Development of a web-based virtual madura tourism application using marzipano

Yudha Dwi Putra Negara[1*], *Budi* Soesilo[1], *Nirwana* Haidar Hari[2], *Khotibul* Umam[3]

[1]Information System, Faculty of Engineering, Universitas Trunodjoyo Madura, Indonesia
[2]Informatics Engineering, Department of Informatics and Computer Engineering, Politeknik Elektronika Negeri Surabaya, Indonesia
[3]Islamic Religious Education, UIN Madura, Indonesia

Abstract. The rapid advancement of digital technology has significantly transformed the way tourism destinations are promoted and presented. One of the emerging innovations is virtual tourism, which enables users to experience and explore tourist attractions interactively without being physically present. This study aims to develop a web-based virtual tourism application for Madura by utilizing Marzipano, an open-source library for 360° panoramic visualization, and adopting the Multimedia Development Life Cycle (MDLC) method. The development process consists of six stages: concept, design, material collecting, assembly, testing, and distribution. The results indicate that the developed application successfully displays 360° panoramic views of Madura's tourist destinations with interactive features and responsive navigation. Functional testing showed that all application components operated properly, while user testing revealed positive responses regarding usability and visual appeal. Black box testing results showed that all application features ran as designed without significant errors. User testing results showed a 90% user satisfaction rate, with the highest scores for visual appearance (92%) and ease of navigation (88%). This indicates that the application is well-received by users as an engaging tourism promotion tool.

1 Introduction

The global tourism industry has shown a significant recovery trend in the post-pandemic era, with many destinations reopening and strengthening digital promotion as a key strategy. In Indonesia, the Tourism Satellite Account report (2019–2023) from Statistics Indonesia (BPS) confirms that tourism remains a national development priority, contributing substantially to GDP both in demand and supply sectors[1]. The Ministry of Tourism and Creative Economy also reports that with over 220 million internet users in 2024[2], digital access has become a crucial driver for tourism promotion. Technologies such as 360° panoramas, virtual tours, virtual reality (VR), and augmented reality (AR) are increasingly viewed as essential tools for creating immersive and interactive user experiences in the digital tourism landscape.

As internet penetration and mobile device usage increase, Indonesian travellers are now more inclined to search, compare, and plan destinations online. The trend in tourism marketing has shifted from static images and textual descriptions toward interactive visualization and virtual exploration, which provide users with realistic previews before physical visits[3]. Surveys on virtual tour adoption in Indonesia show that ease of access, visual quality, and interactivity are the most influential factors affecting user satisfaction and engagement. To remain competitive, tourism managers must present engaging, responsive, and high-quality virtual content.

At the same time, national tourism trends emphasize cultural immersion, wellness tourism, and eco-tourism as growing segments[4]. tourism supports these trends by offering immersive cultural or natural experiences that can either complement or substitute physical travel. However, the transition from conventional digital promotion to fully interactive virtual experiences faces several challenges—technical limitations, user perception issues, and infrastructure disparities such as unstable internet connectivity in rural regions.

Madura Island possesses substantial tourism potential encompassing natural, cultural, and religious attractions[5]. Yet, the digital promotion of these destinations remains underdeveloped. Most tourism websites or social media pages rely solely on static images and brief text descriptions, which fail to provide an engaging or realistic sense of place. In cases where virtual tours exist, they often suffer from low-resolution images, poor navigation, or lack of interactivity, leading to limited user engagement. Additionally, inconsistent internet access in some areas of Madura poses a technical barrier to high-quality virtual media streaming.

The main problem, therefore, lies in understanding how technical attributes of a virtual tour application—such as visual quality, interactivity, and navigation—affect user attitudes and behavioural intentions toward virtual tourism. Other challenges include user trust toward virtual experiences compared to real ones and the

* Corresponding author: yudha.putra@trunojoyo.ac.id

adaptability of web-based applications across different devices and network conditions[6]. Although some may argue that virtual tourism cannot replace real experiences, it can serve as a complementary or preliminary tool to enhance destination awareness and interest.

Previous research has explored virtual tours and 360° panorama applications across various contexts, including education, tourism promotion, and digital communication in Indonesia. For instance, Eddy Guridno and aderar Guridno study "Virtual Tour in the Indonesian Tourism Sector During the New Normal Era" highlights virtual tours as a crucial post-pandemic promotional tool[7]. Another study in developed a virtual tourism application using the Marzipano tool[8], demonstrating that Marzipano is a viable open-source alternative for 360° tour creation. Similarly, "Virtual Tour of Sadeng Beach Tourism Route Using the Multimedia Development Life Cycle (MDLC) Method" proved that MDLC can effectively guide multimedia-based system development [9].

Furthermore, quantitative research by Yuling Sun examined the effect of brand awareness and perceived quality on purchase intention in virtual tour services, finding that perceived quality significantly influenced intention, whereas brand awareness did not[10]. Another example is the development of a "Scientific Advances and Applications of 360 Tours in the XXI Century", which showed that web-based panoramic visualization can enhance user satisfaction and engagement[11]. These studies indicate that virtual tours have practical potential, yet many lack empirical validation regarding their behavioural impact.

Despite these contributions, prior studies tend to focus on qualitative evaluations, small case studies, or technical feasibility analyses, rather than empirical quantitative testing of user responses[12]. Most do not investigate causal relationships between application quality attributes and user behaviour, especially in regional contexts such as Madura. In addition, many works fail to examine moderating variables—such as device performance or internet speed—that may influence the user experience.

For example, while the Sadeng Beach study confirmed that its MDLC-based application worked on specific hardware, it did not test how variations in device capability or network bandwidth affected user satisfaction or usability[13]. Similarly, research on brand awareness and perceived quality revealed an insignificant effect of brand awareness, raising questions about whether visual quality or navigational interactivity might play a stronger role in influencing user intentions in local Indonesian contexts. These gaps underscore the need for a more rigorous, quantitative approach to understanding virtual tourism adoption.

Based on the literature review, a clear research gap emerges: the lack of quantitative studies in local contexts like Madura that empirically test how specific technical factors (visual clarity, interactivity, navigation) affect user attitudes and intentions toward virtual tourism applications[14]. No study has yet integrated Marzipano with the MDLC methodology and tested it statistically using a representative sample from the Madura region. Variables such as device specifications, internet quality, and user trust have also been largely overlooked as potential moderating factors. Another important gap is that prior research predominantly centers on design evaluation or usability testing, rather than modelling predictive relationships among variables that drive user engagement or travel intention. This study seeks to address these gaps by combining technological implementation with empirical behavioural analysis, thereby producing a more holistic understanding of web-based virtual tourism systems.

This study aims to analyze the influence of visual quality, navigation, and interactivity in a web-based virtual tourism application using Marzipano on user attitudes and behavioral intentions in Madura, while considering device specifications and internet speed as potential moderating variables. Employing a quantitative survey design and statistical modeling (e.g., regression or SEM), the research seeks to generate empirical evidence about how users perceive and engage with virtual tourism platforms.

Theoretically, this study will enrich the body of knowledge in digital tourism and virtual experience research by introducing Marzipano as a measurable system component and by applying MDLC within a behavioral analysis framework rather than merely as a development process. Practically, the findings will provide valuable insights for tourism developers, government agencies, and destination managers in designing more effective, visually appealing, and user-friendly virtual tourism applications. Such advancements are expected to enhance destination promotion, strengthen destination branding, and ultimately increase tourists' interest and visitation intention—both virtually and physically[15].

2 Methodology

This research adopts a quantitative research design integrated with the Multimedia Development Life Cycle (MDLC) framework proposed by Luther (1994) and adapted by Sutopo (2003)[16], [17]. The study employs a developmental and evaluative approach, aiming to both develop a web-based virtual tourism application and quantitatively measure user perceptions regarding the application's quality and usability. The development process focuses on implementing Marzipano, an open-source 360° panoramic viewer, while the evaluation emphasizes testing user responses to multimedia quality factors. The quantitative component uses a descriptive–causal research design, as it seeks to determine the influence of multimedia attributes (independent variables) on user attitudes and behavioral intentions (dependent variables).

2.1 MDLC Development Framework

The Multimedia Development Life Cycle (MDLC) model serves as the primary framework for the application's creation. This model consists of six sequential stages—concept, design, material collecting, assembly, testing, and distribution[16], [18], [19].

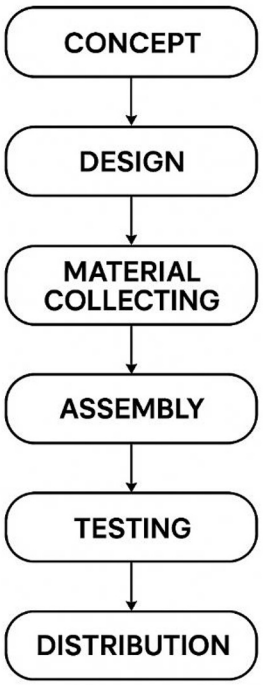

Fig. 1. Multimedia Development Life Cycle (MDLC).

2.1.1 Concept Stage:

At this stage, the research team defined the objectives, target users (domestic and foreign tourists), and the overall concept of the Madura virtual tourism application. Requirements were identified through literature review and initial field observation of key destinations such as Bukit Kehi.
The application to be built is a dynamically developed website-based software, thus the application has two user types: website visitors (users) and website managers (admins)[20]. The goal of this application is to serve as a platform for visitors to become more familiar with the tourist attraction, while simultaneously acting as a tourism promotion medium to enhance the area's appeal. On the website's main page, users will find information about the application, presented in text and images, along with navigation menus to direct visitors to the Virtual Tour and 3D Maps pages[21]. The Virtual Tour feature will display a real view of the tourist area in the form of a 360° x 180°panoramic photo, while the 3D Maps feature will function to represent the location map of Bukit Kehi Pamekasan Beach in a three-dimensional format.

2.1.2 Design stage:

This design process is conducted to detail the system requirements, the application's workflow, and the expected final outcomes of the software being created.

1. System Architecture Design
System architecture is defined as a comprehensive plan or mapping of information needs within an organization. This architecture is essential as a guideline for ongoing operations and as a strategic reference for future development directions. The application being developed is a website-based application that involves two user roles: admin and user[22]. The system's operation is illustrated in Fig. 2.

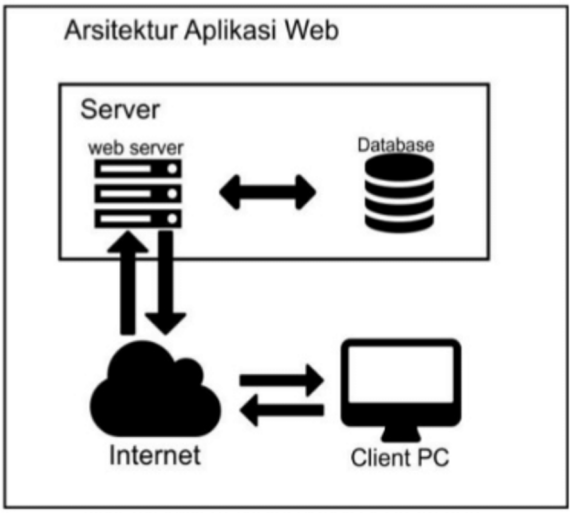

Fig. 2. System architecture.

2. System Usecase Design
Fig. 3 shows a Use Case Diagram for the Bukit Kehi Virtual Tour application, which maps all system functions through transactions between actors and the system. This application has two main actors: 'user' and 'admin'. 'User' can access functions to view facilities, virtual tours, news, and contacts. Meanwhile, 'admin' has broader responsibilities, including all the functions of 'user' plus the ability to manage user data, facilities, virtual tours, news, and contacts.

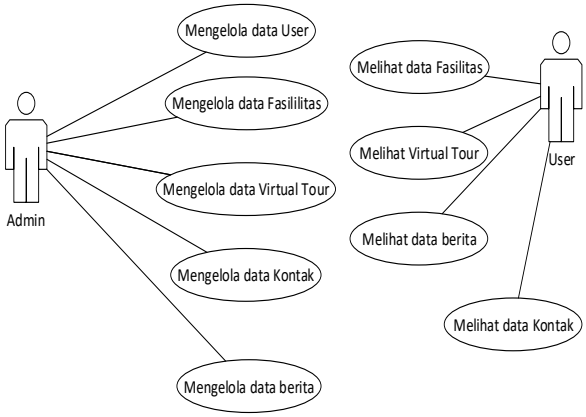

Fig. 3. System usecase.

2.1.3 Material collecting:

Following the design stage, a data collection process was conducted, divided into primary and secondary data. The primary data for this study were 360° x 180° panoramic images taken directly at five points on Bukit Kehi (entrance gate, parking lot, swimming pool, playground, and meeting area)[23]. The photography process at each point involved four horizontal shots (front, right, back, left) and two vertical shots (top,

bottom). For the development of the 3D Maps feature, additional primary data required was a 2D location plan as a reference for the 3D structure. On the other hand, secondary data were collected from literature studies to obtain a theoretical basis that supports the research through reading and understanding related references.

2.1.4 Assembly stage:

The development of this virtual tour application follows several key technical stages. It begins with stitching existing images to generate the panoramic visuals that form the core of the virtual tour[24]. Concurrently, a 3D map of the site is constructed using Google Street View. In the final stage, the Marzipano platform is used to combine both the panoramic images and the 3D map into an interactive website. This finished application provides users with essential resources, including a guide, a site map, a panorama index, and navigation tools. The experience is further enriched by an audio guide describing each panorama and interactive hotspots that allow users to move between different locations.

2.1.5 Testing stage:

Maintaining software quality is crucial and highly dependent on customer satisfaction. To ensure this quality, testing is conducted after the application is developed[25]. This study employs three primary testing methodologies. First, Compatibility Testing measures how well the product operates with other products in the same environment. Second, Usability Testing evaluates the effectiveness, efficiency, and user satisfaction in achieving specific goals while using the application. Third, Portability Testing ensures the application is accessible across various browsers, both desktop and mobile, with a focus on the website interface.

2.1.6 Distribution Stage:

The completed application was hosted on a web server with public access. The URL was distributed to participants for the empirical testing phase, allowing data collection through online surveys.

3 Results and Discussions

3.1 Development Results

A successful virtual tourism application for Madura has been developed with six main menus: Home, Tourist Destinations, About Bukit Kehi, Gallery, Contact, Facilities, and Virtual Tour. The application displays 360° panoramas of several key Madura tourist destinations with interactive displays.

3.1.1 Interface Display

The various components of an application, including the Home, Tourist Destinations, About Bukit Kehi, Gallery form the user interface. This interface is essentially a display that allows a person to interact or communicate with the application.

Fig. 4. Home page.

The homepage interface, illustrated in Fig. 4, is the initial display that greets users upon opening the application. This page displays interactive images of Jumiang Beach. There is also a single button on the homepage that launches a virtual tour when clicked by the user.

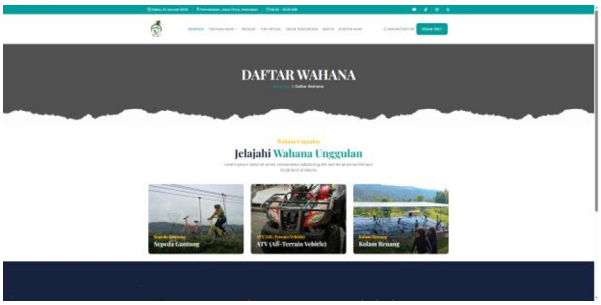

Fig. 5. Tourist destinations.

Fig. 5 shows the various attractions offered by Bukit Kehi. The main attractions and areas identified at the Bukit Kehi tourist site include:

1. Entrance Gate: The official starting point or entrance for visitors arriving at the tourist site.
2. Parking Area: A facility provided for visitors to park their vehicles.
3. Swimming Pool: A water feature available on-site, likely for swimming or relaxing.
4. Playground: An area equipped with play facilities, likely intended for children.
5. Gathering Area: A place or hall (such as a pavilion or hall) where visitors can gather, rest, or hold events.

These five areas are the main points that will be featured in the virtual tour application based on the research.

Fig. 6. About Bukit Kehi.

Fig. 6 shows the history of Kehi Hill which is explained in detail.

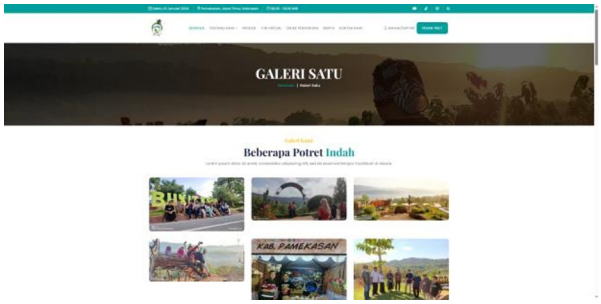

Fig. 7. Gallery.

Fig. 7 shows a collection of galleries that can be used as a reference for the best photo spots on the Bukit Kehi tour.

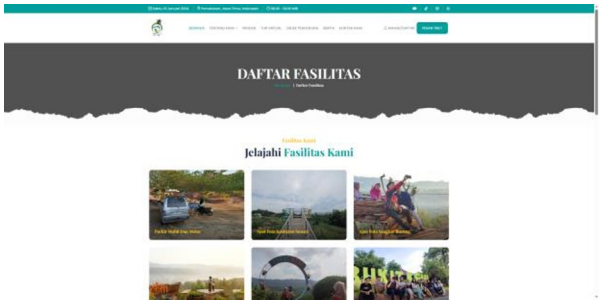

Fig. 8. Facilities.

Fig. 8 shows a collection of facilities provided by the Kehi Hill tourist attraction.

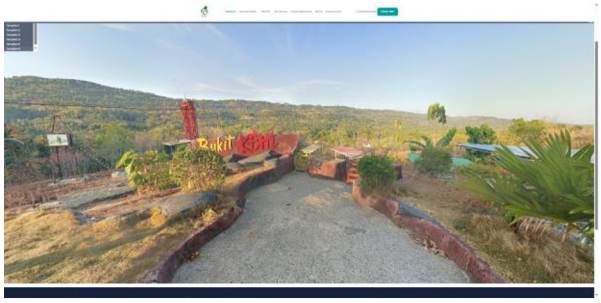

Fig. 9. Virtual tour.

The virtual tour interface (shown in Fig. 9) appears after the user selects “Start Virtual Tour.” The main feature here is the user’s ability to rotate the image 360 degrees. This page also features two types of “back” functions: (1) Navigation buttons within the tour that allow the user to move between locations, including returning to the previous location, and (2) A button to return to the previous page (close the tour), which functions the same as the “back” navigation button on the user’s device.
The implementation of the Marzipano library results in smooth and realistic visuals. Interactive features like zoom, camera rotation, and navigation between destinations work well. The user interface is responsive to support access from desktops, tablets, and mobile phones.

3.2 Application testing

Black box testing results showed that all application features ran as designed without significant errors. User testing results showed a 90% user satisfaction rate, with the highest scores for visual appearance (92%) and ease of navigation (88%). This indicates that the application is well-received by users as an engaging tourism promotion tool.

3.3 Discussion

The application of the MDLC method in application development has proven to provide a systematic and structured workflow. Each stage supports each other in producing an interactive and high-quality multimedia product. The Marzipano integration has also proven effective in displaying 360° virtual panoramas with light performance and realistic displays.
In addition to functioning as a promotional medium, this application has the potential to be used as an educational tool for the public and students to learn about local tourism potential. With this interactive digital approach, tourism promotion becomes more engaging, informative, and in line with digital transformation trends.

4 Conclusion

This research successfully developed a web-based virtual tourism application for Madura using Marzipano and the MDLC method. The application displays 360° panoramas of various Madura tourist destinations in an interactive, user-friendly, and responsive manner. Tests demonstrated the application's performance and positive user response.
This application can be used as an effective digital promotional tool to showcase Madura's tourism potential and encourage the adoption of digital technology in the regional tourism sector.

References

1. B. P. S. Indonesia, Tourism Satellite Account Indonesia 2019-2023, 5. (2025).
2. U. I. N. Maulana, M. Ibrahim, Proceeding Iconies Faculty Of Economics Characteristics Of Entrepreneurs In The Perspective Of International Conference of Islamic Economics and Business 10th 2024 International Conference of Islamic Economics and Business 10th 2024. Int. Conf. os Islam. Bus. 273–280 (2024).
3. L. Neuburger, J. Beck, R. Egger, The ‘phygital’ tourist experience: The use of augmented and virtual reality in destination marketing. Tour. Plan. Destin. Mark. 183–202 (2018). https://doi.org/10.1108/978-1-78756-291-220181009
4. L. Bardukova, Health and Wellness Tourism: Current Trends and Strategies in the Bulgarian Tourism industry. Electron. J. "Economics Comput.

Sci. 2, 22–36 (2024).

5. P. Prasetyono *et al.*, Madura Coastal Tourism Problem: A Stakeholder Perspective. Proc. 9th Int. Conf. Mark. Retail. (INCOMaR). 133 (2024). https://doi.org/10.15405/epsbs.2024.05.79
6. B. Shen, W. Tan, J. Guo, H. Cai, B. Wang, and S. Zhuo, A study on design requirement development and satisfaction for future virtualworld systems. Futur. Internet. 12, 12 (2020), https://doi.org/10.3390/FI12070112
7. D. E. Guridno, A. Guridno, Covid-19 Impact: Indonesia Tourism in New Normal Era. Int. J. Manag. Humanit. 4, 11, 31–34 (2020). https://doi.org/10.35940/ijmh.k1049.0741120
8. M. I. Iglesias, M. Jenkins, G. Morison, Enhanced low-cost web-based virtual tour experience for prospective students. Proc. - 2021 IEEE Conf. Virtual Real. 3D User Interfaces Abstr. Work. VRW. 677–678 (2021). https://doi.org/10.1109/VRW52623.2021.00221
9. N. D. Dewi Retnowati, D. Nugraheny, Virtual Tour of Sadeng Beach Tourism Route Using The Multimediae Development Life Cycle Method. Angkasa J. Ilm. Bid. Teknol. 12, 1, 52-63 (2025). http://dx.doi.org/10.28989/angkasa.v12i1.578
10. Y. Sun, Y. Huang, X. Fang, F. Yan, The Purchase Intention for Agricultural Products of Regional Public Brands: Examining the Influences of Awareness, Perceived Quality, and Brand Trust. Math. Probl. Eng. 1, 4991059 (2022). https://doi.org/10.1155/2022/4991059
11. J. Rodríguez, M. I. Lamas, L. Castro-Santos, Scientific Advances and Applications of 360 Tours in the XXI Century. Societies. 15, 4, 1–26 (2025). https://doi.org/10.3390/soc15040074
12. L. Argyriou, D. Economou, V. Bouki, Design methodology for 360° immersive video applications: the case study of a cultural heritage virtual tour. Pers. Ubiquitous Comput. 24, 6, 843–859 (2020). https://doi.org/10.1007/s00779-020-01373-8
13. M. O. Al-Jabari, T. K. Tamimi, A.-A. N. Ramadan, Multimedia Software Engineering Methodology: A Systematic Discipline for Developing Integrated Multimedia and Software Products. Softw. Eng. 1, 1–10 (2019). https://doi.org/10.5923/j.se.20190801.01
14. A. Alfan, Z. Setiawan, Exploring the Driving Factors and Impact of Business Satisfaction and Social Media Marketing on Virtual Tourism Product Adoption : A Case Study of MSME Members in Indonesia. IECON: International Economics and Business Conference. 2, 1, 193-231 (2024). https://jurnal.amertainstitute.com/index.php/IECON/article/view/103
15. K. Kieanwatana, R. Vongvit, Virtual reality in tourism: The impact of virtual experiences and destination image on the travel intention. Results Eng. 24, 103650 (2024). https://doi.org/10.1016/j.rineng.2024.103650
16. N. N. Ali, D. V. Rahayu, Development of Website-Based Learning Media Based on Learner Behaviorism. Plusminus J. Pendidik. Mat. 4, 3, 533–544 (2024). https://doi.org/10.31980/plusminus.v4i3.2411
17. D. Dede, A. G. Abdullah, B. Mulyanti, Augmented Reality Based Digital Practicum Card Design and Implementation during the COVID-19 Pandemic. Educare, 14, 19–34, (2021). https://distantreader.org/stacks/journals/educare/educare-1447.pdf
18. S. Aslamiyah *et al.*, Journal of Soft Computing Exploration Augmented reality development using multimedia development life cycle (MDLC) method in learning media," *J. Soft Comput. Explor.*, vol. 4, no. 1, pp. 30–38, (2023). https://doi.org/10.52465/joscex.v4i1.118
19. R. Roedavan, A. Pirus Leman, S. Geovani Putri, A Framework for Developing Augmented Reality Applications Based on the Multimedia Development Life Cycle (MDLC). J. Ilm. Inform. Glob. 16, 1, 20–27 (2025). https://doi.org/10.36982/jiig.v16i1.5183.
20. N. Khoirunnisa, E. Jubaedah, T. Rostiawati, Designing Website-Based Administration Management Information System. Designing Website-Based Administration Management Information System. 1, 1, 21–32 (2023). https://doi.org/10.60005/coreid.v1i1.6
21. W. Sangmanee, R. Suwanwerakamtorn, Integrated Framework for Virtual Tours and 3D Visualization of Cultural Tourism in Pattani, Thailand Based on WebGIS Platform. International Journal of Geoinformatics. 19, 9, 44–60 (2023). https://ijg.journals.publicknowledgeproject.org/index.php/journal/article/view/2835
22. T. Taqwa and S. Raupu,\ Website-Based Academic Service Development with ADDIE Design in Higher Education. AL-ISHLAH J. Pendidik. 14, 2, 1511–1526 (2022). https://doi.org/10.35445/alishlah.v14i2.1323.
23. B. Rodriguez, G. Henar, G. Sanz, D. Checa, A systematic review of virtual 3D reconstructions of Cultural Heritage in immersive Virtual Reality. Multimedia Tools and Applications. 83, 42, 89743-89793 (2024). https://doi.org/10.1007/s11042-024-18700-3
24. A. D. Samala, F. Ranuharja, B. R. Fajri, Y. Indarta, W. Agustiarmi, ViCT — Virtual Campus Tour Environment with Spherical Panorama : A Preliminary Exploration. *Int. J. Interact. Mob. Technol.* 16, 16, 205–225 (2022). https://doi.org/10.3991/ijim.v16i16.32889
25. A. Bhanushali, Ensuring Software Quality Through Effective Quality Assurance Testing : Best Practices and Case Studies. International Journal of Advances in Scientific Research and Engineering. 26, 26,1–18 (2023).