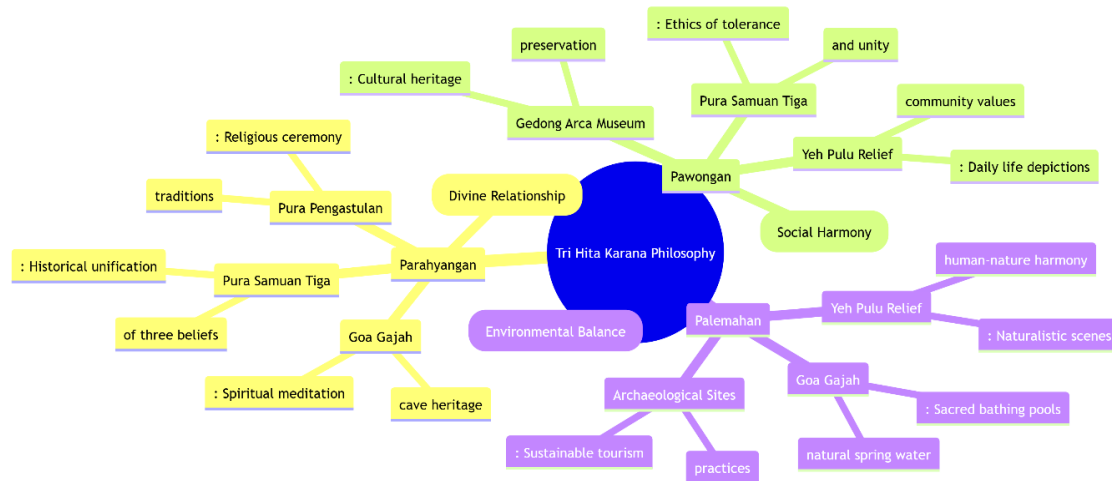


Figure 9. Cultural content map

Table 4. Summary of user needs analysis results and respondent profiles (N =30)

Respondent category	Number (n)	Percentage (%)	Primary demographic characteristics	Identified primary needs/interests	Most desired features
Domestic tourists	10	33.3%	- Age: 25-40 years (70%) - Education: Bachelor's degree (80%) - Previous visit: 40%	- Structured historical information (90%) - Easy site navigation (85%) - Cultural philosophy explanations (75%) - Deep cultural context (88%)	- Indonesian audio guide (100%) - Site photos and videos (90%) - Interactive map (85%)
International tourists	8	26.7%	- Age: 30-50 years (75%) - Origin: Europe (50%), East Asia (38%), others (12%) - First visit: 88%	- Practical information (opening hours, tickets) (100%) - Engaging narrative stories (75%) - Accurate and verified content (100%) - In-depth philosophical information (90%)	- English audio guide (100%) 360° virtual tour (88%) - Interactive quiz (63%) - Digital artifact catalog (100%) - Historical timeline (90%)
Local tour guides	5	16.7%	- Experience: 3-10 years (80%) - Languages: Indonesian + English (100%), Balinese (80%)	- References for additional explanations (80%) - Accurate archaeological data (100%) - Bibliographic references (75%) - Comprehensive philosophical context (100%)	- Cultural glossary (80%) - High-resolution image zoom (100%) - Detailed chronology data (75%) - Digital library (75%)
Academics/researchers	4	13.3%	- Field: archaeology (50%), tourism (25%), cultural studies (25%) - Institution: local/regional universities	- Engaging and interactive content (100%) - Easy-to-understand explanations (100%) - Gamification elements (67%)	- Quiz with badges (100%) - Short video content (100%) - Social media integration (67%)
Students	3	10.0%	- Age: 18-25 years (100%) - Origin: Bali (67%), outside Bali (33%) - Interest: history and culture		

Additionally, users can easily navigate to and plan their visits using an interactive map that shows each site's geographic coordinates [18]. Each site features audio narrations that enable users to listen to the texts while taking virtual tours of the sites [19]. The feature “Between Westernization and preservation” deals with the educational gap regarding the challenges of modernization and the preservation of archaeological sites.

A “Did you know?” section shares informative tidbits about preservation myths, facts, and current efforts. A cultural awareness module briefly covers the negative impacts of Westernization on cultural sites

and the significance of citizen participation in their conservation. Finally, a planned user contribution module will allow members of the community to upload their own pictures, stories, and experiences, providing an incentive for active participation in conservation as part of future development.

The UI design is done with visual appeal and ease of use in mind [26]. Balinese culture's colors and typography are used alongside a clean layout, giving it a professional and appealing look [27]. UX is better when icons are clear, and navigation buttons are responsive [28]. This application can serve as a highly effective educational tool that harnesses modern technology [29]. Educating young ones through interactive outreach will ensure that a broader demographic is reached [30]. Through this application, interest in learning about and preserving our historical landmarks will be promoted through active edutourism. Attractively presented, easily accessible information will overcome barriers of distance and time [31].

Bali is always changing, so the theme "Between Westernization and preservation" absolutely applies. The tide of globalization and modernization, often accompanied by Westernization, brings both benefits and challenges to local cultural values and heritage. This application aims to solve the problem by presenting history while also teaching users why they should care about sustaining their culture amid global pressure. Choosing Pengastulan Temple as one of the study objects enables this application to highlight the lack of attention to preservation issues, which are complicated by constant environmental changes driven by development.

3.7. Towards sustainable preservation: implications for community empowerment and cultural policy

Moving beyond its immediate role as an educational tool for tourists, this application is conceptualized as a strategic infrastructure for long-term cultural sustainability and community empowerment. It not only informs visitors but also enables inter-generational knowledge transfer, integrates local philosophical values into formal education, and creates economic opportunities for community-based artisans. It can build a sense of common purpose by presenting it as an education issue, and encourage collaboration between educators and policymakers toward cultural preservation. The wider socio-cultural and policy implications of these findings are discussed in the following sub-sections, including the potential for the application to be incorporated into school curricula in Gianyar Regency, its role in promoting inclusive tourism economies, and its relevance as an operational model for managing a UNESCO site in Bali.

3.7.1. Intergenerational knowledge transfer and formal education integration

The application provides a necessary digital connection between the different generations. The application protects intangible heritage, which is the type of heritage most affected by globalization, by digitalizing the stories approved by local spiritual guides (*Pemangku*) and local historians. To make this transfer more permanent, the study suggests creating app-based curriculum modules aligned with national education standards. These modules, which will cover local history, the philosophy of Tri Hita Karana, and the environment, will be incorporated into the social studies and cultural arts curriculum in the Schools of Gianyar Regency and the rest of Bali. It changes the application from a discretionary tourist guide to a cultural pedagogical tool for preserving Balinese culture, ensuring that Balinese children are exposed to it.

3.7.2. Fostering economic prospects for community and inclusive tourism

The app will transform local economic dynamics by shifting from passive consumption to more active, appreciative, and educational participation. A deeper understanding of site significance can increase demand for qualified local guides who can provide contextualized tours, thereby enhancing the value of their services beyond basic logistics. Furthermore, the app can include a dedicated module or link to a "Local artisan network", connecting users with craftspeople in Bedulu and surrounding villages who practice arts related to the sites (e.g., stone carving inspired by Yeh Pulu, *Canang* (offerings) making for temple rituals). It creates a direct economic incentive for cultural preservation, where the viability of traditional crafts is supported by tourist interest cultivated through the app.

3.7.3. Implications for regional cultural policy and UNESCO site management

Bali, as a UNESCO World Cultural Heritage Site (cultural landscape of Bali Province: the Subak system as a manifestation of the Tri Hita Karana Philosophy), adds to the challenges of managing the impact of tourism on the Subak system and associated traditions. The community-centered, glocal design approach demonstrated in this study offers a concrete operational model for heritage managers. The Bali provincial cultural office and the management boards of UNESCO sites could adopt the principles of this model participatory narrative development, digital archiving of intangible heritage, and value-based visitor education to ensure that tourism development aligns with the protection of outstanding universal value (OUV). Specifically, the application's framework can be adapted to interpret other components of Bali's cultural landscape, such as the Subak (irrigation cooperative) system or other temple networks.

3.7.4. Digital archiving strategy and future technical extensions

The application's structured database acts as a foundational digital repository for Bedulu's archaeological and narrative assets, for future initiatives that guarantee both the continued preservation and the accessibility of the projects. Collaborations may be constructed with national archival institutions, e.g., National Archives of Indonesia and with Bali Digital Library for the management of the sustainable storage of data and preservation of data sets for the digital library. Apart from the current prototype, we envision several extensions with high technical promise: i) AR on-site experiences: users could aim a camera at a ruin or a relief (with a particular statue or monument) and AR would overlay the image with 3D reconstructions, as well as animations of mythological scenes and text explanations, thus integrating both the digital and physical heritage; ii) multilingual expansion: in addition to Balinese and Indonesian, we would prefer to add Mandarin, Japanese, and French. It would increase the volume of tourists, while still observing the hierarchy of the languages; iii) a more sophisticated, advanced community co-creation portal. It entails turning the "user contribution" feature into a more moderated zone where the community can upload their own stories, historical images, and video testimonies. It would create a digital archive that is more alive and will be more 'growing and living' over time; and iv) integration with smart tourism infrastructure: potential linkage with broader Bali "smart tourism" initiatives, providing data on visitor flow and interests to aid in sustainable site management.

4. CONCLUSION

This study successfully developed a conceptual framework and high-fidelity prototype for a glocal edutourism application tailored to the Bedulu archaeological sites in Bali. The application blends the IDS and A-IDS frameworks with decolonial, community-centered design principles, as seen in the translation of Balinese philosophy (Tri Hita Karana) into features like multilingual audio guides (with a focus on Balinese), culture-rooted badges, and stories from local communities. The main contribution is a replicable glocalization model for digital heritage that balances global standards of usability with local epistemological sovereignty. However, the research is limited to the planning and prototyping phase. Future work should empirically validate the proposed metrics for user engagement (e.g., SUS scores, knowledge retention) and the planned AR features, multilingual expansion, and community co-creation portal. Further research needs to be carried out to: i) formulate a complete application and assess long-term educational and socio-economic impacts; ii) integrate the prototype into formal school curricula of Gianyar Regency; and iii) establish policy partnerships with the cultural offices of Bali and UNESCO site managers to scale up the model. The results of this study demonstrate that digital tools, created by means of participatory and culturally sensitive approaches, can be an infrastructure for the sustainable preservation of heritage, rather than a threat.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualizationM : **M**ethodologySo : **S**oftwareVa : **V**alidationFo : **F**ormal analysisI : **I**nvestigationR : **R**esourcesD : **D**ata CurationO : Writing - **O**riginal DraftE : Writing - Review & **E**ditngVi : **V**isualizationSu : **S**upervisionP : **P**roject administrationFu : **F**unding acquisition

CONFLICT OF INTEREST STATEMENT

There was no potential conflict of interest in this study.

INFORMED CONSENT

All participants provided written informed consent prior to data collection.

ETHICAL APPROVAL

Ethical approval was obtained from all participants before data collection.

DATA AVAILABILITY

All data supporting the findings are included within the manuscript.

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