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Virtual Geocultural Tour of the Baduy Tribe at Bayah Dome Geopark Toward an Inclusive Global Geopark

Dentik Karyaningsih[1*], Ahmad Sugiyarta[2], Donny Fernando[3], Reza Pramudita[4], Irfan Hadi[5], Muhammad Aris Febriawan[6]
[1*]Program Studi Teknik Informatika, Fakultas Teknologi Informasi, Universitas Serang Raya
[2]Program Studi Sistem Informasi, Fakultas Teknologi Informasi, Universitas Serang Raya
[3] Program Studi Sistem Informasi, Fakultas Teknologi Informasi, Universitas Serang Raya
[4]Program Studi Teknik Informatika, Fakultas Teknologi Informasi, Universitas Serang Raya
[5]Program Studi Teknik Informatika, Fakultas Teknologi Informasi, Universitas Serang Raya
[6]Program Studi Teknik Informatika, Fakultas Teknologi Informasi, Universitas Serang Raya

Email: [1*]karya.tiek@gmail.com, [2]ahmad.sugiyarta@unsera.ac.id, [3]mr.donny2008@gmail.com, [4]hanyqueen14@gmail.com, [5]friexlif@gmail.com, [6]arisfebriawan26@gmail.com

Abstract – The Bayah Dome Geopark in Lebak Regency possesses significant geological and cultural heritage; however, it currently holds the status of an "Aspiring Geopark." A primary challenge in optimizing its geotourism potential—particularly for the Baduy tribe—is the physical accessibility constraint caused by adverse weather conditions and rugged terrain. This study aims to develop and evaluate a mobile-based 360-degree virtual tour website as an inclusive digital geocultural and educational medium. The research follows a Research and Development (R&D) approach using the Multimedia Development Life Cycle (MDLC) framework, encompassing concept, design, material collection, assembly, testing, and distribution stages. The system integrates 360-degree panoramic visualizations with interactive navigation and informational hotspots to represent Baduy's local wisdom. Empirical results from black-box testing confirmed 100% functional validity across all system features. Furthermore, a User Acceptance Test (UAT) conducted using a Likert scale yielded an average acceptance index of 82.8%, categorizing the platform as "Very Good." This virtual tour serves as a strategic digital solution for cultural preservation and sustainable geotourism promotion, effectively surmounting geographical and temporal barriers for a global audience.

Keywords – Geopark Bayah Dome, Geocultural, Baduy Tribe. Virtual Tour 360, Website

I. INTRODUCTION

A Geopark is a single or composite geographical area that possesses valuable geological heritage sites (geosites) and landscapes, related to aspects of Geological Heritage, Geological Diversity, Biodiversity, and Cultural Diversity. Therefore, every region throughout Indonesia that has geological heritage, landscapes, and other forms of diversity should be designated as a Geopark. A Geopark also incorporates educational aspects as a means of disseminating knowledge in the field of geoscience, highlighting the uniqueness and diversity of Earth's heritage, as well as economic aspects through community involvement in area management as geotourism [1][2].

Lebak Regency possesses numerous geological heritage sites as well as rich biodiversity and cultural diversity with strong potential to be developed into a nationally and even internationally recognized Geopark. Consequently, the Ministry of Energy and Mineral Resources (ESDM) has designated the Bayah Dome Geopark, which comprises 32 geological heritage sites. The Bayah Dome Geopark is currently an Aspiring Geopark and has not yet been officially designated as either a National Geopark or a UNESCO Global Geopark. To achieve National Geopark status in 2023 and UNESCO Global Geopark status in 2024, comprehensive socialization, promotion, and dissemination of information are required, which must be widely accessible to the public through information and communication technology.

One form of cultural diversity is the Baduy Tribe, which represents cultural geotourism that upholds the preservation of local wisdom, including language, customs, and other cultural elements [3]. The Baduy are one of Indonesia's indigenous communities that have consistently maintained their local wisdom to this day. The Baduy Tribe is located in Lebak Regency, Banten. The noble values embedded in Baduy customary law emphasize preserving and protecting nature without altering it, let alone damaging it [4]. The Baduy Tribe is a cultural tourism destination of world-class significance, as it is already recognized internationally [5]. However, in its development, local wisdom-based culture has gradually been eroded by modernization, affecting ethics, habits, norms, and traditions. As a result, many younger generations in Indonesia are still unfamiliar with the local cultural heritage of their respective regions [6]. Therefore, it is important to introduce local culture, particularly the Baduy local culture of Lebak Regency, to the wider community. Efforts to introduce Baduy local culture have included visiting the Baduy cultural villages and observing traditional ceremonies held at certain times. However, tourism activities or merely observing ceremonies have not been sufficient for optimal cultural introduction, considering the vast and hilly geographical conditions of the Baduy area. Additionally, unfavorable weather conditions may limit access, making it difficult to visit and fully experience the Baduy cultural villages.

Currently, technology is widely used as a medium for promotion and education, particularly mobile-based technology, which offers various conveniences and interactive features that can attract public interest. Speed and convenience are among the positive values of the internet, as applications can be easily accessed by communities in various regions using only an internet

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connection [7]. Geotourism destinations should be equipped with interactive applications that can serve as alternatives during unfavorable weather conditions and when there is a shortage of tour guide human resources during peak visitor periods. Through the use of interactive mobile-based applications, the community is also expected to develop awareness of the importance of preserving and not damaging the surrounding geotourism environment [8]. Based on this background, the problem formulation identified is the absence of promotional and educational media to introduce, disseminate, and educate the public about the Bayah Dome Geopark in support of conservation and sustainable economic development. To address this issue, this research focuses on the development of a mobile website-based 360-degree geocultural virtual tour application. This study employs a Research and Development (R&D) methodology, specifically utilizing the Multimedia Development Life Cycle (MDLC) framework—encompassing concept, design, material collecting, assembly, testing, and distribution—to ensure the systematic creation of an effective digital tourism platform.

Previous studies have been conducted under the title Design and Development of a Virtual Tour Application as a Tourism Information Media in Majalengka Regency Based on Android. The research method employed was Agile, consisting of the stages of Planning, Design, Development, Testing, Release, and Feedback [9]. Another study entitled Virtual Tour Application of Mount Pilar Natural Tourism Site in Serang Regency enabled users to view locations from unlimited and seamless perspectives [10]. A further study, entitled Interactive Multimedia-Based Virtual Tour Application for Qubu Resort Pontianak, utilized interactive multimedia as an information medium for the Qubu Resort Pontianak tourism destination and served as a promotional tool for the resort [11]. In addition, a study entitled Design and Development of a Virtual Reality Tour as a Tourism Promotion Media in Riau Province applied the ADDIE development model, which consists of five stages: analysis, design, development, implementation, and evaluation [12].

Based on this background, the problem formulation identified is the absence of promotional and educational media to introduce, disseminate, and educate the public about the Bayah Dome Geopark in support of conservation and sustainable economic development. To address this, the research methodology employed is Research and Development (R&D) utilizing the Multimedia Development Life Cycle (MDLC) framework—encompassing concept, design, material collecting, assembly, testing, and distribution. The result of this study is the development of a mobile website–based 360° geocultural virtual tour of the Baduy Tribe, which serves as an alternative medium for geotourism during unfavorable weather conditions as well as an effort to preserve and safeguard local wisdom.

II. RESEARCH METHODOLOGY

This study aims to introduce and preserve the Baduy Geocultural heritage of the Bayah Dome Geopark through a mobile-based 360° Virtual Tour application with positioning features for the Bayah Dome Geopark. Through this application, Baduy geotourism is expected to be widely recognized by the public, even at a global level, while also providing educational value to the community in terms of preservation, conservation, and support for sustainable economic development through a website-based platform.

The development of the website-based 360-degree virtual tour follows the Multimedia Development Life Cycle (MDLC) methodology. This methodology is a structured framework specifically designed for creating multimedia-based products, ensuring a systematic and iterative process from initial planning to final deployment [13]. In this study, the MDLC approach—adopting the Luther-Sutopo model—is utilized to integrate various digital assets, such as 360-degree panoramic photography, interactive navigation, and informational hotspots. The process consists of six integrated stages: (1) **Concept**, to define the objectives and target audience; (2) **Design**, to create the storyboard and navigation structure; (3) **Material Collecting**, to gather all necessary digital assets; (4) **Assembly**, to develop the interactive platform; (5) **Testing**, to ensure functional validity; and (6) **Distribution**, to deploy the application on the Geopark's official website.

The development of the website-based Virtual Tour of Baduy Geocultural Diversity is carried out using an engineering approach, which consists of the stages of analysis, design, implementation, and evaluation. The research stages are illustrated in Figure 1 as follows:

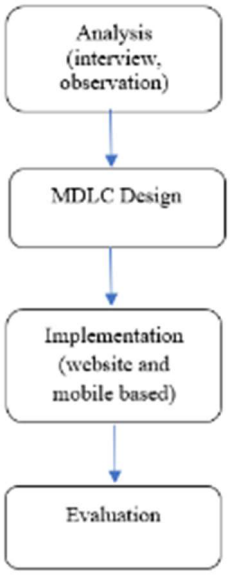

Figure 1. Research Stage

The analysis stage is the initial step in the development process of the website-based Virtual Tour of Baduy Geocultural Diversity as a medium for introducing cultural geotourism objects of the Bayah Dome Geopark. This stage consists of two main activities: field observation and data collection. Field observations were conducted at the Office of the Bayah Dome Geopark Management Agency in Lebak Regency, Banten, using interview methods, as well

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as at the Lebak Regency Tourism Office and Kanekes Village, Ciboleger District, for data acquisition.

The design stage involves creating a program blueprint based on the results obtained during the analysis stage. The system development method used in this study is the Multimedia Development Life Cycle (MDLC), which adopts the Luther method with modifications to its stages. The process begins with the concept stage and ends with the distribution stage. However, the material collecting stage can be carried out in parallel with the assembly stage. The Luther–Sutopo version of the stages consists of concept, design, collecting, assembly, testing, and distribution [14].

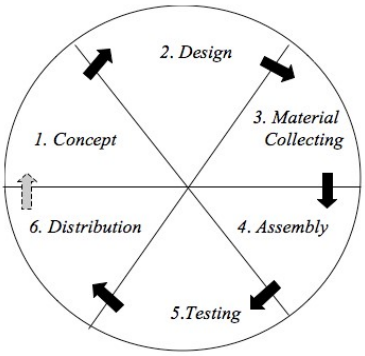

Figure 2. Luther–Sutopo Multimedia Development Cycle

a. The concept stage is intended to determine the objectives of the multimedia and to identify the target audience. This stage also defines the type of application as interactive and establishes the application's purpose, namely to introduce geotourism objects representing the geocultural diversity of Baduy culture. Basic design rules are also determined at this stage, such as size and target specifications. The output of this stage is a narrative document on Saba Budaya Baduy, along with explanations of its location components.

b. The design stage is the process of developing interface specifications and determining the required materials for the 360° panorama virtual tour application. At this stage, storyboards are used to illustrate the description of each scene by including all multimedia elements. In this design process, the researcher prepares the storyboard using applications such as Canva.

c. The material collecting stage involves gathering materials in accordance with the project requirements. These materials may include photographs or videos. In this study, the materials used consist of 360-degree panoramic photographs.

d. The assembly stage involves the creation of all multimedia objects and materials. Project development is carried out based on the design stage, such as storyboards, flowcharts, or navigation structures. This stage utilizes the finalized design and all collected materials, employing applications including Panorama Studio 360, 360 Studio, and HTML/CSS for the website-based platform.

e. The testing stage is conducted after the assembly process is completed by running the project to ensure that no errors are present. This testing is referred to as the alpha testing stage (black-box testing), which is performed by experts in informatics engineering. Furthermore, system testing includes black-box testing, a software quality testing method that focuses on functional aspects [15].

f. At this stage, the project is stored and deployed on a storage medium in the form of a website. The virtual tour is hosted on the official website of the Bayah Dome Geopark Management Agency and can be accessed via personal computers, laptops, and Android mobile devices through the link https://geoparkbayahdome.com/vt/.

g. The implementation stage is carried out to apply the research results that have been tested and deemed feasible. The virtual tour will be distributed and utilized by the Bayah Dome Geopark Management Agency of Lebak Regency.

h. The evaluation stage aims to determine whether there are any issues arising from the implementation and to identify opportunities for further development of the Baduy Geocultural Diversity Virtual Tour system of the Bayah Dome Geopark.

III. RESULTS AND DISCUSSION

The results of this research demonstrate the systematic implementation of the system development process aimed at creating an immersive digital experience for the Bayah Dome Geopark. Following the methodology established in the previous section, the development of the website-based 360° virtual tour adheres strictly to the Multimedia Development Life Cycle (MDLC) stages. This structured approach ensures that each technical and creative phase—from initial conceptualization to final deployment—is aligned with the objective of preserving and promoting Baduy geocultural heritage.

1. Concept

The concept stage is the foundational phase intended to determine the specific objectives of the multimedia project and to identify the target audience. At this stage, the application is defined as an interactive medium with the primary purpose of introducing geocultural objects that represent the unique diversity of Baduy culture. Basic design rules, including display size and target specifications, are also established to ensure compatibility across various devices. The final output of this stage is a narrative document regarding Saba Budaya Baduy, which includes detailed explanations of the location components to be included in the virtual environment.

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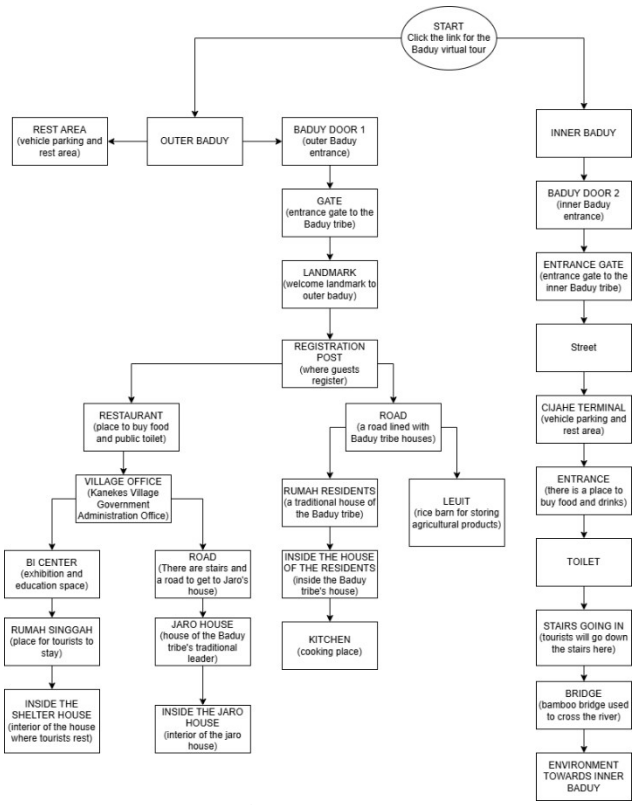

Figure 3. Concept

The research at this stage focuses heavily on the navigation flow of the Baduy Virtual Reality Tour to ensure a logical user experience. This navigation flow is structured before entering the design stage, serving as the primary reference framework for the creation of storyboards and the overall development of the system. To realize this structure, interactive hotspot buttons are required as the primary interaction medium, allowing users to transition between different panoramic scenes.

The application is operated by manipulating the 360-degree panoramic images, where users can touch and drag the view or select specific navigation buttons to determine their direction of exploration. By providing a comprehensive visual reconstruction of the Baduy area, this virtual tour serves as an ideal solution for individuals who wish to learn about the tribe but face limitations related to time, distance, or physical access to the Lebak Regency site.

2. Design

The design stage involves the development of detailed interface specifications and the determination of materials required for the 360-degree panoramic virtual tour. During this phase, storyboards are created to illustrate the description of each scene, incorporating all necessary multimedia elements to ensure a cohesive user experience. These storyboards serve as a visual blueprint and were developed using professional design applications such as Canva.

A critical aspect of the design stage is the specification of the user interface (UI) components that facilitate interaction within the virtual environment. The interface presented in this system includes the following components:

The navigation bar of the Baduy virtual tour website features a set of intuitive icons and buttons designed to provide seamless control over the 360-degree environment:


Figure 4. Navigation Button

a. Rotation Control Buttons.
   These include the Left Rotation Button (←), Right Rotation Button (→), Upward Rotation Button (↑), and Downward Rotation Button (↓). Their primary function is to control the viewing direction, allowing users to look around the virtual space freely.
b. Zoom Buttons.
   The interface provides a "Zoom In" feature represented by a Plus (+) icon and a "Zoom Out" feature represented by a Minus (−) icon. These buttons allow users to adjust the magnification level of the virtual tour display for a more detailed view.
c. Auto-Rotate Button.
   Identified by a rotating symbol (↻) or play icon (▶), this button activates an automatic 360-degree rotation, enabling a hands-free panoramic view of the surroundings.
d. Fullscreen Button.
   Represented by four outward-facing corners (⤢), this function allows users to toggle the fullscreen mode for a more immersive exploration experience.

To ensure optimal usability, all buttons are designed with colors and shapes that contrast sharply with the background, enhancing visibility. Furthermore, the buttons are equipped with hover effects to provide interactive feedback and are sized appropriately to ensure comfortable navigation on both desktop and mobile devices.

3. Material Collecting

The material collecting stage involves gathering all digital assets and information required to fulfill the project's specifications. In this study, the primary materials consist of 360-degree panoramic photographs captured through field observations at the Bayah Dome Geopark Management Agency, the Lebak Regency Tourism Office, and Kanekes Village. These materials are essential for constructing the immersive virtual environment.

The following visual materials were collected to serve as the core content of the virtual tour:

a. Rest Area


Figure 5. Rest Area

Rest Area Visual data was collected at the starting point of the route, showcasing facilities such as seating areas, public toilets, and parking spaces intended for tourists.

b. Entrance Gate

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Figure 6. Entrance Gate

Entrance Gate This material captures the traditional structure that serves as the official entry point to the Baduy region, reflecting the tribe's local wisdom through its architectural design.

c. Welcome Landmark

Figure 7. Welcome Landmark

Welcome Landmark Photographs were taken of the informational signage and welcome message that officially mark the entrance to Baduy territory .

d. Guest Registration Area

Figure 8. Guest Registration Area

Guest Registration Area Visuals of the registration post were gathered to represent the point where visitor data is collected and initial guidelines regarding rules and etiquette are provided.

e. Baduy Residential Settlement

Figure 9. Baduy Resedential Settlement

Baduy Residential Settlement The collected materials display the distinctive layout of the residential area, highlighting the uniform architectural philosophy and the adaptation of houses to the natural environment .

f. Souvenir Center

Figure 10. Souvenir Center

The souvenir center is located in front of residents' houses, where local people sell distinctive Baduy products. Through the virtual tour, visitors can view various handicrafts such as woven fabrics, koja bags, machetes (golok), beaded jewelry, and other traditional products neatly arranged on the house veranda. This area illustrates the traditional economic activities of the Baduy community.

g. Leuit

Figure 11. Leuit

The leuit is a traditional stilted structure used for storing rice. The virtual tour presents the leuit structure made from natural materials with a high roof in the form of julang ngapak. Visitors can observe construction details specifically designed to keep rice dry and protected from pests, as well as the traditional ventilation system applied.

h. Kanekes Village Office

Figure 12. Kanekes Village Office

Kanekes Village Office Documentation was made of the administrative building, which serves as a public service center and uniquely combines traditional elements with modern functionality.

i. BI Center

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Figure 13. BI Center

BI Center Visual content includes the information and education center, which houses photo displays, artifacts, and historical data regarding Baduy daily life.

j. Tourist Rest House

Figure 14. Tourist Rest House

Tourist Rest House Materials were gathered of the traditional lodging facilities, which utilize natural materials such as wood, bamboo, and palm fiber while maintaining the authentic Baduy style.

k. Jaro House

Figure 15. Jaro House

Jaro House Visuals capture the residence of the customary leader, which features a larger structure and specific architectural ornaments that signify the social status of its occupant .

l. Entrance Gate 2

Figure 16. Entrance Gate 2

Entrance Gate 2 Documentation was conducted of the simple bamboo and wood gate that serves as a transitional zone into the more sacred Inner Baduy territory.

m. Cijahe Terminal

Figure 17. Cijahe Terminal

Cijahe Terminal This material represents the final stopping point for motorized vehicles, where visitors must transition to traveling on foot.

n. Entrance Ticket Payment Area (Gate 2)

Figure 18. Entrance Ticket Payment Area (Gate 2)

Entrance Ticket Payment Area (Gate 2) Visual data includes the registration and payment point specifically for visitors traveling toward the Inner Baduy villages of Cibeo, Cikertawana, and Cikeusik.

4. Assembly

The assembly stage is the phase where all multimedia objects and materials are integrated into a functional system based on the finalized designs, such as storyboards and navigation structures. In this study, the project development was executed using a combination of specialized software, including Panorama Studio 360 and 360 Studio for panoramic processing, along with HTML and CSS for the website-based platform implementation.A key output of this stage is the creation of the interactive landing interface, which serves as the gateway for the entire virtual experience.

Figure 19. Main Page

The Main Page provides users with two primary location options to initiate their journey: Ciboleger, which grants access to the Outer Baduy Virtual Tour, and Cijahe, which leads to the Inner Baduy Virtual Tour (comprising Cibeo, Cikertawana, and Cikeusik). Users can intuitively select their preferred starting point by clicking or tapping on the respective location card. This interface is designed to be responsive, ensuring that the visual elements and selection buttons remain accessible across both desktop and mobile devices.

5. Testing

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Following the assembly process, the testing stage is conducted to ensure the system is free of errors and satisfies the predefined requirements. This stage is divided into functional validation through black-box testing and user perception evaluation through a User Acceptance Test (UAT).

a. Blackbox Testing

Black-box testing focuses on evaluating the application's functionality without considering its internal structure or source code. This testing was performed by informatics experts to ensure the application operates smoothly and provides an optimal user experience.

Table 1. Blackbox Testing Result

Input Testing	Detail	Output Testing	Result
Click “Start Virtual Tour” button	Checking whether the button functions to start the virtual tour	Virtual tour starts and displays the initial 360° location view	Valid
Click navigation buttons (right, left, up, down arrows)	Ensuring navigation movement in the virtual tour functions properly	Camera moves according to the selected direction	Valid
Click information hotspot	Checking whether the hotspot displays information when clicked	Information pop-up appears with location/object details	Valid
Zoom in/out using mouse scroll	Ensuring zoom functionality operates properly	Virtual tour display is zoomed in/out	Valid
Drag virtual tour display	Checking whether users can drag the 360° view	Display moves according to mouse drag	Valid
Click “Fullscreen” button	Ensuring fullscreen mode can be accessed	Virtual tour is displayed in fullscreen mode	Valid
Mobile device rotation	Checking responsiveness on mobile devices	Display adjusts to screen orientation	Valid

The results confirm that 100% of all features function correctly according to the established specifications, with no significant technical issues identified.

b. User Acceptance Test

The User Acceptance Test was conducted with 20 participants using a Likert scale to measure perceptions, attitudes, and opinions regarding the application. Respondents indicated their level of agreement across ten criteria using a five-point scale ranging from "Strongly Disagree" to "Strongly Agree".

Table 2. User Acceptance Test Result

No	Question	SS (5)	S (4)	N (3)	TS (2)	STS (1)	Total Score	Interpretation (Index %)
1	The virtual tour application interface display is attractive	35	28	15	2	0	80	80%
2	The information presented is easy to read	60	16	9	0	1	85	85%
3	The quality of the displayed 360° images is good	45	24	15	0	0	84	84%
4	The content is appropriate to Baduy culture and local wisdom	70	8	3	6	0	87	87%
5	The application runs smoothly without technical issues	25	48	6	2	0	81	81%

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6	The application is responsive on various devices (PC/mobile)	50	20	15	0	0	85	85%
7	No errors occur while using the application	45	28	6	2	1	82	82%
8	The virtual tour provides an engaging experience	35	36	6	4	0	81	81%
9	Navigation within the virtual tour is easy to understand	35	40	6	0	1	82	82%
10	The zoom in/out function works properly	40	16	24	0	0	80	80%
Average	**Total index (%) / number of questions**							**82.8%**

The website-based Baduy Geocultural Virtual Tour achieved an average acceptance index of 82.8%, falling into the "Very Good" category. The highest individual score (87%) was for content suitability with Baduy culture, indicating that the virtual tour accurately reflects local wisdom and traditional values. Overall, the UAT results confirm that the system meets user expectations and is highly suitable for sustainable geotourism promotion.

6. Distribution

The distribution stage is the phase where the finalized project is stored and deployed on a designated storage medium to ensure broad public access. In this study, the Baduy Geocultural Virtual Tour has been successfully integrated into a website-based platform, allowing it to serve as a sustainable digital asset for the region.

The application is officially hosted on the website of the Bayah Dome Geopark Management Agency and can be accessed through the following URL: https://geoparkbayahdome.com/vt/. To ensure an inclusive global reach, the system is designed with cross-device compatibility, enabling seamless exploration via personal computers, laptops, and Android mobile devices.

Furthermore, the research results have been formally distributed to and implemented by the Bayah Dome Geopark Management Agency of Lebak Regency. This implementation allows the agency to utilize the virtual tour as a strategic medium for geotourism promotion, particularly as an alternative solution during adverse weather conditions or for visitors who face geographical and time limitations. By hosting this platform on their official site, the agency supports the ongoing effort toward achieving UNESCO Global Geopark status by enhancing the dissemination of information through modern communication technology.

IV. CONCLUSION

This study successfully developed a website-based 360° Geocultural Virtual Tour of the Baduy Tribe within the Bayah Dome Geopark as an innovative medium for promotion, education, and cultural preservation. The virtual tour enables users to explore both the Outer Baduy and Inner Baduy areas virtually, providing an interactive and immersive experience that overcomes limitations related to distance, time, weather conditions, and accessibility. By integrating geocultural elements, local wisdom, and geotourism concepts, the developed system supports the dissemination of knowledge about Baduy culture while promoting sustainable geotourism within the Bayah Dome Geopark.

The development process followed an engineering approach using the Multimedia Development Life Cycle (MDLC), encompassing the stages of analysis, design, material collecting, assembly, testing, distribution, implementation, and evaluation. The application integrates 360° panoramic visualization, interactive navigation, hotspot information, and responsive design to ensure usability across desktop and mobile devices. Black-box testing results confirmed that all system functionalities operated correctly and met the predefined specifications, indicating system reliability and technical feasibility.

Furthermore, the User Acceptance Test (UAT) results demonstrated a high level of user satisfaction, with an average acceptance index of 82.8%, categorized as very good. Users positively evaluated the system in terms of interface design, ease of use, content clarity, cultural relevance, and overall experience. These findings indicate that the virtual tour application is effective as a digital

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platform for cultural education, conservation awareness, and sustainable economic support. Overall, the website-based Baduy Geocultural Virtual Tour has strong potential to be utilized by the Bayah Dome Geopark Management Agency as a strategic tool for inclusive geotourism development and the preservation of local cultural heritage at both national and global levels.

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