Virtual Tour Web System as a Guide and Entrepreneurial Tool for Tourism in Selayar

Nur Mustika[1*] (iD), Sutarsi Suhaeb[2] (iD), Mirfan[3] (iD), Andryanto Aman[4] (iD), Andi Maulidinnawati Abdul Kadir

Parewe[5] (iD), Nicholas Lachlan[6] (iD)

[1]Department of Computer Systems, Universitas Handayani Makassar, Indonesia
[2]Department of Electronic Engineering Education, Universitas Negeri Makassar, Indonesia
[3]Department of Informatics Engineering, Universitas Handayani Makassar, Indonesia
[4]Department of Agricultural Technology, Pangkep State Polytechnic of Agriculture, Indonesia
[5]Department of Informatics Engineering, Universitas Teknologi Akba Makassar, Indonesia
[6]Rey Group, United States
[1]mustika@handayani.ac.id, [2]sutarsi.suhaeb@unm.ac.id, [3]mirfan@handayani.ac.id, [4]andryantoaman@polipangkep.ac.id,
[5]amaulidinnawati@akba.ac.id, [6]nicholaslach@rey.zone
*Corresponding Author

Article Info

ABSTRACT

This research aims to explore the use of virtual tour web systems as an innovation in developing the tourism sector in the Selayar Islands Regency, highlighting the potential of tourist destinations in the area. Using a **Research and Development (R&D)** method with an **Interactive Multimedia System Design & Development (IMSDD)** approach, this research produced an interactive system that allows users to explore tourist sites virtually. The system includes 360-degree panoramas, videos, maps, and tourist information. 34 respondents were involved in evaluating the system using the USE Questionnaire, focusing on three dimensions: Usability, Satisfaction, and Ease of Use. **The results** showed that the system was highly appreciated, with an average feasibility score of 81%, indicating that the Virtual Tour system is very feasible and suitable for promoting regional tourism as well as providing guidance for tourists to get to know more about tourist destinations virtually. These findings suggest that Virtual Tour technology can be an effective tool in enhancing tourism marketing, especially in post-pandemic times when physical travel is limited.

1.   INTRODUCTION

The Selayar Island Regency, located in South Sulawesi, Indonesia, encompasses small islands in the Selayar Strait [1]. Its capital, Benteng, is renowned for its natural beauty, pristine beaches, and coral reefs. The local economy is supported by tourism and fisheries [2]. This region has rapidly developing tourism potential, strategically situated between Bali, Labuan Bajo (NTT), and Lombok (NTB) [3]. The natural beauty and cultural richness of Selayar Island make it a promising area for tourism development for both domestic and international visitors [4, 5]. A key attraction is Taka Bonerate Marine National Park, recognized by UNESCO as a biosphere reserve and the third largest and most beautiful atoll in the world [6, 7]. Additionally, Selayar Island offers a diverse array of tourist attractions, including 72 marine spots, 22 historical sites, 21 cultural

destinations, 13 natural attractions, 6 karst locations, 4 water tourism sites, 3 agro areas, and 1 religious site.

The tourism sector in Kepulauan Selayar Regency has faced significant challenges in recent years due to the global pandemic [8, 9]. Travel restrictions and social interaction limitations imposed during the pandemic have hindered tourist mobility and adversely affected the tourism industry as a whole. In response to this situation, the government and tourism industry stakeholders must adapt to new strategies to sustain tourist interest and participation [10].

One solution that can be implemented is the utilization of Virtual Tour technology. This technology allows tourists to explore destinations virtually through computers or mobile devices, employing visual displays, audio, and other interactive experiences [11, 12]. With Virtual Tours, prospective travellers can experience the sensation of being physically present at a tourist location, even if they cannot visit it directly [13].

In an effort to promote tourist destinations in the Selayar Islands Regency and address the impacts of the pandemic, Virtual Tour technology can serve as a highly effective tool.

Various previous studies have used the Research and Development (R&D) approach of Interactive Multimedia System Design and Development (IMSDD) to develop interactive multimedia. [14] developed information technology-based interactive multimedia for entrepreneurship learning using the R&D method, which involves the stages of needs analysis, design, development, implementation, and evaluation. [15] used the IMSDD method to develop the Gerbang Game application, an educational game with the theme of Indonesian colonial history based on Android, through the stages of system requirements, design, implementation, and evaluation. [16] applied the APPED model in R&D research to develop interactive multimedia as a learning solution in the COVID-19 pandemic era, with the aim of encouraging students' critical thinking. [16] utilised augmented reality technology in the development of a virtual tour as an interactive multimedia for biology learning, which provides an innovative learning experience by utilising modern visualisation technology. These studies show that the development of interactive multimedia can use the R&D method of the IMSDD approach [17].

Interactive multimedia systems, particularly virtual tours, have emerged as powerful tools for education and tourism promotion. The Multimedia Development method is commonly used to design and develop these systems [18, 19]. Virtual tours offer 360° panoramic views, voice-over information, and text details, allowing users to explore locations remotely [20]. In educational contexts, virtual tourism-based interactive multimedia has been found highly feasible and suitable for learning activities. These systems can serve as information hubs, providing profiles, social media links, and reviews for tourist attractions Beyond virtual tours, interactive multimedia in education encompasses various technologies like gamification, simulations, and augmented reality, enhancing teaching and learning experiences [21]. The implementation of these systems in both the tourism and education sectors shows promising results in engaging users and promoting destinations effectively.

Recent studies have explored the potential of 360-degree Virtual Reality (VR) tours in promoting tourism, particularly mountain walking. Using the Stimulus-Organism-Response (S-O-R) model, researchers have found that VR experiences can positively influence visit intentions through factors such as vividness, presence, and emotional involvement [22]. The authentic experience provided by VR tours has been shown to impact cognitive and affective responses, which in turn influence attachment and visit intention. Key attributes of VR travel, including sense and information quality, contribute to the flow experience, leading to satisfaction and increased visit intention. Furthermore, VR has been demonstrated to be an effective promotional tool at consumer travel fairs, with positive responses across demographic groups and an increased likelihood of visiting the showcased destinations [23]. These findings highlight the potential of VR as a powerful marketing tool for tourism destinations.

Recent studies have highlighted challenges in survey response rates and respondent demographics across various fields. Response rates have declined significantly over time, with one maternity survey dropping from 67% in 1995 to 29% in 2018 [24]. Demographic factors consistently associated with higher response rates include older age, being married, UK-born status, and living in less deprived areas. However, socioeconomically vulnerable individuals are often underrepresented, potentially biasing results New data collection methods, such as online questionnaires and smartphone applications, offer alternatives but may impact respondent characteristics [25]. Despite these challenges, some studies found minimal non response bias; for instance, a farm injury survey reported few differences between responders and non responders, although early responders reported more injuries than late responders. Researchers suggest using multiple data collection methods and sophisticated bias control techniques to improve survey representativeness [26].

Web and virtual tour technologies not only enable wider and more in-depth promotion to potential tourists but also help to increase awareness and understanding of the area's tourism potential. This research aims to explore the use of virtual tour web systems as an innovation in the development of the tourism sector in Selayar Islands Regency while highlighting the potential of tourist destinations in the area. It is hoped that the results of this research can make a significant contribution to advancing regional tourism through innovative technological approaches.

2.   METHODOLOGY

2.1.   Research Site and Data Collection

This research was conducted from August to December 2024 in Selayar Islands Regency, South Sulawesi Province, Indonesia. The selection of this location was based on the potential of the area to offer a variety of enchanting tourist destinations, which have been recognised by UNESCO as one of the world-class tourist destinations. Research data collection was carried out at several key tourist destinations, including Takabonerake, Sumingi Turtle Conservation, Balojaha, Liang Tarrusu, Bonemalea, Liang Lipang, Bahuluang, Nane Hill, Tambolongan, Bone Kiddi, Karang Tomb Island, Bunging Bahuluang, Bone Malea, and Liang Kareta. These locations represent the region's rich cultural and natural heritage, contributing to the study's exploration of local tourism potential.

2.2.   Demographic Information of the Respondents

Respondents in this study totalled 34 people consisting of 17 men and 17 women, with the following age distribution: less than 20 years 11.8%, 21-30 years 61.8%, and 31-40 years 26.5%. In terms of education, 52.9% have completed junior high school, 35.3% hold a bachelor's degree, and 11.8% have a master's degree. Regarding technology usage, 94.1% use it every day, while 5.9% use it several times a week. When it comes to experience with virtual tours, 47.1% have used virtual tour technology, while 52.9% have never used it. Additionally, based on the location of the domicile, 91.2% live outside the Selayar Islands Regency, while 8.8% reside within the regency. This study provides a comprehensive overview of the demographic and technological characteristics of the respondents.

2.3.   System Development Method

The system development method used in this is Research and Development (R&D) with the Interactive Multimedia System Design & Development (IMSDD) approach, the IMSDD method is used for the design and development of interactive multimedia application systems consisting of stages ranging from System Requirement, Design Consideration, Implementation, and Evaluation. IMSDD focuses on an organised and structured design approach.

The system architecture is based on a client-server model, utilizing a combination of web technologies and multimedia integration to deliver a seamless virtual tour experience. The backend of the system is developed using a Node.js framework for server-side operations, ensuring scalability and efficient data handling. The database uses MongoDB to store multimedia content, such as 360-degree images, videos, and metadata for tourist destinations. For the frontend, the system employs React.js to create an interactive and responsive user interface, while Three.js is utilized to enable 3D and panoramic rendering of the virtual environments. Additionally, RESTful APIs are implemented to facilitate communication between the frontend and backend, ensuring efficient data retrieval and update processes. The hosting environment is powered by AWS, providing reliability and global accessibility for users. This technical foundation not only supports the system's functional requirements but also ensures its robustness and scalability for future enhancements.
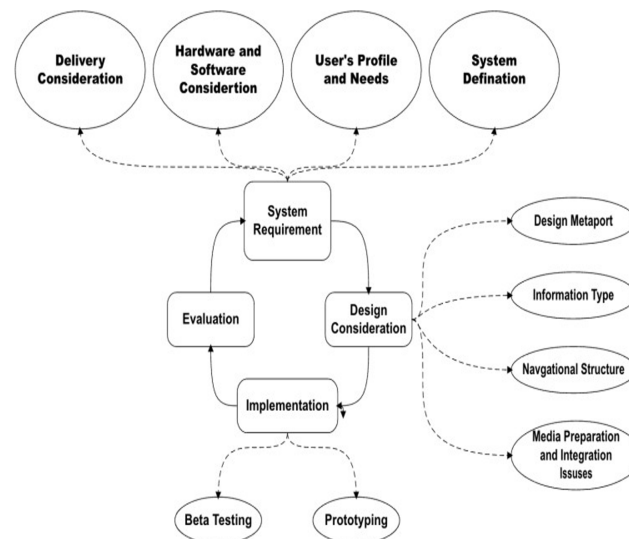
Figure 1. Stages of the IMSSD Development Method

- System Requirement.

  The first stage in IMSDD is (1) defining the system in general, (2) clarifying each user who will use the system, (3) evaluating each hardware and software requirement that will be used, (4) considering the technology or delivery media that will be used in the system to be created.

- Design Consideration.

  The second stage is to describe clearly and in detail the design of the media that will be created through the user interface design.

- Implementation.

  The third stage of IMSDD is to create a system prototype and test the prototype that has been created.

- Evaluation.

  The last stage of IMSDD is to evaluate the virtual tour system according to the objectives of the system development.

2.4.   USE Questionnaire and Feasibility Scale

Table 1 The questionnaire method used in this research is the USE Questionnaire, a method that is often used as an evaluation instrument designed to measure the user experience of a system based on three main dimensions, namely, Usefulness, Satisfaction, and Ease of Use, especially in research to assess the quality or feasibility of a system, product, or service.

Table 1. USE Questionnaire

Aspect	Statement
U1-Usefulness	This Virtual Tour System helps me find information about tourist sites in Selayar Islands Regency.
U2-Usefulness	The features in this system are useful for me as a user.
U3-Usefulness	This system makes travel planning more efficient.
U4-Usefulness	The system provides accurate and up-to-date information about tourist sites.
U5-Usefulness	I feel this system is important to improve the tourism experience in Selayar Islands Regency.
S1-Satisfaction	The system is easy to use even for users who are not very tech-savvy.
S2-Satisfaction	Navigation within the system is easy to understand.
S3-Satisfaction	I was able to quickly learn how to use the system.
S4-Satisfaction	The interface of this system is well-designed and makes it easy for me to find the features I need.

Aspect	Statement
S5-Satisfaction	The system is responsive to my commands.
E1-Ease of Use	I am satisfied with the experience of using this Virtual Tour system.
E2-Ease of Use	The system fulfils my expectations in providing information about tourist sites.
E3-Ease of Use	I would recommend this Virtual Tour system to other people who want to visit Selayar Islands Regency.
E4-Ease of Use	I feel comfortable using this system to plan my travel.
E5-Ease of Use	Overall, I am satisfied with the quality of this Virtual Tour system.

The feasibility assessment uses a Likert scale model, the Likert scale model used starts from the lowest assessment, namely 'Strongly Disagree' to the highest assessment, namely 'Strongly Agree', which is shown in Table 2. Furthermore, the results obtained from the questionnaire are processed using a measurable strategy, to obtain objective and accurate values in assessing the feasibility of the system being developed.

Table 2. Feasibility Scale

Scale value	Classification
<21	Very Unworthy
21-40	Not Worth It
41-60	Neutral
61-80	Proper
81-100	Very Decent

Table 2 illustrates a Feasibility Scale that categorizes scale values into five classifications. Scale values below 21 are classified as "Very Unworthy". Values between 21-40 fall under the "Not Worth It" category. Scores ranging from 41-60 are labeled as "Neutral". Values from 61-80 are classified as "Proper", while scores between 81-100 are considered "Very Decent". This scale is used to assess the feasibility of a system, product, or concept based on the obtained score.

3.   RESULTS
3.1. System Requirement
The initial stage before the virtual tour is created, this stage explains several aspects of preparation before the virtual tour is created.

3.1.1. System Definition
This virtual tour web system is a system that can be used as a tour guide for tourist attractions in the Selayar Islands district, this system was built to make it easier for users to see tourist destinations directly with a 360-degree panorama. Tourist destinations that can be accessed on the system are Takabonerake, Sumingi Turtle Conservation, Balojaha, Liang Tarrusu, Bonemalea, Liang Lipang, Bahuluang, Nane Hill, Tambolongan, Bone Kiddi, Karang Tomb Island, Bunging Bahuluang, Bone Malea, and Liang Kareta. The system also features maps, 360 photos, videos, English language options, social media and information about the system developers.

The virtual tour system was developed with a focus on handling the high computational demands of rendering 360-degree images and video. To achieve this, the design prioritizes modularity and scalability. Node.js was selected as the backend due to its non-blocking, event-driven architecture, which allows simultaneous processing of multimedia requests. MongoDB's document-oriented database schema was ideal for storing hierarchical data such as tourist site metadata, 360-degree image paths, and user interactions. To ensure smooth delivery of content, AWS S3 was utilized for static asset storage, enabling content distribution via a global Content Delivery Network (CDN). On the client side, React.js paired with Redux for state management was crucial in maintaining a responsive and dynamic user interface across devices. Challenges such as delivering high-quality panoramic images without affecting load times were addressed by implementing adaptive streaming and image compression using the WebP format.

3.1.2. User's Profile and Needs
The users of this virtual-tour web system are local and international tourist visitors, who need information before they actually visit tourist sites. The purpose of making this system is to help local and international

visitors see directly the virtual panorama of tourist destinations in the Selayar Islands Regency. So that these visitors get information from the tourist destinations that have been provided.

3.1.3. Hardware and Software Consideration

System requirements Creating a Virtual Tour requires specific system requirements: sufficient hardware with recommended 16 GB RAM and i5 or i7 processor; compatible software, including recommended operating systems Windows 10 and 11 or OS X; browser; sufficient network bandwidth for smooth content delivery; and support for content formats such as 360-degree images and videos, to ensure optimal performance and user experience.

3.1.4. Delivery Consideration

At this stage, the virtual-tour web system is disseminated through the website virtualtourselayar.com, so that the system can be accessed by users anytime and anywhere as long as it is connected to internet access.

3.2. Design Consideration

The virtual-tour web system design stage includes preparation and materials that will be needed for the interface and so on.

3.2.1. Design Metaphor

This stage is part of the design that aims to adopt facts from the real world into a virtual-tour system, the facts taken are the results of documentation of data collection of tourist locations in the form of videos, 360-degree photos, and descriptions of interview results from the local government (tourism office of the Selayar Islands Regency).

3.2.2. Information Type and Format

The formats and types integrated into the virtual tour web system consist of 360 images (jpg), sound (mp3), and video (mp4).

3.2.3. Navigation Structure

The navigation structure of this virtual tour web system is described using a use case diagram. Use case diagram describes the functions of the system performed by the user. Figure 2 shows the role of actors in the system, admin actors can manage tourism data, manage website content, manage users, and edit profiles. User actors can see virtual tour coordinates on maps, see website information such as about system development, and can access virtual tours. The following is a use case diagram of the Selayar Islands Regency virtual-tour web system.

The use case diagram provides a clear representation of the interactions between the system and its users, emphasizing the roles and activities that each actor can perform. It helps to identify the primary features of the system and the flow of actions required to achieve specific goals. For instance, the admin actor's ability to manage tourism data ensures the accuracy and relevance of information displayed to users, while the capability to edit profiles supports dynamic system administration. On the other hand, the user actor's access to virtual tour coordinates on maps and other system information enhances user engagement by providing an interactive and informative experience. This structured approach to illustrating system functionality ensures a comprehensive understanding of how the system operates and serves its intended audience effectively.

3.2.4. Media Preparation and Integration Issue

This stage pays attention to the media that will be integrated into the creation of a virtual tour web system, where each media will one by one form a complete system. The intended media such as images, sound and video will be put together well to provide visual and sound effects. The media used in this system is the result of data collection in the form of 360-degree videos and photos, and additional free assets from the internet such as music and images such as icons. The media is collected, then selected and used one by one according to the required system design.

3.3. Implementation

The IMSDD implementation stage has two stages, namely: prototyping and beta testing.
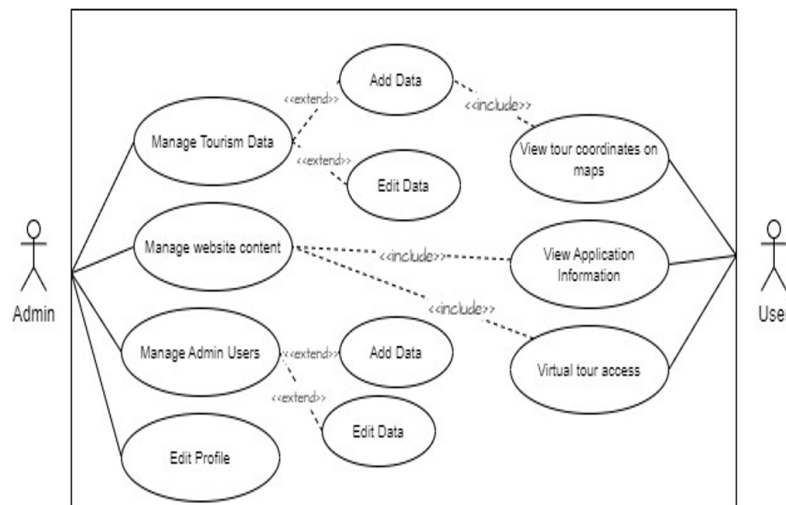
Figure 2. Use case diagram system web virtual-tour

3.3.1. The virtual-tour web system prototype is a user interface display when users access the system.

At this stage, several user interfaces are described. The implementation phase focused on translating system requirements into functional prototypes while iteratively solving technical and user experience challenges. The use of Three.js enabled the seamless rendering of 3D panoramas, incorporating interactions like zooming and panning with minimal latency. RESTful API endpoints were developed to handle queries efficiently, such as retrieving location-based multimedia content or filtering destinations by category. During prototype testing, latency issues were identified when loading large multimedia files, which were mitigated by implementing server-side caching using Redis and adopting lazy loading for on-demand content retrieval. Additionally, user interface adjustments, such as dynamic tooltip generation and keyboard navigation support, were introduced to accommodate a wider range of accessibility needs. These implementations ensured the system maintained high performance and usability, even during peak loads or on lower-spec devices.

- Main page

The user interface on the main page is the display accessed by users when visiting the virtual-tour web system, on this page users can view coordinates from maps, view information, and access tourist destinations. This system provides two languages, namely Indonesian and English, making it easier for users to choose the language they understand. The following Figure 3 is the main page display.
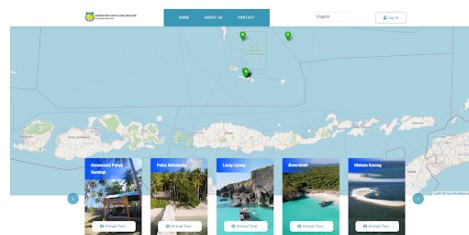

Figure 3. Main page

- Virtual-tour

The virtual tour user interface, displays details of tourist destinations that have been selected by the user, on the page the user sees a 360-degree panorama, additional features provided in the form of information or description of the tour, list of panoramas, and tourist locations. The following is Figure 4 of the virtual tour display.
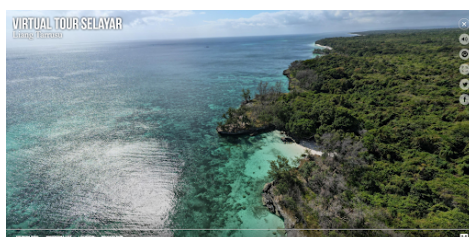
Figure 4. Virtual-tour

- About us and contact page

The About and contact pages display information on the Selayar Islands regency, and system developer information. The following Figure 5 is the about us and contact page that has been implemented.

Figure 5. About us and contact page

The developed virtual tour prototype offers an interactive experience by utilizing a RESTful API to display the main map, destination information, and virtual tours that showcase the beauty of Selayar Island. The main page serves as the initial access point, while the virtual tour provides detailed views of destinations integrated with landscape visualizations, allowing users to explore locations virtually. The about and contact page complements the system by providing essential information about Selayar Island and the developers, making it a comprehensive tool for promoting technology-based tourism.

3.3.2. Beta testing

The Beta testing stage in this study uses the USE questionnaire method, where 34 users are involved to assess the product based on their experience using the system, the questionnaire contains statements according to the aspects of Usefulness, Satisfaction, and Ease of Use.

The feedback gathered through the USE questionnaire played a pivotal role in refining the virtual tour system. Respondents highlighted the need for faster loading times and smoother navigation, which led to the optimization of the backend database queries and image compression techniques to improve performance. Additionally, users requested a more intuitive interface for accessing specific tourist sites, which resulted in redesigning the navigation structure to include a clear dropdown menu and search functionality. Feedback on the responsiveness of the system prompted the development team to implement real-time error handling and dynamic loading of content, ensuring a more seamless user experience. These adjustments, directly influenced by user input, significantly enhanced the system's usability, satisfaction, and overall functionality.

Table 3. Questionnaire evaluation

Aspects	Respondent score	Maximum score	Percentage
U1	142	170	
U2	139	170	
U3	142	170	81.9%
U4	137	170	
U5	136	170	
Total score of respondents (Usefulness): 696		**850**	

Aspects	Respondent score	Maximum score	Percentage
S1	132	170	
S2	138	170	
S3	138	170	79.1%
S4	133	170	
S5	131	170	
Total score of respondents (Satisfaction): 672		**850**	
E1	139	170	
E2	139	170	
E3	143	170	81.9%
E4	136	170	
E5	139	170	
Total score of respondents (Ease of Use): 696		850	
Average			80.9%

Table 3 resents the evaluation results from the USE Questionnaire used to assess the feasibility of the Selayar Islands Regency Virtual Tour system based on three main dimensions: Usefulness, Satisfaction and Ease of Use. Respondent's lowest score was 131 on aspect S5 (Satisfaction), indicating the need for more attention to the responsiveness of the system to user needs. In contrast, the highest score of respondents was 143 on aspect E3 (Ease of Use), which indicates that respondents are very satisfied with the system and tend to recommend it to others. Referring to Table 2, the average value of Table 3 is 81% (rounded from 80.9%), which falls into the 'Very Decent' classification on the feasibility scale. This shows that the Virtual Tour system is very feasible based on the respondents' evaluation.

4.   DISCUSSION

The development of a virtual tour Web System for tourist attractions in the Selayar Islands Regency using a Research and Development (R&D) methodology with an Interactive Multimedia System Design and Development (IMSDD) approach has proven to be an effective means of promoting regional tourism potential. Similar research by [27] demonstrated the positive impact of virtual tour technology in promoting cultural and heritage tourism, emphasising its role in attracting tourists and raising awareness of lesser-known destinations.

A closer comparison with other virtual tour projects implemented in regional or cultural contexts further underscores the distinctiveness of the Selayar Islands Virtual Tour system. For example, virtual tour systems such as those developed for Bali and Yogyakarta primarily focus on well-known tourist attractions and cultural heritage, often lacking integration with lesser-known or remote destinations. In contrast, the Selayar Islands system uniquely combines the promotion of UNESCO-recognized marine sites, such as the Taka Bonerate Marine National Park, with features that spotlight local cultural, historical, and natural attractions. Moreover, this system stands out by offering bilingual support (Indonesian and English), a feature not commonly found in many local virtual tour systems. It also integrates interactive 360-degree panoramas and detailed multimedia content, enabling a more immersive experience than the static or minimally interactive tours available in similar initiatives. By targeting underrepresented destinations and providing comprehensive functionality, this system not only meets but exceeds the standard expectations for virtual tourism platforms in the region, reinforcing its novelty and contribution to the field.

Similarly, research by [28] showed that virtual tours can significantly increase the attractiveness of tourist destinations by providing an immersive and engaging experience for potential visitors. The results of the USE Questionnaire evaluation, which assessed Usability, Satisfaction, and Ease of Use, showed that the system received high appreciation from the respondents. With an average score of 81%, which is categorised as 'Very Feasible' on the feasibility scale, the system is considered useful, easy to use, and satisfying. This is in line with findings from previous research, such as that conducted by [11], who also found that virtual tour systems can increase user satisfaction and ease of use, so it is clear that virtual tours offer significant value, especially in terms of providing practical and efficient information.

Interactivity and multimedia features, such as 360-degree images, audio, and detailed descriptions in Virtual Tour systems, have been shown to provide a more immersive and engaging experience for tourists. Research by [29] shows that the use of virtual reality technology, including interactive multimedia elements, can increase travelers interest in a destination through the creation of emotional closeness. This is in line with the findings of Guttentag, who stated that this technology is very effective for providing comprehensive information, especially in locations that are difficult to reach physically. Research by [30] confirmed that the integration of features such as 3D virtual worlds and interactive technologies can expand accessibility for both local and international travelers. Research by [31] showed that user experience at tourist destinations can be enhanced by using virtual reality and augmented reality, particularly in cultural tourism and remote locations. The addition of accessibility in multiple languages, as implemented in the Virtual Tour system for the Selayar Islands Regency, has also been supported by [32] research, which highlights the importance of inclusive and personalised tourism experiences. Thus, features such as 360-degree images, multilingual descriptions and ease of navigation in this system not only enhance the attractiveness of the destination but also expand accessibility for local and international users.

Furthermore, a deeper comparison with existing virtual tour systems in Indonesia highlights the distinctive qualities of the developed system. For instance, while the Bali Tourism Board's virtual tour system primarily focuses on cultural attractions with limited interactivity, the Selayar Islands Virtual Tour system integrates 360-degree panoramas, bilingual support, and comprehensive tourist guides that encompass not just cultural but also marine, historical, and agro-tourism sites. Similarly, unlike the Jogja Virtual Tour which centers on historical narratives, this system provides a wider array of multimedia elements, including immersive audio-visual features and detailed user-centric navigation tools. These additional functionalities cater to both local and international audiences, positioning the Selayar Islands system as a more holistic and inclusive virtual tourism solution [32].

In addition, the implementation of a system like this can help overcome various issues faced by the tourism sector in the Selayar Islands Regency, such as limited infrastructure or accessibility issues, and can be an innovative promotional tool to reach a wider audience, findings of this research also hold potential implications beyond the tourism sector. In edupreneurship, virtual tour systems could be adapted to create interactive, immersive learning environments. For instance, educational institutions can leverage similar technologies to develop virtual campus tours, enhance remote learning experiences through virtual labs, or showcase cultural and historical sites for educational purposes [33]. Similarly, in healthpreneurship, such technologies could be employed to develop virtual environments for mental health therapy, such as guided relaxation tours in natural settings, or virtual orientations for hospital facilities to reduce patient anxiety. By extending the principles of interactive multimedia and user-centered design to these sectors, the impact of virtual tour technologies can be amplified, demonstrating their versatility in addressing diverse entrepreneurial challenges and opportunities. These broader connections underscore the significance of this research in driving innovation across multiple domains [34].

The virtual tour system not only supports tourism promotion but also acts as a catalyst for local entrepreneurship by fostering opportunities for new digital ventures. For example, local startups could leverage this platform to develop complementary services such as virtual souvenir shops, personalized virtual tour guides, and AI-driven itinerary planners. Moreover, by providing a digital infrastructure, this system enables small businesses in the tourism sector, such as local hotels, restaurants, and transport providers, to integrate their services directly into the platform, enhancing visibility and market reach. Beyond tourism, the virtual tour framework can inspire entrepreneurs in sectors such as digital marketing, by creating immersive promotional campaigns, and e-commerce, by integrating virtual storefronts for local products. These initiatives not only stimulate economic activity but also encourage the adoption of innovative technologies, fostering a digitally driven entrepreneurial ecosystem in the Selayar Islands Regency and beyond.

Beyond tourism, the virtual tour system demonstrates significant potential for fostering innovation in other entrepreneurial sectors. In edupreneurship, similar platforms can be developed to provide immersive virtual classrooms or training modules, enhancing access to quality education in remote areas. The system's integration of multimedia elements, such as 360-degree videos and interactive simulations, could revolutionize digital learning experiences by offering virtual labs, historical recreations, or cultural exchanges. In healthpreneurship, the virtual tour framework could support initiatives such as virtual wellness retreats, guided meditation tours in serene natural settings, or virtual hospital tours to familiarize patients with facilities and reduce anxiety before procedures. Additionally, the platform's ability to highlight social impact projects makes it

highly applicable to socialpreneurship, enabling local artisans, small-scale producers, or NGOs to showcase their work and connect with global audiences. By bridging the gap between innovation and accessibility, this virtual tour system serves as a template for entrepreneurial ventures that combine technology with social and economic empowerment, driving growth in various sectors Offering a glimpse of its natural beauty to potential travellers around the world.

5. MANAGERIAL IMPLICATION

The managerial implication of this study suggests that companies aiming to capitalize on Gen Z's preference for eco-friendly products should understand the significance of functional and green value in purchase decisions. The findings indicate that managers should focus on developing products that not only offer practical benefits but also reflect a commitment to environmental sustainability, as both values serve as key drivers influencing purchase intentions. Furthermore, communication strategies emphasizing positive environmental impacts can strengthen the brand image among young consumers who are increasingly conscious of sustainability issues, thereby creating a competitive advantage in a market that prioritizes social and environmental responsibility.

6. CONCLUSIONS

The conclusion of this research shows that the development of a Virtual Tour system for the Selayar Islands Regency, designed using the Interactive Multimedia System Design & Development (IMSDD) approach, has great potential to improve the promotion of tourism in the region. Evaluation results using the USE Questionnaire showed that the system is very useful, satisfying and easy to use by users, with an average score of 81% indicating the system is suitable for use. Features such as 360-degree views, tourist destination information, and ease of access were highly appreciated by users. Nevertheless, there are some aspects that need to be improved, especially regarding the responsiveness of the system to user needs. Overall, this study confirms that Virtual Tour technology can be an effective tool for promoting tourist destinations, especially in the post-pandemic era, when physical mobility is limited and in-person visits to tourist sites are challenging.

The research on the development of a virtual tour system for the Selayar Islands Regency demonstrates the significant potential of digital technologies in promoting regional tourism and fostering entrepreneurial growth. The system's features, such as 360-degree panoramas, multilingual descriptions, and interactive navigation, received high appreciation from users, as evidenced by the USE questionnaire results with an average score of 81%. These findings affirm the system's feasibility and utility for enhancing tourism experiences.Moreover, this study underscores the broader implications of virtual tour technologies beyond tourism. For instance, the system's design principles can inspire applications in edupreneurship, such as virtual classrooms or historical recreations, and healthpreneurship, such as virtual wellness retreats or hospital orientations. These interdisciplinary applications highlight the versatility of interactive multimedia systems in addressing diverse societal challenges. Future research should explore advanced integrations such as augmented reality (AR) and artificial intelligence (AI) to further enhance user experience. Additionally, expanding the system's scope to include more localized entrepreneurial ventures, such as virtual marketplaces for artisanal products or AI-driven personalized travel itineraries, would significantly contribute to the economic empowerment of local communities.

7. DECLARATIONS

7.1. About Authors

Nur Mustika (NM) [iD] https://orcid.org/0009-0005-8115-681X

Sutarsi Suhaeb (SS) [iD] https://orcid.org/0009-0001-9553-7550

Mirfan (MM) [iD] https://orcid.org/0009-0009-8664-3704

Andryanto Aman (AA) [iD] https://orcid.org/0000-0002-8755-6874

Andi Maulidinnawati Abdul Kadir Parewe (AM) [iD] https://orcid.org/0000-0002-8902-2278

Nicholas Lachlan (NL) [iD] https://orcid.org/0009-0002-9144-1372

7.2.   Author Contributions

Conceptualization: NM; Methodology: SS; Software: MM; Validation: NM and SS; Formal Analysis: AA and AM; Investigation: NM; Resources: SS; Data Curation: SS; Writing Original Draft Preparation: NL and AA; Writing Review and Editing: NL and AA; Visualization: SS; All authors, NM, SS, MM, AA, AM and NL, have read and agreed to the published version of the manuscript.

7.3.   Data Availability Statement

The data presented in this study are available on request from the corresponding author.

7.4.   Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

7.5.   Declaration of Conflicting Interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

REFERENCES

[1]   M. N. Islam, S. Tamanna, S. R. Islam, and M. S. Islam, "Marine ecosystem services: Sdgs targets, achievement, and linkages with a blue economy perception," in *Global Blue Economy*.   CRC Press, 2022, pp. 259–284.

[2]   P. Wulandari, S. Sainal, F. Cholifatullah, Z. Janwar, N. Nasruddin, T. M. Setia, D. Soedharma, R. A. Praptiwi, and J. Sugardjito, "The health status of coral reef ecosystem in taka bonerate, kepulauan selayar biosphere reserve, indonesia," *Biodiversitas Journal of Biological Diversity*, vol. 23, no. 2, 2022.

[3]   M. RAJAKUMAR, T. UMAMAHESWARI, K. N. SUJATH, P. JAWAHAR, R. K. NARESH, Y. RAJPAL *et al.*, "Ecosystem service approach for community-based management towards sustainable blue economy," *The Indian Journal of Animal Sciences*, vol. 91, no. 12, pp. 1122–1126, 2021.

[4]   J. Supriatna and C. Margules, *The national parks of Indonesia*.   Yayasan Pustaka Obor Indonesia, 2022.

[5]   S. Adhityatama, R. Anderson, A. Abbas, C. M. King, J. C. M. Ng, and B. Orillaneda, "A preliminary report on the late 13th-to early 14th-century bontosikuyu shipwreck site, selayar island, south sulawesi, indonesia: A case study for regional capacity building and research," *International Journal of Nautical Archaeology*, pp. 1–16, 2024.

[6]   A. Salim *et al.*, "Land use development of bahuluang island as a leading tourism object in selayar regency, south sulawesi," *Journal of Tourism and Hospitality Studies*, vol. 1, no. 1, p. 31, 2023.

[7]   E. Ligia, K. Iskandar, I. K. Surajaya, M. Bayasut, O. Jayanagara, and K. Mizuno, "Cultural clash: Investigating how entrepreneural characteristics and culture diffusion affect international interns' competency," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 6, no. 2, pp. 182–198, 2024.

[8]   A. Tuwo, M. Yunus, R. Aprianto, and J. Tresnati, "Marine ecotourism development in south sulawesi, indonesia," in *IOP Conference Series: Earth and Environmental Science*, 2021, p. 12068.

[9]   C. Maharja, R. A. Praptiwi, and Y. Purwanto, "Understanding the cultural impacts of climate change harms on small-scale fisher communities through the lens of cultural ecosystem services," *Marit. Stud.*, vol. 22, no. 4, p. 41, 2023.

[10] A. D. Samala, M. Ricci, C. J. A. Rueda, L. Bojić, F. Ranuharja, and W. Agustiarmi, "Exploring campus through web-based immersive adventures using virtual reality photography: A low-cost virtual tour experience," *Int. J. Online Biomed. Eng.*, vol. 20, no. 1, 2024.

[11] O. El-Said and H. Aziz, "Virtual tours a means to an end: An analysis of virtual tours' role in tourism recovery post covid-19," *J. Travel Res.*, vol. 61, no. 3, pp. 528–548, 2022.

[12] X. Wu and I. K. W. Lai, "The use of 360-degree virtual tours to promote mountain walking tourism: Stimulus–organism–response model," *Inf. Technol. & Tour.*, vol. 24, no. 1, pp. 85–107, 2022.

[13] A. A. et al., "The virtual tour panorama as a guide and education media of the historic objects at datu luwu palace," *Ingénierie des Systèmes d'Information*, vol. 28, no. 2, pp. 425–432, 2023.

[14] M. Aji and H. N. Fauzi, "Educational introduction to asean countries for class viii middle school students using game media," *Journal of Multimedia Trend and Technology*, vol. 2, no. 3, pp. 135–143, 2023.

[15] F. I. Omar, U. M. S. M. Zan, M. A. A. Ab Aziz, and N. A. Hassan, "Interactive learning media and its relationship towards students'academic performance in a new civilization era," *Languages and Communication (ICLC) 2021*, 2021.

[16] A. S. Laswi and B. Bungawati, "Virtual tour based in augmented reality as a biology learning media," *JPBI (Jurnal Pendidik. Biol. Indones.)*, vol. 10, no. 3, pp. 1049–1058, 2024.

[17] D. I. Af'idah, "Virtual tour as a tourist attraction promotion media using multimedia development life cycle," in *International Conference On Digital Advanced Tourism Management And Technology*, 2023, pp. 253–266.

[18] M. R. Hossain, "A review of interactive multimedia systems for education," *J. Innov. Technol. Converg.*, vol. 5, no. 2, 2023.

[19] A. Ruangkanjanases, A. Khan, O. Sivarak, U. Rahardja, and S.-C. Chen, "Modeling the consumers' flow experience in e-commerce: The integration of ecm and tam with the antecedents of flow experience," *SAGE Open*, vol. 14, no. 2, p. 21582440241258595, 2024.

[20] L.-Z. Lin and H.-R. Yeh, "Using zmet to explore consumers' cognitive model in virtual reality: take the tourism experience as an example," *Current Issues in Tourism*, vol. 26, no. 14, pp. 2250–2264, 2023.

[21] U. Rusilowati, F. P. Oganda, R. Rahardja, T. Nurtino, and E. Aimee, "Innovation in smart marketing: The role of technopreneurs in driving educational improvement," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 5, no. 3, pp. 305–318, 2023.

[22] T. S. Goh, D. Jonas, B. Tjahjono, V. Agarwal, and M. Abbas, "Impact of ai on air quality monitoring systems: A structural equation modeling approach using utaut," *Sundara Advanced Research on Artificial Intelligence*, vol. 1, no. 1, pp. 9–19, 2025.

[23] J. Williams, A. G. Prawiyogi, M. Rodriguez, and I. Kovac, "Enhancing circular economy with digital technologies: A pls-sem approach," *International Transactions on Education Technology (ITEE)*, vol. 2, no. 2, pp. 140–151, 2024.

[24] K. J. Harris, R. B. Harris, M. Valle, J. Carlson, D. S. Carlson, S. Zivnuska, and B. Wiley, "Technostress and the entitled employee: impacts on work and family," *Information Technology & People*, vol. 35, no. 3, pp. 1073–1095, 2022.

[25] X. Fan, X. Jiang, and N. Deng, "Immersive technology: A meta-analysis of augmented/virtual reality applications and their impact on tourism experience," *Tourism Management*, vol. 91, p. 104534, 2022.

[26] J. C. Uhl, B. Prodinger, M. Murtinger, and A. Brysch, "A journey for all senses: Multisensory vr for pre-travel destination experiences," in *ENTER e-Tourism Conference*. Springer, 2024, pp. 128–139.

[27] W. Hadikurniawati, K. D. Hartomo, I. Sembiring, H. D. Purnomo, A. Iriani *et al.*, "Triangular fuzzy numbers-based madm for selecting pregnant mothers at risk of stunting," *Jurnal RESTI (Rekayasa Sistem dan Teknologi Informasi)*, vol. 7, no. 3, pp. 579–585, 2023.

[28] G. Li, S. Lin, and Y. Tian, "Immersive museums in the digital age: exploring the impact of virtual reality on visitor satisfaction and loyalty," *Journal of the Knowledge Economy*, pp. 1–34, 2024.

[29] M. Alyahya and G. McLean, "Examining tourism consumers' attitudes and the role of sensory information in virtual reality experiences of a tourist destination," *Journal of Travel Research*, vol. 61, no. 7, pp. 1666–1681, 2022.

[30] J. Li and C. Lv, "Exploring user acceptance of online virtual reality exhibition technologies: A case study of liangzhu museum," *PLoS One*, vol. 19, no. 8, p. e0308267, 2024.

[31] F. Benghadbane, H. Khawaldah, B. Al Kurdi, and N. Alzboun, "The impact of using virtual reality (vr) and augmented reality (ar) on museum marketing to enhance visitors' engagement, enjoyment, and experience," *International Journal of Management and Marketing Intelligence*, vol. 2, no. 2, pp. 60–70, 2025.

[32] J. Hutson and P. Hutson, "Immersive technologies," in *Inclusive smart museums: Engaging neurodiverse audiences and enhancing cultural heritage*. Springer, 2024, pp. 153–228.

[33] N. P. L. Santoso, D. I. Desrianti, D. Darmawan, S. M. Wahid, A. Fitriani, and A. Y. Fauzi, "Optimizing solar energy adoption through technological and economic initiatives," in *2024 3rd International Conference on Creative Communication and Innovative Technology (ICCIT)*. IEEE, 2024, pp. 1–6.

[34] R. Ahli, M. F. Hilmi, and A. Abudaqa, "The influence of leadership dynamics and workplace stress on employee performance in the entrepreneurial sector and the moderating role of organizational support," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 6, no. 3, pp. 300–313, 2024.