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Kajian Malaysia (early view)

THE APPLICATION OF AN AUGMENTED REALITY OFFLINE SYSTEM FOR RURAL TOURISM DEVELOPMENT AT PA' LUNGAN, BARIO

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ABSTRACT

The development of rural tourism is one of the Malaysian government's primary priorities for improving the socio-economic and living conditions of the local community. Therefore, new ideas for assisting the rural population's growth and economy through tourism must be explored. This paper examines the application of Augmented Reality offline systems in improving this issue. It aims to review the planning, implementation, and effectiveness of the ID-MAP (Interactive Digital Map) as part of a rural tourism project in Pa' Lungan, Bario, Sarawak. The study is carried out through a practical visual approach and analyzed through observational, experiential, and reflection approaches. The analysis elaborates on one of the main themes contained in the ID-MAP, which is linked to the famous tourist attraction of Pa' Lungan – a megalithic rock called Batuh Ritung. The outcome was initially presented through an exhibition that applied digital information delivery using Augmented Reality applications. As a result, an offline system was developed to assist locals in efficiently promoting tourism sites. This serves as an alternative platform that can verify the eligibility of tourist spots based on the existing digital and interactive multimedia systems, which are vital components in developing the Smart Village concept with Bario as a case study. Thus, this research has opened new interdisciplinary research opportunities and can be considered an alternative method to visual-based research, especially to stimulate the tourism industry and inform stakeholders and academics on the future of rural tourism.

Keywords: Augmented Reality, *Batuh Ritung*, Megalith, Offline Information System, Rural Tourism

ABSTRAK

Pembangunan pelancongan luar bandar merupakan salah satu keutamaan kerajaan Malaysia untuk meningkatkan sosio-ekonomi dan keadaan hidup masyarakat setempat. Oleh itu, idea baharu untuk membantu pertumbuhan dan ekonomi penduduk luar bandar melalui pelancongan perlu diterokai. Kertas ini menerangkan pengaplikasian sistem 'Augmented Reality' luar talian dalam membantu pembangunan pelancongan luar bandar. Ia bertujuan untuk mengkaji perancangan, pelaksanaan dan keberkesanan ID-MAP (Peta Digital Interaktif) sebagai sebahagian daripada projek pelancongan luar bandar di Pa' Lungan, Bario, Sarawak. Kajian dilaksanakan melalui pendekatan visual praktis dan dianalisis melalui pendekatan pemerhatian, pengalaman kendiri dan refleksi. Analisis akan merujuk kepada salah satu tema utama yang terkandung dalam ID-MAP, berkaitan dengan tarikan pelancongan terkenal di Pa' Lungan iaitu sebuah batu megalitik yang dinamakan Batuh Ritung. Hasil dapatan awal kajian dipersembahkan melalui pameran yang menerapkan penyampaian maklumat secara digital menggunakan aplikasi 'Augmented Reality'. Hasilnya, sistem luar talian dibangunkan untuk membantu penduduk tempatan mempromosi tapak pelancongan dengan lebih berkesan. Ia juga berfungsi sebagai sebuah platform alternatif yang dapat menunjukkan tempat-tempat pelancongan menggunakan sistem multimedia digital dan interaktif, yang menjadi komponen penting dalam mengembangkan konsep 'Perkampungan Pintar' dengan Bario sebagai kajian kes. Penyelidikan ini telah membuka peluang penyelidikan silang disiplin baru dan dianggap sebagai satu kaedah alternatif untuk penyelidikan berasaskan visual, terutama untuk merangsang industri pelancongan dan untuk memberi maklumat kepada pihak berkepentingan dan akademik mengenai masa hadapan pelancongan desa.

Kata kunci: Augmented Reality, *Batuh Ritung*, Megalith, Sistem Maklumat Luar Talian, Pelancongan Luar Bandar

INTRODUCTION

Rural tourism can be described as a rural tourism destination that relies on the natural environment, as well as engaging in a variety of local activities related to the preservation and conservation of arts, culture, and traditions. In addition, the uniqueness of local arts and cultural practices also plays a key role in creating a natural experience for visiting tourists (Duxbury & Richards, 2019; MacLeod, 2017). The topic of competitiveness of tourist destinations in the rural area is frequently discussed and debated in the academic world (Gómez & Picazo-Tadeo, 2019; de Souza, Mendes-Filho, & Buhalis, 2020; de la Peña et al., 2019).

Competitiveness in the context of the rural tourism industry refers to the ability of a destination to attract and retain tourists by offering unique, appealing, and sustainable experiences that are distinct from other tourism options. This competitiveness is critical for the survival and long-term profitability of rural tourism destinations, especially in the face of increasing domestic and international competition. The traits and characteristics required for rural tourism to be competitive are multifaceted and can be outlined as follows:

1. Natural Environment and Sustainability: Focus on preserving and sustainably using natural resources.
2. Cultural Experiences: Offer unique local cultural and traditional activities.
3. Innovation in Activities: Provide innovative and engaging local experiences.
4. Improved Accessibility: Enhance infrastructure and make the destination more accessible.
5. Effective Marketing: Use strong marketing strategies to highlight the destination's uniqueness.
6. Collaboration with Community: Work closely with local communities and stakeholders for inclusive tourism development.
7. Adapt to Visitor Preferences: Stay updated with and adapt to changing trends and visitor interests.

Using Pa' Lungan in Bario as an example, if we consider a rural tourism destination that emphasizes natural beauty and cultural heritage, strategies could include developing eco-tours that showcase the region's unique flora and fauna, promoting local handicrafts and traditional arts that involve local communities. By focusing on these unique aspects, the destination can create a compelling and competitive tourism product that stands out from more conventional or urban tourist destinations.

This is one of the most notable problems in the rural tourism industry, as increased domestic competition has also put more pressure to ensure the industry's survival. Destination competitiveness has received particular attention from all parties because the rural tourism industry players must maintain their competitiveness in order to remain profitable in the long run. The rural tourism industry also faces additional threats from other popular tourist destinations (Zielinski et al., 2020). For example, compared with rural tourism, visitors are more likely to visit more popular tourist destinations or those that provide modern travel facilities (Kastenholz et al., 2018; Zielinski et al., 2020).

Due to their remote location from the city and gradual adoption of technology, rural communities also receive relatively little information about the

environment, community, and eco-tourism, which adds to the difficulty of the situation (Almeshqab & Ustun, 2019). Hence, this paper aims to describe a project that incorporates digital and multimedia technology with an innovative and creative visual arts approach in assisting the development of the tourism sector in rural communities with limited online connectivity. This project was conducted to improve the rural tourism industry by designing and delivering information using upgraded interactive multimedia technology, equipped with digital mapping and augmented reality application, known as ID-MAP (Interactive Digital Mapping). Moreover, this project was conducted using an Augmented Reality offline system to encourage the dissemination of information more efficiently and effectively for areas without internet access. This system is specifically designed to work effectively in areas lacking internet connectivity. By incorporating AR technology in an offline mode, the project ensures that information dissemination is not hindered by the lack of internet access. This approach allows tourists to engage with interactive digital content, enhancing their experience even in the most remote tourism destinations.

This approach can potentially benefit the local community, especially in economic and social terms. It is also able to enhance the visitor's experience through the process of interacting with the local community and other tourists, as has been proven through a tourism project in Kuching, Sarawak by Chia et al. (2021). This project employed an information technology strategy based on Augmented Reality to promote tourism destinations. However, this project was carried out in an urban region with high internet connectivity, which is not available in rural areas. The Rural Tourism Master Plan, proposed by the Malaysian government, defines rural tourism as a system that provides visitors with the opportunity to visit places of interest in rural areas, in addition to experiencing Malaysia's own culture and heritage (Chin et al., 2018). Indirectly, this activity can also provide socio-economic benefits for the local community.

Problem Statement

As previously observed (Gazzola et al., 2018), the development of rural tourism in locations with poor internet connectivity, such as Bario, Sarawak, poses a significant difficulty in delivering immersive experiences to tourists without relying on real-time online data. The lack of dependable internet access in these rural locations makes it difficult to provide tourists with up-to-date information, limiting their capacity to fully engage with the local culture and environment. Adoption of an augmented reality offline system, which can provide tourists with immersive experiences independent of real-time online data, is one potential answer (Kresic and Gjurasic, 2022). However, developing and implementing such a system necessitates careful consideration of the local context, including visitor demands and preferences, as well as the capacity of local people to

support and sustain the system (Harris, 2009; Adeyinka, 2020). Introducing advanced technology such as ID-MAP in remote areas like Pa' Lungan and Bario presents specific challenges, including geographical remoteness which complicates technical support and system maintenance. It's crucial to consider the local context, particularly the capabilities of the local community to manage and sustain these technologies and align them with the preferences and demands of visitors. Addressing these issues is essential for ensuring the successful implementation and long-term viability of such technological solutions in enhancing the rural tourism experience.

LITERATURE REVIEW

Most studies related to the use of digital technology among rural communities have focused on individual factors such as innovation, personality, and motivation, which is reflected in the study by Philip and Williams (2019), or contextual factors in the study by Roberts, et al., (2017) that include community interpersonal networks and features. However, it is necessary to investigate how rural tourism interacts with the digital and interactive multimedia setting and how both can benefit each other. As mentioned by Solima (2014) and Di Pietro, et al. (2018), the role of new communication technology and technological innovation in the tourism industry can increase the depth and breadth of interaction among tourists and improve their learning experience during the visit. New technologies also have the potential to expand the accessibility and dissemination of information about tourist attractions as presented in this paper.

Kelabit Highland

The Kelabit Highlanders live in Bario (Figure 1 and 2), and the community has extensive connections with the upstream river communities of the neighboring Kayans, Kenyahs, or Dayaks (Metcalf, 2006). They are known for practicing stone-based cultural traditions for many purposes, such as conducting funeral ceremonies and making commemorative items (Janowski, 2012; Hitchner et al., 2009). The popularity of Bario as a tourist attraction draws visitors from across the world, particularly those who enjoy the solitude of the countryside and the challenge of jungle trekking. As a result, the tourism industry provides more than one-third of Bario's economic resources, with 36% of the employment here being those who work as tourist guides and provide homestay services (Tabassum et al., 2017). This demonstrates that, in addition to agriculture, tourism is a major economic source in Bario. Despite the prolonged isolation of the Kelabit minority, this indigenous community emerged from seclusion more than half a century ago. They have largely responded positively to the growth and

development that has taken place in their community as a result of numerous projects.

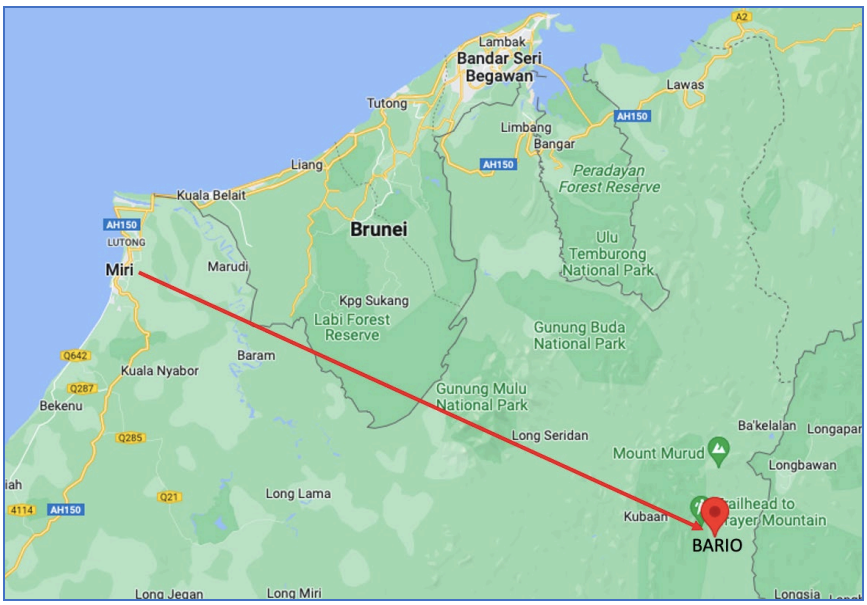

Figure 1: Location Map of Bario, Sarawak.

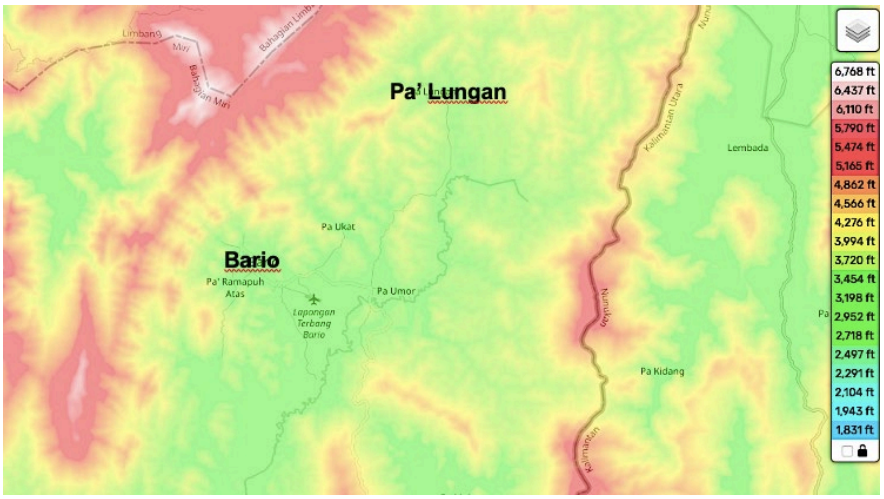

Figure 2: The topographic map of Pa' Lungan, Bario shows that most of the land here has an elevation exceeding 2500 feet above sea level, which complicates logistics and transportation activities

Bario is a settlement that is 3,280 feet above sea level, situated in the Kelabit Highlands in northeastern Sarawak, not far from the Indonesian province of Kalimantan. It may be accessible by the air transportation network from Miri or Marudi to Bario twice a day. While driving a 4-wheel drive car on land from Miri to Bario takes around 14 hours. Nevertheless, despite several infrastructure developments such as police stations, airports, Immigration Departments, military camps, schools, clinics, and several other government agencies, the communication system in Bario is limited to a basic radio network, while electricity is obtained from limited supply sources, home generator, or solar panels. Bario has 7513 people, of whom 4,987 are Kelabit, 1,526 Penan, and 1,000 Saban. Many visitors from inside and outside of the country are drawn to the Bario area since it is situated in a highland location with a temperate climate. As a result, the Bario community was able to start boarding houses to house the yearly increase in tourists. The owners of guesthouses in Bario have benefited financially from these tourism-related activities. Agriculture is the mainstay of the locals, with the cultivation of paddy and pineapple, as well as hill salt processing among the other primary economic activities. Thus, Bario represents an extreme example of the separation of digital space, and this project has provided opportunities for rural communities to use ICT for sustainable development because of the physical constraints of connecting rural communities with their urban and suburban counterparts.

The Sarawak government plays a critical role in developing research and development efforts in the region's tourist sector. This is demonstrated by the implementation of numerous policies intended at economic diversification and elevation, most notably the support for cultural tourism, as underlined by Haigh (2020). Recognizing tourism's significant contribution to state revenue, the government has aggressively worked to shift its economy towards this sector, as Puah, Jong, and Arip (2019) highlight. The Ministry of Tourism, Arts, and Culture Sarawak is responsible for overseeing the growth of the tourism sector and encouraging sustainable practices. Furthermore, in response to the challenges provided by the post-Covid-19 landscape, the government has launched the Post Covid-19 Development Plan, which is intended to create resilience and growth in the tourism industry. The Sarawak government is unwaveringly committed to developing tourism research and development and facilitating sustainable practices through these concentrated efforts. In particular, rural tourist development is a high-impact strategy for economic growth in Malaysia, Sarawak, and Bario. Several projects have been launched in the area to support rural tourism growth. These include an in-depth analysis of the existing tourism industry in Bario, taking into account its economic implications (Lo et al., 2012); the integration of tourism with community development through pro-poor community-based tourism endeavors in Bario, Sarawak (Harris, 2009); the development of a destination brand framework for rural tourism destinations such

as Bario, Sarawak (Adeyinka, 2020); and the implementation of solar panel projects. These multifarious programs demonstrate Sarawak's persistent dedication to the region's rural tourist development and the promotion of sustainable tourism practices.

The study began by collecting information related to rural tourist spots in a small village in the north of Bario known as Pa' Lungan. One of the most famous tourist spots here is a megalithic stone known as the Batuh Ritung (Figure 3). It is a big type of table stone, which is called batuh nangan in the Kelabit native language. Although unique in the community, the structure of the Batuh Ritung's is akin to Stonehenge in the United Kingdom. Similar stone formations – with the stones overlapping on top of others – have also been identified among the Ngorek people and other close-kin ethnics of Central Northern Borneo. Most table stones were erected for funeral purposes, specifically to mark or to cover the top of the grave. In Kelabit culture, the table stones were also built by the people in the past to honor or memorialize a noble individual at the time, besides also acting as their second burial site (Harrison, 1974; Hitchner, 2009; Sellato, 2016; Janowski, 2003). Indeed, according to local folklore, this megalith was erected to commemorate a novel individual, as well as his wife. Information related to this megalithic stone is included in the creation of ID-MAP, which aims to promote the transmission of tourism information from rural areas to the public. However, the methods of collecting, analyzing, and presenting this information need to be adapted to the technology and internet access facilities that are available today. Although internet connectivity infrastructures have improved, and the level of use is also high either in developed or developing countries, the digital divide between urban and rural areas remains wide (Lembani et al., 2020; Onitsuka, Hidayat & Huang, 2018). Despite such efforts and improved internet access, there are still some areas, especially in the rural areas of Sarawak, which are falling behind in this regard. Furthermore, providing this facility can be very costly. Previous studies have shown that the availability of infrastructure and resources is only the preliminary step in the digital entry process. Therefore, it is also important to consider several other factors such as motivation, needs, culture, and even social context for this purpose (Erdiaw-Kwasie & Alam, 2016; Suwana, 2017).

Figure 3: The monument called Batuh Ritung was erected at Pa' Lungan, Bario for a nobleman known as Ritung.

Despite these setbacks, policymakers are still promoting increased connectivity in rural areas because having an internet connection is seen as a tool that can benefit the region by redressing geographical isolation, increasing resource-based access opportunities, and introducing social interactions along with wider inter-community relationships. In Sarawak, efforts to bridge the digital divide in remote rural areas involve a combination of strategies. This includes setting up rural internet centers, expanding mobile network coverage, implementing government-sponsored digital literacy programs, and partnering with private companies to improve infrastructure (Vong et al., 2017). Additionally, educational initiatives in schools promote digital awareness among the youth, and local community involvement ensures that connectivity solutions are tailored to specific needs. These efforts collectively aim to overcome geographical isolation and integrate rural communities into the wider digital world. This plan is an effort to reduce the likelihood of external migration and stimulate the local economy (Park, Freeman & Middleton, 2019). In addition, it can increase awareness outside the community on numerous economic and social activities, as well as facilitate long-term relationships with friends or family (Philip & Williams, 2019; Correa, Pavez & Contreras, 2017).

Augmented Reality

Currently, the Augmented Reality application works when the camera launches to capture a sequence of real-world images and identifies feature points that have been extracted from the referenced images (Figure 4). Then, user point and position point data are sent to the server via online networks before the data is recognized on the cloud server and sent back to the smartphone once the transfer process is complete. Next, virtual instruments are provided on top of the actual object layer for additional display (Jain, Manweiler, & Roy Choudhury, 2015). However, the effectiveness of using Augmented Reality depends entirely on the speed of internet access and the cloud system. Despite intentions to increase internet access in Sarawak's rural regions, implementation took a long time and came at a high cost due to geographical and logistical constraints. Thus, applying Augmented Reality in rural areas, especially without internet access to promote a tourism-related event in rural areas is a daunting mission, unlike in urban areas where almost all infrastructures are readily available and accessible. Although Augmented Reality applications are expected to boost the rural tourism industry, they still require a reliable internet connection before they can be optimally applied (Llerena, Andina, & Grijalva, 2018).

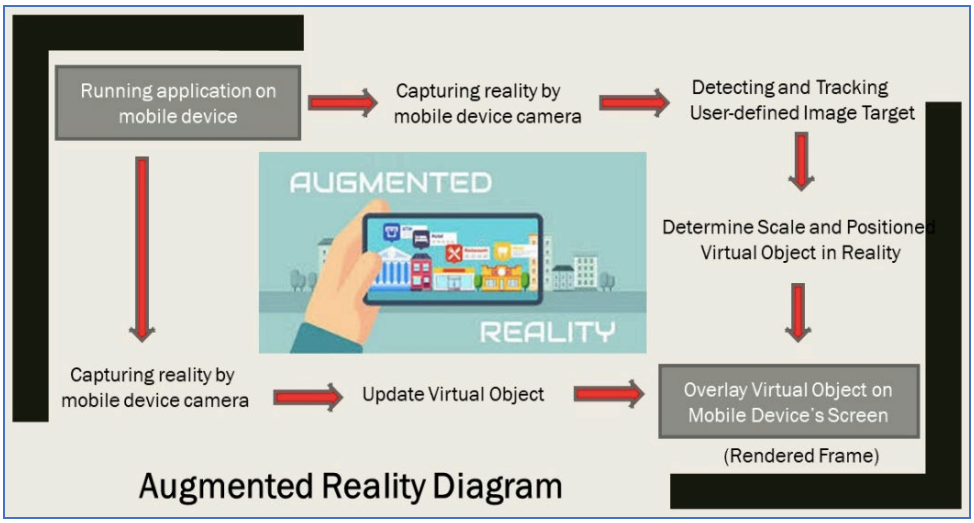

Figure 4: Augmented Reality Diagram

A new solution is required to provide an offline system with a similar purpose to assist villages in boosting their income through rural tourism via a digital platform without having to wait for the government to fully provide internet access. Hence, it is necessary to establish a digital tourism system based on digital and interactive multimedia technology to develop and enhance the competitiveness and rapid development of the rural tourism industry. Therefore, the establishment of a community information center that enables the dissemination of information about tourist attractions and services through information technology will make it easier for villagers to convey information, especially to tourists who arrive without internet access. This also will increase the income of villagers involved in eco-tourism businesses such as homestays and tour guides.

METHODOLOGY

Researchers have identified that visual research has the potential to be enhanced by the presence of certain influences in the process. Therefore, this project uses fully practical visual research with an approach based on experiential learning, observation, and visual analysis (as applied by Maying et al., 2019; Leong et al., 2019). Pa' Lungan in Bario, Sarawak was picked as a case study because of the number of small settlements and the presence of several tourist attractions such as the megalith stone, paddy fields, and an abundance of beautiful landscapes. These are the factors that make Pa' Lungan popular as one of the rural tourist destinations in Sarawak. The project involved four phases of visits to Bario which consisted of the following – documentation, transportation, installation, documents, field observations, and surveys. The preparation of the ID-MAP prototype was implemented through three different frameworks, namely design, information technology, and physical construction. The entire process of this study is explained as shown in Figure 5.

Analysis

All the data that were obtained and recorded were used for analysis and re-evaluation purposes from the field study. The data analysis was performed based on the data collected. For instance, the megaliths are vital for the cultural understanding of the case study, besides serving as a material through which improvements in cultural knowledge can be obtained using a Virtual Research Model (Figure 6). The environment in the analytical process of this study is directed based on the art practitioner's perception of the cultural materials, thus utilizing the knowledge of arts to study the megaliths through a visual medium. Moreover, the analysis also involved a critical study of the physical cultural objects as well as their visual cultures. The analysis process also was to study critically the physical of cultural objects and their visual cultures.

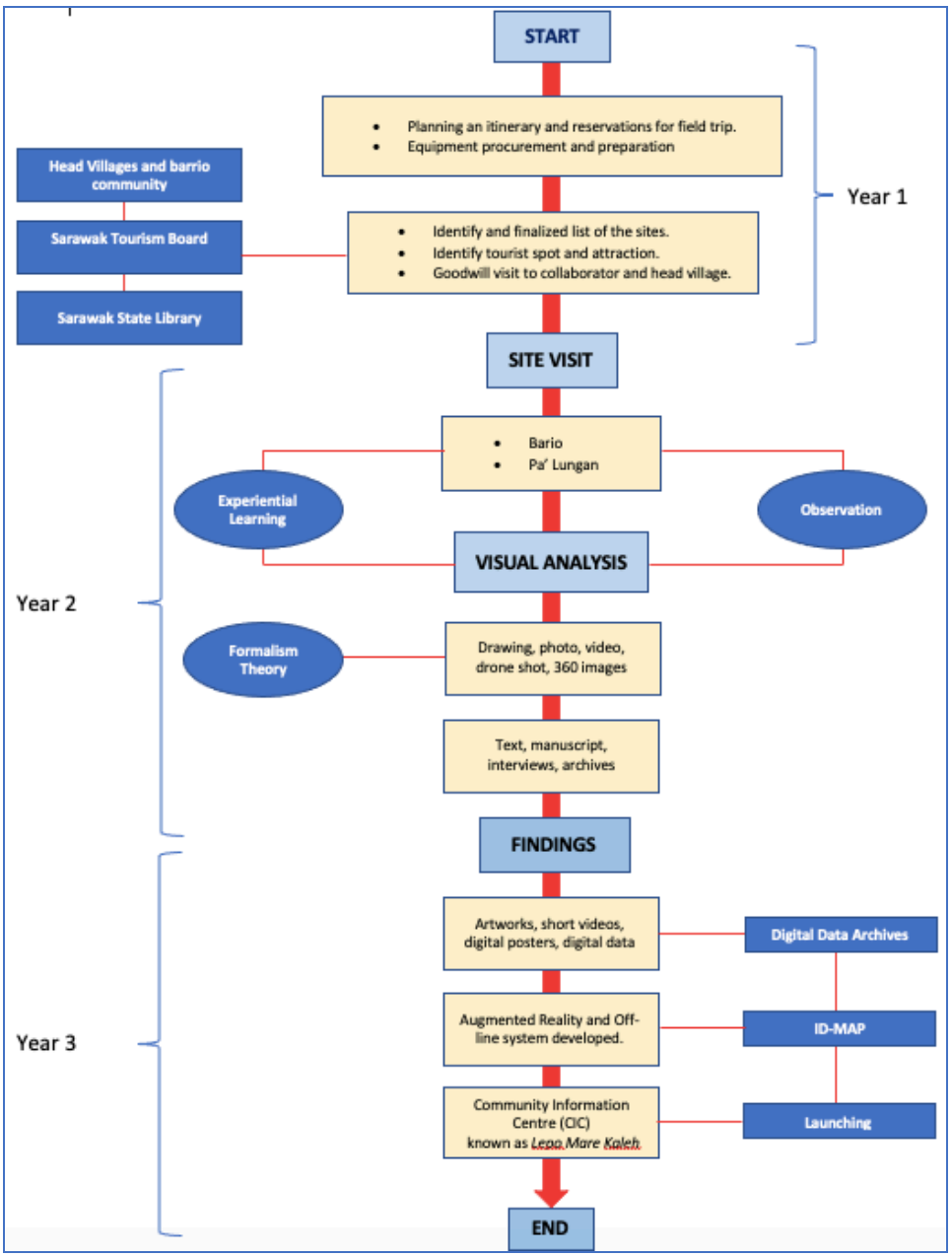

Figure 5: Research Flow

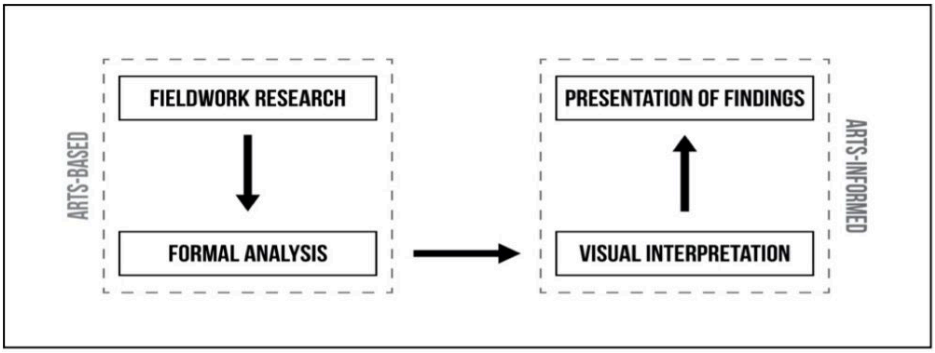

Figure 6: Visual Research Model, extracted from Leong, et.al (2019)

More than 5,000 visual data consisting of photos, drawings, and videos were collected from two visits to Pa' Lungan, Bario. These data were then analyzed visually to determine potential photos for analytical representation and subsequent findings. The visual analysis conducted focused on filtering out unwanted images by analyzing the visual content and overall visual performance; images that do not meet the standard will be deleted. Visual data were also divided into their own categories. The visual data collected were compiled and edited using graphics or design software such as Adobe Photoshop, Illustrator, Premiere, and After Effect. The data were documented and analyzed digitally so that they can be subsequently launched using Augmented Reality applications. Through a visual analysis method, researchers focused on megalithic structures whose shapes are digitally redrawn, edited, and reconstructed by separating each slab. The selected monument photos were filtered and traced from the background of the image, and then each boulder display was visualized according to the traced outline for component analysis (see Figure 7). The most difficult part of this procedure is transferring the carving drawing from stone to digital form, especially in ensuring the precise scale and size of the original carving.

The results of the image and video editing were developed into an Augmented Reality presentation using "AR Creative Builder". Currently, there are two forms of Augmented Reality applications, namely marker-based applications, and location-based applications. Marker-based apps use predefined markers to create Augmented Reality effects on overlapping images. Meanwhile, location-based apps use GPS systems, acceleration, or compass information to create Augmented Reality effects on objects. This project applied the marker-based applications based on image recognition as a trigger to view Augmented Reality content. For this purpose, smartphones were used, especially those with digital vision, as well as cameras and AI software to detect images that can be expanded with video, animation, audio, and other presentations.

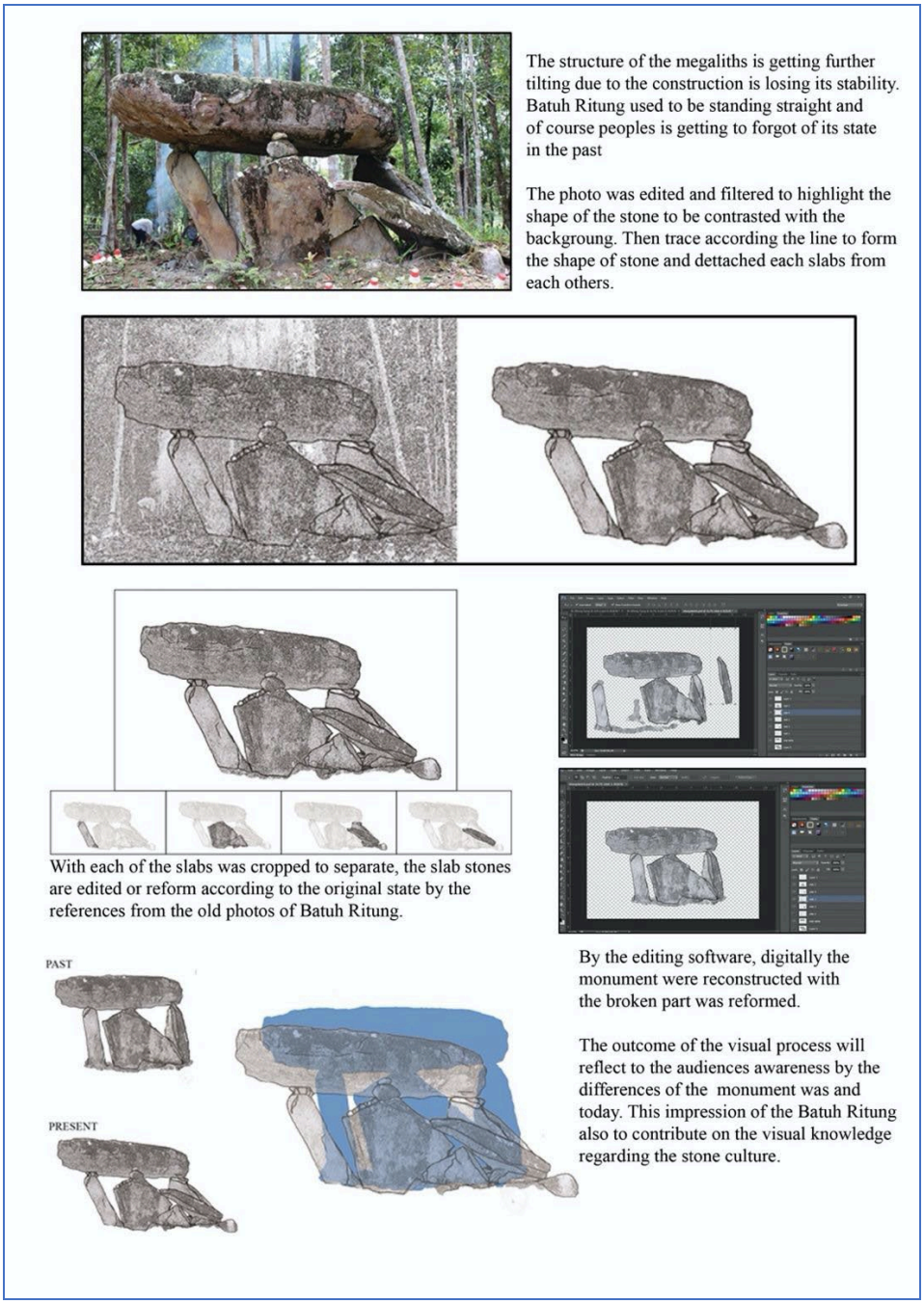

Figure 7: Batuh Ritung analysis process

For the design, the focus was to design the ID-MAP to be more user-friendly and easily accessible. This includes completing all Augmented Reality-related data mainly in the context of video editing and artistic images. The design division also focused on the construction of a tourist information center at Pa' Lungan to serve as a platform for ID-MAP. Simultaneously, for the purpose of producing an interactive offline system, a mobile Apps software (computer software developed to perform a set of coordinated functions, tasks, or activities) has been developed so that data for Augmented Reality applications can be downloaded by using another custom-made product which is specially designed for transmitting information offline using Wi-Fi technology.

The construction of a tourism information center served as a prototype for assessing the project's efficacy. The actual construction of the tourist information center is planned based on several aspects, including design, materials, and size to minimize the cost. As a result, this information center was constructed utilizing materials that are easily acquired from the environment, such as wood from the forest, and the power source for ID-MAP will be provided by solar energy. Given the location of Pa' Lungan in the interior of the Borneo Highlands, the construction and labor expenses have also completely exploited the villagers' labor force. Finally, in the tourist information center, a set of interactive posters with an offline Augmented Reality system were installed for the benefit of Pa' Lungan residents to promote their interesting places.

RESULTS

Early Outcomes

In the early stages, several interactive posters were produced to test the effectiveness of the Augmented Reality application in conveying information. The posters were used as a medium of delivery through an interactive exhibition entitled 'Megalith Cultures through Time and Space,' held at Teripun/Kelabit Community Museum, in conjunction with the 13th Nukenen Festival 2018, in Bario. A total of three panels, featuring information and photos including a 7ft digital vector of Batuh Ritung, were exhibited to the public (Figure 8). Brief information, such as the location and the physical characteristics of the rock, was explained in this panel poster (Figures 9a & 9b). The purpose of the exhibition was to share research findings on megaliths with the local communities and to obtain feedback from local communities and visitors. The exhibition established a dialogue between researchers and the public, and at the same time allowed researchers to reveal things beyond the scope of hypothesis through the eyes of the public. An important feature of this exhibition was the simultaneous use of Augmented Reality, in which multiple layers of multimedia content such as

video, animated graphics, and sound are embedded to enhance the user experience and allow visitors to watch lifelike still images. The use of information and communication technology (ICT) can be another method in anthropology and cultural studies to accurately understand the performance of cultural practices and well-documented heritage.

Figure 8: Part of 'Megalith Cultures through Time and Space' Exhibition at Teripun Museum, Bario, 2018.

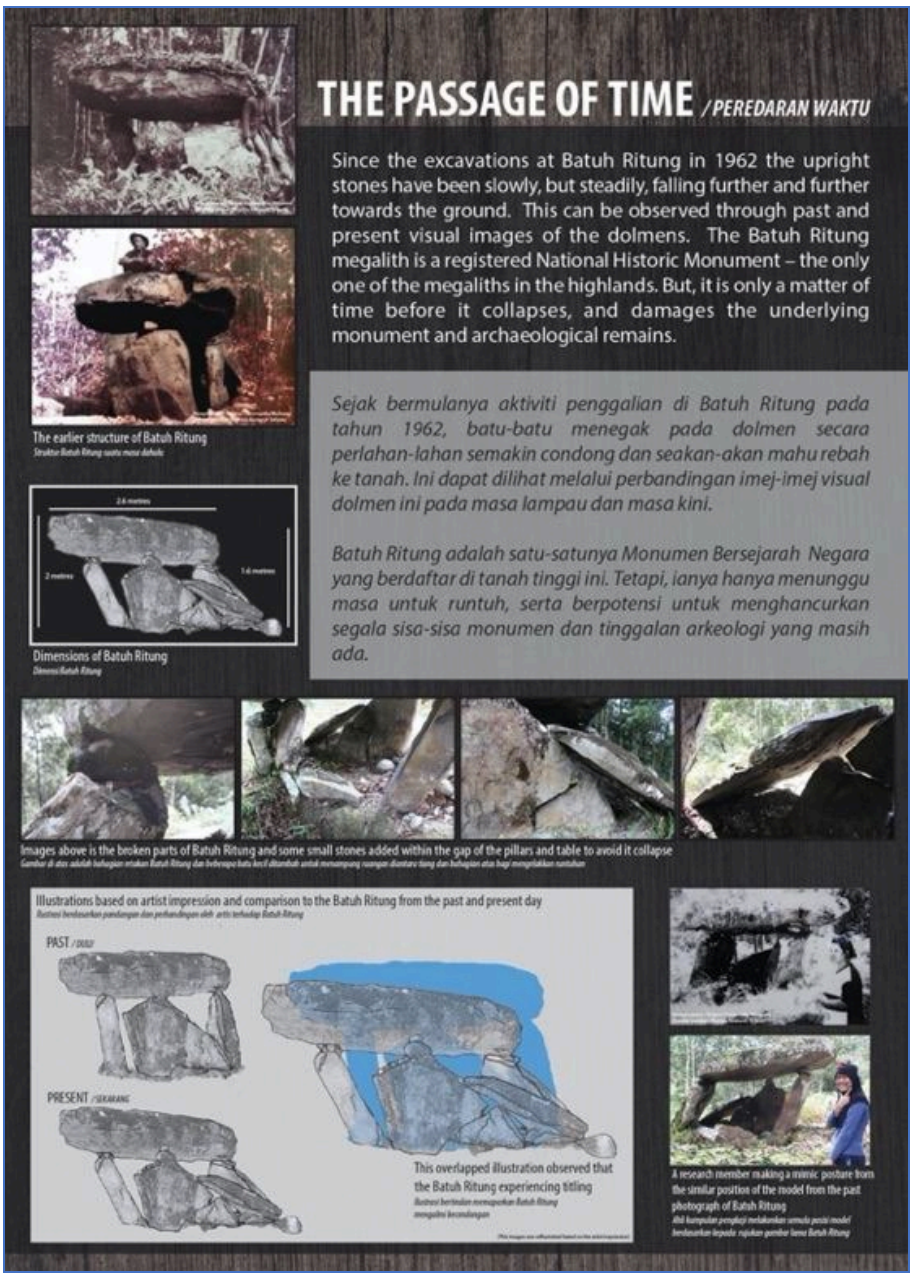

Figure 9a: Among the posters related to *Batuh Ritung* that have been displayed through the exhibition

Figure 9b: Among the posters related to *Batuh Ritung* that have been displayed through the exhibition

Interactive Digital Map (ID-MAP)

After the success of the exhibition, information related to this megalith was used as the main content to complete the ID-MAP. Based on the data collection and analysis, two versions or prototypes of the ID-MAP were designed and constructed for this project (Figures 10a & 10b). ID-MAP implemented digital and multimedia technology with innovative and creative visual art approaches in assisting the development of the rural tourism sector in areas with limited online connections. It is a highly informative digital map using digital mapping and Augmented Reality to illustrate the location of local tourist attractions, available public facilities, prominent landmarks, as well as the means of locating the locality of each house in the village. The retrieval of the desired information is made possible with the usage of smartphones equipped with selected Augmented Reality Apps, besides providing artistic images captured from different artistic angles and visual documentation equipment such as drones, DSLR, and action-cam. Data security is also ensured by this method because it can only be accessible in a limited area and cannot be viewed online. As a result, data control can only be performed internally and by responsible parties.

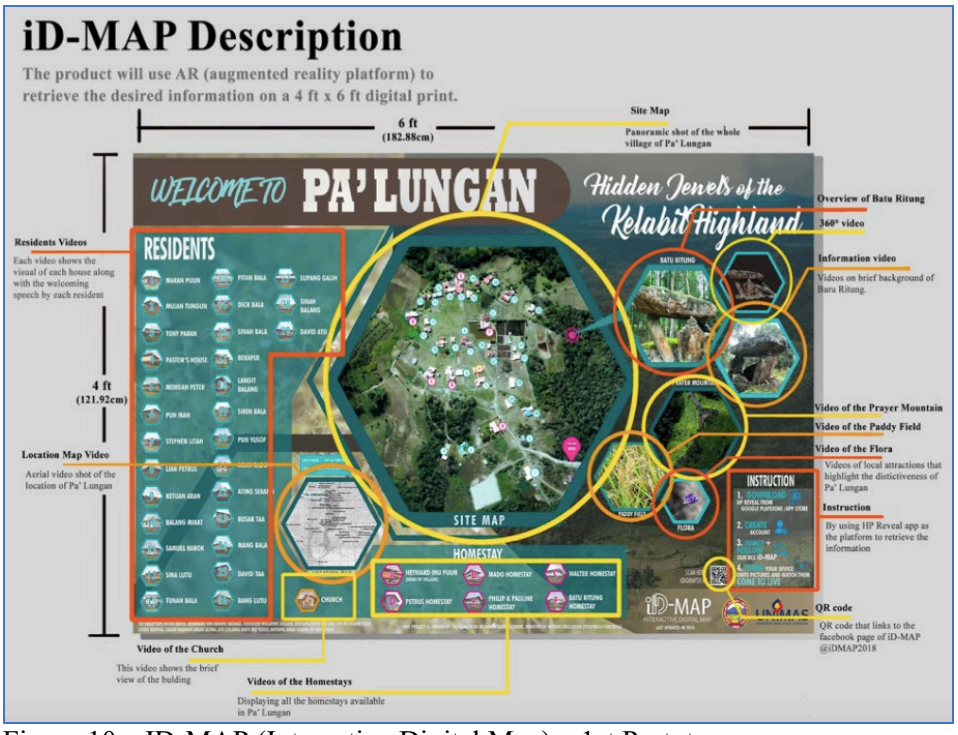

Figure 10a: ID-MAP (Interactive Digital Map) – 1st Prototype

Figure 10b: ID-MAP (Interactive Digital Map) – 2nd Prototype

The design also implemented a mobile Augmented Reality browser system where different computational tasks are performed at each level. The learning and offline identification process will go through an offline Augmented Reality server. Apart from target tracking, user positioning, and information delivery can also be done on smartphones through data exchange and processing on both sides. Thus, the hybrid interaction experience between humans and computers can be communicated to users through smartphone platforms and Augmented Reality. To ensure a balance between the relatively limited mobile data processing capabilities in ID-MAP and fast data transfer, the data exchange between the smart device and the Augmented Reality server will be performed via an internal wireless network, which is provided by the Offline System Set boxes. This app is complemented with the ID-MAP visual display so that the process of delivering information becomes more effective by downloading the apps via smartphone without needing access to the internet (Figure 11).

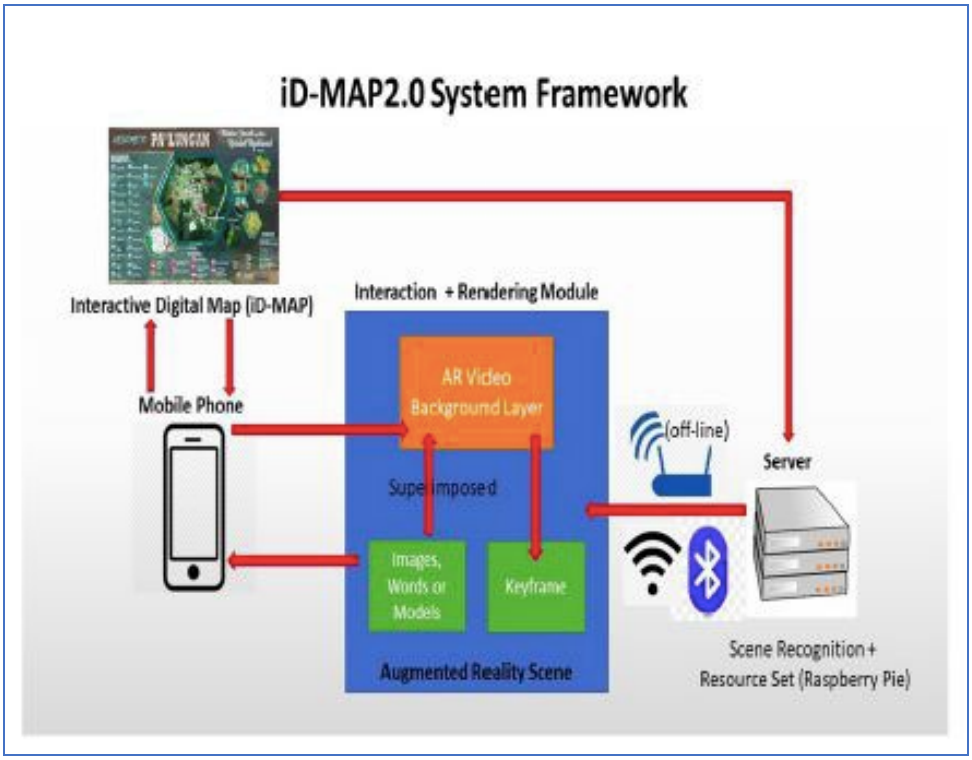

Figure 11: ID-MAP System Framework

This invention discloses the installation and techniques for augmented reality offline systems in the development of rural tourism. The assembly called ID-MAP includes an interactive digital server, an interactive digital poster, and an Android Package (APK) software. This data-saving invention will provide users with an Augmented Reality (AR) application for offline usage. ID-MAP is a highly informative digital map that employs digital mapping to locate the position of local tourist attractions, public services, notable landmarks, and the neighborhood of each house in the village. Whilst APK was developed in correlation with an offline AR server to handle the process of information dissemination and offline identification. The present invention provides a new means of establishing the feasibility of tourist attractions based on the digital and interactive multimedia system for developing a Smart Village concept.

Tourist Information Centre

Despite a slight delay owing to the Covid-19 outbreak, the entire ID-MAP system has been completed and deployed, along with a series of interactive posters displayed in an information center developed via the participation of villagers and researchers. Inside the Tourist Information Center, eight posters measuring 32 x 60 inches and one interactive poster spanning 68 x 60 inches were displayed, as well as a set of Offline System Set boxes (Figure 12) consisting of connectors, routers, minicomputers, controllers, and batteries that function as a medium for disseminating information offline. This prototype is powered by solar energy and does not need to be monitored because it operates autonomously. A number of tests have also been performed to verify that all technological systems are operational prior to the opening ceremony. Each panel on the external facade of this structure is decorated with mural paintings of Kelabit figures from Pa' Lungan (Figure 13). This painting may pique the curiosity of tourists, prompting them to snap photographs, and this structure may serve as a new landmark in Pa' Lungan. On August 6, 2022, a successful launch ceremony was held and officiated by Datuk Gerawat Gala, Mulu N78 assemblyman and also Deputy Minister in the Sarawak Premier's Department (Labour, Immigration, and Project Monitoring) (Figure 14). This Tourist Information Center was then renamed Lepo Mare Kaleh, which means ‘Village Information Center’ in Kelabit (Figure 15a & 15b).

Next, the villagers participated in a short workshop on August 7, 2022, which served as a knowledge transfer session (Figure 16). More than 30 people, primarily homestay and tour guides, attended this program. This session demonstrated how to use the ID-MAP and how to update information using the current system. Overall, although it was initially difficult for the locals to use ID-MAP, following explanation and practice, they have embraced it well and acknowledged that this technology will help them communicate with visitors more efficiently.

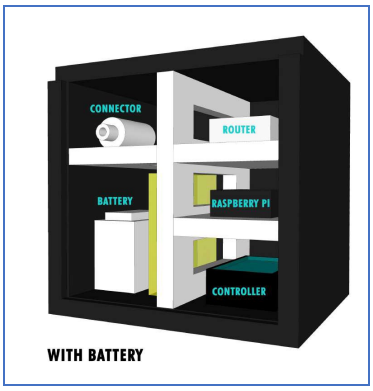

Figure 12: Offline System set box.

Figure 13: Mural painting process on the external façade of the Tourist Information Centre / Lepo Mare Kaleh.

Figure 14a: Poster installation inside Tourist Information Centre / *Lepo Mare Kaleh.*

Figure 14b: External view of the Tourist Information Centre / Lepo Mare Kaleh.

Figure 15: The inauguration of ID-MAP and Lepo Mare Kaleh on 6 August 2022 by the representative of the N78 Mulu assemblyman, Datuk Gerawat Gala.

Figure 16: Knowledge transfer session with residents of Pa' Lungan on 7 August 2022.

DISCUSSION

Referring to Datuk Gerawat's speech during the ID-MAP opening ceremony in Pa' Lungan, the digital approach used in this initiative has eased the role of tour guides and homestay owners in marketing fascinating spots in Pa' Lungan. This viewpoint is also shared by Mr. Heyward Inu Puun, the Head Village of Pa' Lungan. They may accompany tourists to Lepo Mare Kaleh and share information based on short documentary videos through smartphones and interactive posters (Figure 17). Datuk Gerawat added that this project should be expanded to other villages, and the government vowed to help the project in developing tourism in Bario. The villagers also remarked during the short workshop that this facility helps them a lot in promoting visitors who come to their village since all the information is available by just downloading the information on a smartphone without the need for the internet.

Figure 17: ID-MAP- Sharing information offline system through smartphones and interactive posters.

Apart from the previously indicated usage to promote rural tourism, ID-MAP may be utilized in a variety of ways. As part of community service, ID-MAP can also be used to empower tourist attractions that are either already established or still new. In short, ID-MAP helps provide a new experience for visitors and tourism-related industries in general. This improved service will, in turn, be able to boost the business industry in the tourist destination. Among the unique features of ID-MAP are:

1. As cultural information points - The use of ID-MAP in selected tourist locations facilitates the public to choose the services provided, in addition to highlighting interesting places and diversifying information related to tourism. Information shared through Augmented Reality can include cultural works as well as other interesting facts to share. The display can also be used as a platform to educate visitors about the tourist area.
2. Direction - The use of ID-MAP makes it easy for visitors to navigate rural areas and tourist attractions. In addition to showing directions to visitors to places they want to visit, ID-MAP can be used as a platform to promote certain destinations such as shops and community centers. It can

be customized based on the use of pictures or suggest nearby landmarks and other places of interest that are easily recognizable by tourists.

3. Local Information Sharing - ID-MAP can also be used for local business advertising and services. This platform can help attract visitors better than printed posters or brochures. Local tour operators can use ID-MAP to advertise certain special offers and sales. While organizing business activities or exhibitions this platform can be used to reach tourists to share contact information and their address, opening hours, prices, and so on. All this can help channel the flow of income through tourism to the whole community.
4. Augmented Reality - ID-MAP is accompanied by an Augmented Reality feature to give an audience an interactive visual experience.
5. Offline networking system - An application system has been developed and equipped with a unique offline system to facilitate the process of downloading information without internet access.
6. User-friendly information update method - The app software update method is designed to be user-friendly and can be handled by villagers with just a little bit of training. Villagers will be given the training to update their village information from time to time without the need for professional assistance.
7. Landmark - The existence of ID-MAP combined with the Tourist Information Center can be used as a landmark and increase the visibility of the village among tourists.
8. Modular Content - The contents of the ID-MAP are modular in nature and can be customized according to the customer's requirements or space requirements.

In addition to being implemented in rural areas for the tourism sector, ID-MAP can also be used as an alternative for exhibitions where digital information is provided without the need for internet access. This product has the potential to be implemented and commercialized in conjunction with tourism, cultural, art, and heritage parties such as the Ministry of Tourism, local government bodies, community attractions centers, homestay operators, and travel agencies. By using contemporary Visual Representation of Art, Culture, and Heritage in Sarawak, the system not only provides a new means of establishing an iconic platform but also verifies the feasibility of tourist attractions based on the digital and interactive multimedia system in developing a Smart Village concept. This acts as a response toward supporting the key economic sectors within the Digital Economy initiatives propagated by the Government of Sarawak as part of the Industrial Revolution 4.0. In line with government directives such as DPN 2020-2030 and DAKEN 2021, this digital system may also be utilized to promote and assist the rural tourism sector. It also fulfills the eighth Sustainable Development Goal (SDG) by supporting sustainable, inclusive, and viable economic growth

that opens new economic prospects through the promotion of local culture and heritage in Malaysia.

CONCLUSION

This product is highly beneficial as an answer to the difficulties in receiving information in areas with limited internet networks. Unlike cloud-based storage, ID-MAP information can be shared locally and downloaded offline using internal data storage and Augmented Reality applications. This product may also be utilized in galleries, libraries, and schools, as it offers just information requested by users and is beneficial for providing information relevant to tourism in rural regions. The abuse of information may, therefore, be controlled, and the user can only get selected information. To sum up, to stimulate the tourist sector and inform stakeholders and academics about the future of rural tourism, this study has the possibility to open up new interdisciplinary research options and may be seen as an alternative to visual-based research. Given that Sarawak has a diverse ethnic population, the use of ID-MAP has high potential, especially in rural areas. Through the support of the government in applying digital technology to state development, the market for ID-MAP has been further widened. Therefore, through the applications based on art, culture, and heritage available in Pa' Lungan, ID-MAP not only creates an alternative information platform but also introduces a new method to attract tourists based on interactive multimedia and digital systems, especially in developing the Smart Village concept. This is also in line with the implementation of key economic sectors by the government in the Digital Economy initiative towards the achievement of the Sustainable Development Goals (SDGs) at the regional level.

REFERENCES

Adeyinka-Ojo, S. (2020). Developing a Rural Tourism Destination Brand Framework from the Perspective of a Relationship-Based Approach. In Tourism. IntechOpen.

Almeshqab, F., & Ustun, T. S. (2019). Lessons learned from rural electrification initiatives in developing countries: Insights for technical, social, financial and public policy aspects. Renewable and Sustainable Energy Reviews, 102, 35-53.

Chia, S. K. S., Lo, M. C., Razak, Z. B., Wang, Y. C., & Mohamad, A. A. (2021). Impact of destination image on tourist satisfaction: the moderating effect of Information Technology (IT). Geo Journal of Tourism and Geosites, 34(1), 88-93.

Chin, C. H., Law, F. Y., Lo, M. C., & Ramayah, T. (2018). The impact of accessibility quality and accommodation quality on tourists' satisfaction and revisit intention to rural tourism destination in Sarawak: the moderating role of local communities' attitude. Global Business and Management Research, 10(2), 115-127.

Correa, T., Pavez, I., & Contreras, J. (2017). Beyond access: A relational and resource-based model of household Internet adoption in isolated communities. Telecommunications Policy, 41(9), 757-768.

de la Peña, M. R., Núñez-Serrano, J. A., Turrión, J., & Velázquez, F. J. (2019). A new tool for the analysis of the international competitiveness of tourist destinations based on performance. Journal of Travel Research, 58(2), 207-223.

de Souza, J., Mendes-Filho, L., & Buhalis, D. (2020). Evaluating the effectiveness of tourist advertising to improve the competitiveness of destinations. Tourism Economics, 26(6), 1001-1020.

Di Pietro, L., Guglielmetti Mugion, R., & Renzi, M. F. (2018). Heritage and identity: technology, values, and visitor experiences. Journal of Heritage Tourism, 13 (2), 97-103

Duxbury, N., & Richards, G. (2019). Towards a research agenda for creative tourism: Developments, diversity, and dynamics. Research Agenda for Creative Tourism. Edward Elgar Publishing.

Erdiaw-Kwasie, M. O., & Alam, K. (2016). Towards understanding digital divide in rural partnerships and development: A framework and evidence from rural Australia. Journal of Rural Studies, 43, 214-224.

Gazzola, P., Pavione, E., Grechi, D., & Ossola, P. (2018). Cycle Tourism as a Driver for the Sustainable Development of Little-Known or Remote Territories: The Experience of the Apennine Regions of Northern Italy. Sustainability, 10(6), 1863. https://doi.org/10.3390/su10061863

Gómez-Vega, M., & Picazo-Tadeo, A. J. (2019). Ranking world tourist destinations with a composite indicator of competitiveness: To weigh or not to weigh? Tourism Management, 72, 281-291.

Haigh, M. (2020). Cultural tourism policy in developing regions: The case of Sarawak, Malaysia. Tourism Management, 81, 104166

Harris, R. W. (2009). Tourism in Bario, Sarawak, Malaysia: A case study of pro-poor community-based tourism integrated into community development. Asia Pacific Journal of Tourism Research, 14(2), 125-135.

Hitchner, S. L., Apu, F. L., Tarawe, L., Galih@ Sinah Nabun Aran, S., & Yesaya, E. (2009). Community-based transboundary ecotourism in the Heart of Borneo: A case study of the Kelabit Highlands of Malaysia and the Kerayan Highlands of Indonesia. Journal of Ecotourism, 8(2), 193-213.

Jain, P., Manweiler, J., & Roy Choudhury, R. (2015). Overlay: Practical mobile augmented reality. In Proceedings of the 13th Annual International Conference on Mobile Systems, Applications, and Services, 331-344.

Janowski, M. (2012). Imagining the forces of life and the cosmos in the Kelabit Highlands, Sarawak. Imagining Landscapes, Past, Present and Future, 143-164.

Kastenholz, E., Eusébio, C., & Carneiro, M. J. (2018). Segmenting the rural tourist market by sustainable travel behaviour: Insights from village visitors in Portugal. Journal of Destination Marketing & Management, 10, 132-142.

Kresic, D., & Gjurasic, M. (2022). Slow Tourism as an Immersive Travel Experience: A Bibliometric Analysis. Academica Turistica-Tourism and Innovation Journal, 15(3).

Lembani, R., Gunter, A., Breines, M., & Dalu, M. T. B. (2020). The same course, different access: the digital divide between urban and rural distance education students in South Africa. Journal of Geography in Higher Education, 44(1), 70-84.

Leong, S. N. A., Rafee, Y. M., Maying, D., Siri, H., bin Awang Arshad, A. H., & Jussem, S. W. (2019). Kolb's Experiential Learning Model as a Conceptual Framework for Visual Research in Rural Tourism Sites: Batuh Narit Arur Bilit as a Case Study. International Journal of Business and Society, 20(3), 1149-1159.

Llerena, J., Andina, M., & Grijalva, J. (2018). Mobile application to promote the Malecón 2000 tourism using augmented reality and geolocation. In 2018 International Conference on Information Systems and Computer Science (INCISCOS) (pp. 213-220). IEEE.

Lo, M. C., Mohamad, A. A., Songan, P., & Yeo, A. W. (2012). Positioning rural tourism: Perspectives from the local communities. International Journal of Trade, Economics and Finance, 3(1), 59.

MacLeod, N. (2017). The role of trails in the creation of tourist space. Journal of Heritage Tourism, 12(5), 423-430.

Marian, I. (2017). Rural tourism and agro-tourism in Romania, "Ovidius" University Annals, Economic Sciences Series, 17(2), 226-231.

Maying, D., Rafee, Y. M., Leong, S. N. A., Arshad, A. H. A., Siri, H., Jussem, S.W., ... & Bala, P. (2019). The Effectiveness of Visual Research In Enhancing The Cultural Knowledge and Practices In Creative Industry. International Journal of Business & Society, 20(2).

Metcalf, P. (2006). The forest, source of life: the Kelabit of Sarawak. Journal of the Royal Anthropological Institute, vol. 12, no. 2, p. 483.

Onitsuka, K., Hidayat, A. R. T., & Huang, W. (2018). Challenges for the next level of digital divide in rural Indonesian communities. The Electronic Journal of Information Systems in Developing Countries, 84(2), e12021.

Philip, L., & Williams, F. (2019). Remote rural home-based businesses and digital inequalities: Understanding needs and expectations in a digitally underserved community. Journal of Rural Studies, 68, 306-318.

Puah, C. H., Jong, M. C., & Arip, M. A. (2019). Determinants of tourism demand in Sarawak: An Augmented Gravity Model. In International Conference on Economics (Vol. 2019, pp. 150-157).

Roberts, E., Beel, D., Philip, L., & Townsend, L. (2017). Rural resilience in a digital society. Journal of Rural Studies, 54, 355-359.

Solima, L. (2014). Digital resources and approaches adopted by user-centred museums: The growing impact of the internet and social media. In L. Aiello (Ed.), Management of cultural products: E-relationship marketing and accessibility perspective (pp. 181–199). London: IGI Global.

Suwana, F. (2017). Empowering Indonesian women through building digital media literacy. Kasetsart Journal of Social Sciences, 38(3), 212-217

Tabassum, G., Kulathuramaiyer, N., Harris, R., Yeo, A.W. (2017). True Value of Telecentre Contribution to Bario Community Development. In: Choudrie, J., Islam, M., Wahid, F., Bass, J., Priyatma, J. (eds) Information and Communication Technologies for Development. ICT4D 2017. IFIP Advances in Information and Communication Technology, vol 504. Springer, Cham. https://doi.org/10.1007/978-3-319-59111-7_52

Vong, W. T., Kong, M. L., Lai, C. C., Then, P. H., & Teo, T. H. (2017). Investigating the roles of knowledge management practices in empowering rural youth to bridge the digital divide in rural Sarawak. Journal of Integrated Design and Process Science, 21(1), 61-79.

Zielinski, S., Jeong, Y., Kim, S. I., & B Milanés, C. (2020). Why community-based tourism and rural tourism in developing and developed nations are treated differently? A review. Sustainability, 12(15), 5938.