Contents lists available at www.journal.unipdu.ac.id

# Register

Journal Page is available to www.journal.unipdu.ac.id/index.php/register

Research article

# Development of GWIDO: An Augmented Reality-based Mobile Application for Historical Tourism

*Faisal Akbar [a*], Hadiyanto Hadiyanto [b], Catur Edi Widodo [c]*

[a,b,c] *Doctoral Program of Information System, School of Postgraduate Studies, Diponegoro University, Semarang, 50275, Indonesia*
[a] *Department of Informatics Engineering, Sekolah Tinggi Ilmu Komputer Poltek Cirebon, Cirebon, 45114, Indonesia*
email: [a*] *faisal.akbar@stikompoltek.ac.id*, [b] *hadiyanto@live.undip.ac.id*, [c] *catur.ediwidodo@gmail.com*
* Correspondence

## ARTICLE INFO

## ABSTRACT

This research aimed to design and reconstruct a business model for an augmented reality (AR) camera mobile application for historical tourism at Keraton Kasepuhan Cirebon. The goal was to utilize AR technology to provide an immersive and informative experience for tourists. The research addressed several main problems, including navigation and historical information through object tracking, by implementing an online application with features such as Indonesian and English language instructions to better serve domestic and foreign tourists. The research also aimed to investigate the benefits of using AR technology for object tracking and navigation and to explore how these aspects could be related to creating a formula that supports each other in addressing the formulated problems. Through the development of the GWIDO application, a positive impact on the development of historical tourist attractions was observed. This can be seen from the usefulness of its features such as AR navigation, which can be used as a virtual guide. The data collected was used to design and reconstruct the business model, which was implemented and tested to collect additional data for analysis. The final results of the research showed that the AR camera mobile application was effective in providing an immersive and informative experience for tourists. The redesigned business model improved the utilization of AR technology in the tourism industry. Based on the test results, the average response time for object distance between 0.1 meters to 0.5 meters was between 1.45 to 2.07 seconds, and the average time for object distance from visitors was between 3.15 to 4.71 seconds with a confidence level of 95%. Meanwhile, testing for navigation features using augmented reality is very dependent on the internet signal used on the user's device. The level of accuracy of objects that have been placed at certain coordinates is determined by how well the internet network performs, allowing objects to appear precisely according to their coordinates.

## 1. Introduction

Historical tourism sites are often considered key landmarks with high intrinsic value in a region. However, these sites have historically been perceived as monotonous and lacking in variety, leading to waning interest among tourists. In addition, the lack of adequate information also negatively impacts the popularity of historical tourism sites. This is compounded by insufficient supporting infrastructure and a limited number of tour guides with international language skills, who serve as a knowledge base for the area's history. Such guides should ideally add historical value to attract more tourists. This notion underscores the need for these sites to possess a unique allure, serving as a 'magnet' for an area to be visited by tourists [1]. Something that has a significant impact on many industries, especially in the tourism sector, to change tourist behavior includes policy-making, information search, and [2] transforming traditional business procedures and changing the value of connectivity.

In response to the increasing use and impact of technology in the tourism sector, several studies, [3], [4], have begun to explore the changes that have been introduced into all aspects of the tourist experience, such as the use of idle time, documentation, and sharing experiences [5]. The increased use of mobile devices and Web 2.0 has created new opportunities for tourism organizations to engage, invite, and interact with tourists. The unique characteristics of mobile technology, namely ubiquity (easily found anywhere), flexibility, personalization, and dissemination, make it a useful and beneficial tool for both tourism providers and consumers. Therefore, [6] and [7] explain that tourism organizations have started to look for new ways to enhance the tourist experience and provide added value services [8], as well as create an enriched experience with new, different, and unique things [9] [10].

Our analysis and synthesis identified 190 scientific publications with the primary theme of augmented reality for e-tourism as the findings of the main data. The findings indicate that, since 2017, the research trend has accelerated. Fig. 1 illustrates the distribution of the gathered articles released annually, beginning in 2019. The research was conducted by tallying and characterizing the published articles based on the year of publication. According to our research, there has been a yearly increase in the conversation around augmented reality and e-tourism from 2019 to 2023. There are many different study topics related to augmented reality; nevertheless, there hasn't been much in-depth discussion of this topic in relation to e-tourism. While some of the information we located still addresses augmented reality technologies in general, it is still pertinent to the subject of the discussion. There was a notable rise following the COVID-19 pandemic in 2019 and 2020. This indicates that scientists are working very hard and seriously to keep publishing the findings of their studies. This demonstrates that this subject has become highly intriguing to investigate over the past five years, and scholars are taking the topic seriously to make it easily implementable in the future. Since we have carefully chosen the gathered papers to ensure their correctness and relevance, we may declare this result to be a discovery. International conference papers are of low quality and consist solely of concepts that have not been established as true or correct, so we do not consider them among the papers that need to be examined. We only examine scientific papers that have been published in globally renowned journals with an SRJ (SCImago Journal Rank) of at least 0.4 and regularly publish the highest caliber research findings.
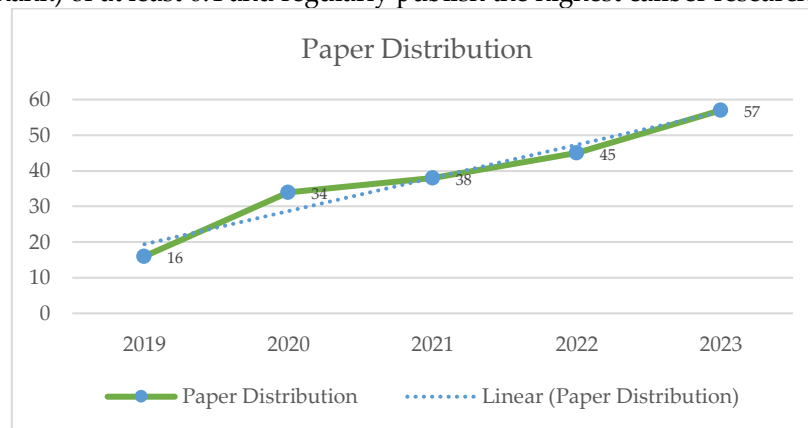


Fig. 1. Paper Distribution

The use of technology, especially augmented reality [11] represents a breakthrough that the author aims to implement to address the needs of managers in promoting or introducing historical tourism areas. To operate the AR functionalities, the Vuforia framework, a computer vision module enabling the creation of interactive experiences and offering various resources related to AR [12], was utilized to enhance the number of tourist visits and provide tourists with necessary information about historical tourism objects. This solution tackles an intriguing problem in E-Tourism business process modeling: making historical tourism objects more engaging and appealing to visit. Additionally, the use of multimedia resources developed in AR [13] [14] allows for the assimilation of abstract and complex concepts, facilitating the understanding of educational content. The benefits of AR technology in education are numerous, including cost-effectiveness, safety, and environmental friendliness [15][16][17]. The use of virtual environments eliminates the costs and hazards associated with physical equipment and activities, while still providing hands-on learning experiences. This technology helps reduce environmental impact, as students only interact with simulations, instead of real-world

materials that may cause harm. One of the advantages of Augmented Reality (AR) technology is its versatility in providing multimedia resources [18][19], allowing students to learn through interactive videos, animations, and other engaging media. This is particularly beneficial in educational settings, as it enhances the teaching and learning process in a wide range of subject areas such as electricity, fluid dynamics, electromagnetism, and more. AR also allows for portability between different devices, making it more accessible. Furthermore, the usage of multimedia resources in education aligns with the multimedia learning theory [20], which suggests that learners retain and understand information better when presented with a combination of words and images. Therefore, the use of multimedia resources in AR enhances student comprehension and the overall learning experience [24].

An inaccurate business process model, encompassing services, applications, infrastructure, and policies, leads to a lack of information dissemination to the wider community and various other problems within these fields. To address this, the authors propose creating a business process model that emphasizes synergy or technological integration through augmented reality in the management of historical tourism areas [21] implemented through a mobile application called GWIDO. Based on these characteristics, [22] augmented reality is superior because of its ability to create richer and deeper content and enhance our interactions and perceptions with the world around us. GWIDO is a mobile application with several features, including multi-language support, AR object recognition, AR navigation, an activity calendar for the year, and historical information about Keraton Kasepuhan Cirebon.

Based on a review of several business models from related research, it is evident that the implementation in the writer's research will refine previous business models, especially in the tourism field, to create an ideal model applicable to tourism sites, particularly historical sites rich in heritage and cultural value. The novelty of this research lies in the design and reconstruction of the Augmented Reality business model applied in the Geevor Museum. This new model is expected to enhance the utilization of technology, especially Augmented Reality, in providing information systems for the digitalization of business processes. Furthermore, AR supports the comprehension of complex phenomena by offering unique visual and interactive experiences that combine real and virtual information [23].

A gap analysis was conducted between research on the use of AR camera mobile applications for historical tourism at Keraton Kasepuhan Cirebon and several studies related to business models, e-tourism marketing, navigation with AR, service experiences in AR, and the usage of AR in the tourism industry. This analysis, combined with information from the research on the AR camera mobile application at Keraton Kasepuhan Cirebon, aims to enhance existing business models for AR technology in the tourism industry, particularly in the field of historical tourism.

Based on the literature review [32], this research has taken a positive step towards increasing the value of historical tourism sites. It emphasizes the importance of a knowledge base on these tourist attractions, which can be leveraged by offering a business model based on knowledge transfer innovation. However, there are shortcomings in this business model that need to be addressed, specifically in packaging the knowledge base attractively and flexibly to reach a wider audience. This can be achieved through the creation of a comprehensive, multilingual knowledge base, which the author intends to develop in this research [32]. Another literature review, "Role of Information Technology in the Development of E-Tourism Marketing: a Contextual Suggestion," highlights the positive impact of information technology on marketing activities in the e-tourism concept. Marketing efforts can be enhanced through the use of technology. Therefore, the authors are interested in leveraging these advantages to target specific tourism objects, particularly historical tourism. There is an opportunity to capitalize on Augmented Reality technology to enhance marketing efforts in e-tourism, which integrates tourism with technology. This can result in an application product that supports the business models of historical tourism objects [33].

The author also reviews a study [34] which utilizes Augmented Reality technology as navigation for visiting tourists [34]. This research identifies a gap that can be addressed by combining Augmented Reality technology's capabilities for navigation and visualizing historical objects in 3D. Furthermore, the implementation of technology in the tourism sector aligns with its continuous development, as described in the research titled "Delineating The Role of Mood Maintenance in Augmented Reality (AR)

**15**
F. Akbar, et.al
regist. j. ilm. teknol. sist. inf.
ISSN 2502-3357 (online) | ISSN 2503-0477 (print)
10 (1) January 2024 12-30

Service Experiences: an Application in Tourism." This study emphasizes that while Augmented Reality-based applications in tourism improve services for tourists, maintaining emotional attachment is crucial. Tourism sites should consider and organize services after tourists visit to leave a positive impression, which can indirectly encourage organic marketing through word-of-mouth [35]. The use of Augmented Reality technology in the tourism industry shows a positive trend, as evidenced in the research titled "A Contextualized Study of The Usage of Augmented Reality Technology in the Tourism Industry." This technology offers numerous benefits, including increased user interaction, which is particularly suitable for the tourism industry. The industry needs unique selling points to provide a different tourist experience and leave a positive impression on every tourist. This trend also aligns with social impact, as Augmented Reality technology can facilitate various needs more widely and with less effort [36].

Based on the gap analysis, it may be recommended that the research on the AR camera mobile application at Keraton Kasepuhan Cirebon considers modeling a business process that utilizes application-based technology to package a knowledge base in multiple languages. This approach could help reach a wider audience of potential tourists in an interesting way through Augmented Reality (AR) technology, which is used as a navigation feature and visualization of historical objects in 3D. This research aims to address previous challenges that only utilized the concept of e-tourism in the tourism industry in general. Instead, it aims to prove the concept of e-tourism can be implemented in the historical tourism sector, which has different challenges compared to previous research. The research was conducted with the aim of encouraging organic marketing by managing it properly after the application is used, through ongoing maintenance to maintain the service's additional selling value. This approach is supported by previous research that has proven the positive impact of using Augmented Reality technology in the tourism industry. Therefore, the authors are interested in continuing this trend in a more specific sector, namely the historical tourism industry, by creating informative and interactive mobile applications to support an e-tourism-based business model.

Based on several similar studies which have been discussed, it is apparent that previous research has identified several weaknesses. The pandemic has had a negative impact on various sectors, including the tourism sector. COVID-19 has profoundly impacted various sectors, including tourism, presenting new challenges for the tourism sector, particularly in historical tourism. These challenges have not been adequately addressed in previous studies. For instance, there is a lack of strategies on how to package historical tourist attractions to attract tourists in the post-pandemic era. Additionally, the language barrier, with local residents not proficient in international languages, has not been considered. The limited number of tour guides is another unresolved issue in dealing with the anticipated surge in the tourism sector post-pandemic. Another important aspect that has not been addressed is how to transform the publication of annual traditional activities typically carried out by historical tourist attractions into an attraction in itself. Therefore, it is crucial to create an annual activity agenda with timing adjusted to the holiday calendar. This research aims to address these challenges by creating a mobile application called GWIDO.

According to the authors, GWIDO utilizes Augmented Reality (AR) technology to address various questions and problems that have been mentioned. One of its functions is to serve as a special attraction for tourists by enabling interactive media combined with GPS for tracking and monitoring. This feature can be used to track and monitor the location and movement of 3D images shown in this AR camera application. It can be useful for AR camera apps that aim to provide features such as location-based filters or effects.

From a thorough understanding of how to integrate technology, especially augmented reality (AR), into historical tourism objects, the authors can map, focus, or create hypotheses for the next phase of this research. Mechanisms and procedures for managing historical tourism objects mediated by technology require interdisciplinary studies. This includes preparing for the formulation of content as the output of the application provided, considering management, various sources of information about historical tourism areas, service plans provided, application concepts, infrastructure adjustments, and policies. Subsequently, testing and feedback are crucial as development inputs to produce an ideal business process model.

**16**

F. Akbar, et.al                                                                     ISSN 2502-3357 (online) | ISSN 2503-0477 (print)
regist. j. ilm. teknol. sist. inf.                                                                     10 (1) January 2024 12-30

This research aims to develop a mobile application in the tourism sector using augmented reality (AR) technology, focusing on the concept of E-Tourism. The goal is to create an information and navigation system to support tourism activities. The specific objectives of this research are to evaluate a business process model based on AR technology applied through the concept of E-Tourism, to determine the significant benefits provided by AR technology in supporting a business process model in the tourism sector, to enhance the business value of tourism objects, particularly historical sites, by developing an information and navigation system as a service for stakeholders and tourists.

## 2. Materials and Methods

### 2.1. Materials

Obviously, every research is born from existing problems. In this study, problems are identified through qualitative and quantitative data analysis. The first step involves collecting qualitative and quantitative data as reference points to determine the significance of the benefits that can be derived from this research. Qualitative data is gathered through observations, interviews, and literature reviews to gather information on applied business process models, policy directions, expected targets, encountered obstacles, inhibiting factors for business development, offered business value, and related literature. On the other hand, quantitative data is collected over a specified period to analyze trends in tourist numbers, income, and tourist behavior through questionnaires. Quantitative data is then presented in statistical form to facilitate conclusions.
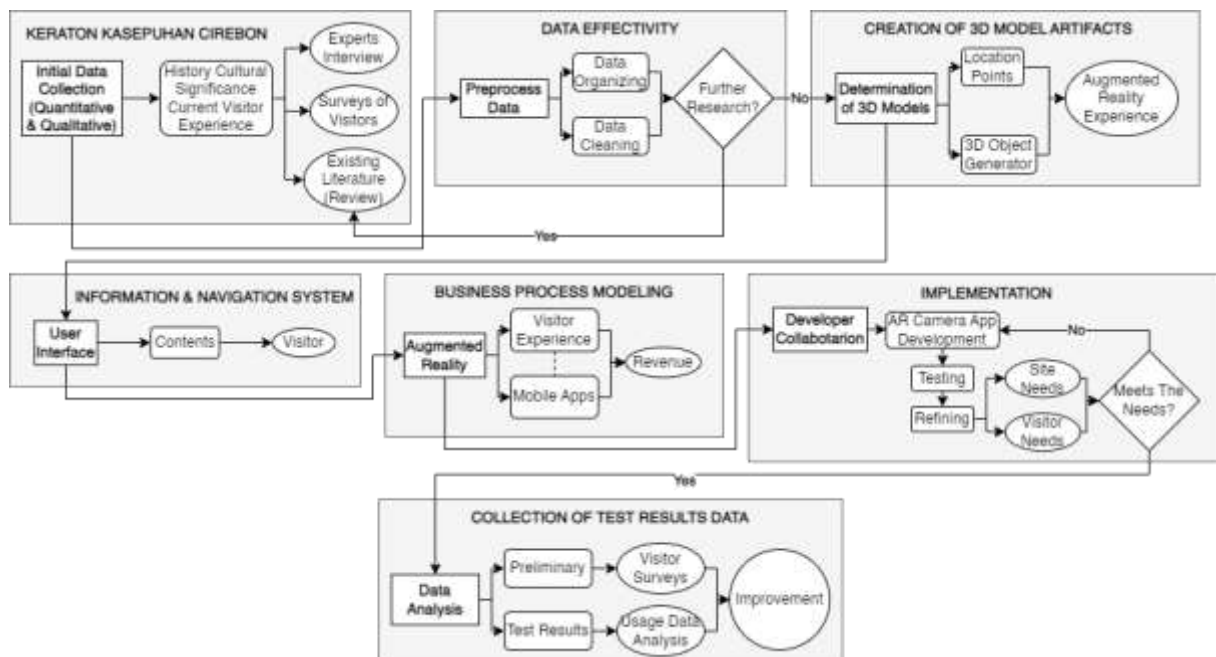


Fig. 2. Research Procedures

AR camera mobile applications have the potential to enhance the historical tourism experience at Keraton Kasepuhan Cirebon, which is a remarkable historical site in Cirebon, Indonesia. To create such an application, a thorough research procedure is detailed on this seven steps. First, the initial data collection phase involved gathering both qualitative and quantitative data about the site, including its history, cultural significance, and current visitor experience. This data was collected through interviews with experts, surveys of visitors, and reviews of existing literature. Second, once the initial data had been collected, it was preprocessed to be effectively used in the development of the AR camera application. This involved organizing and cleaning the data, as well as identifying any gaps or areas that needed further research.

Third, the next step was the creation of 3D models of the historical site artifacts and its key features. These models were used to create location points and 3D object generator patterns, which triggered the AR experiences within the application. And the fourth, after determining the location points and 3D object generator patterns, the design of the information and navigation systems began. This involved creating the user interface and developing the content that would be displayed to visitors

when they used the AR camera application at the site. Fifth, the modeling of the business process based on augmented reality was the next step in the research procedure. This involved identifying the various ways in which the AR camera application could enhance the visitor experience and generate revenue for the site. Sixth, once the modeling results had been determined, it was time to implement them. This involved working with developers to create the actual AR camera application, as well as testing and refining it to ensure that it met the needs of the site and its visitors. Finally the seventh steps, the collection of test results data, both qualitative and quantitative, was necessary to assess the effectiveness of the AR camera application. This data was collected through surveys of visitors, interviews with experts, and analysis of usage data. The data analysis phase, both preliminary and of the test results, was critical in determining the success of the AR camera application and identifying areas for improvement.

## 2.2. Methods

Research on the development of GWIDO, an augmented reality-based mobile application for historical tourism, follows the procedures described in this section. This research method explains the problems related to the conducted research, including the time and place, as well as the procedures for developing the apps. With the significant development of technology, it is undeniable that it has a direct impact on many changes in all aspects of human life. When viewed from a business perspective, technology provides many benefits for a business to survive and develop. However, its usefulness has not been widely felt, especially in the field of tourism, especially in historical tourism objects. This is evident from the challenges faced by historical tourist attractions in the digital world.

To address the challenges previously outlined, the authors have developed a conceptual framework. This framework serves as a research method in this case study, aligning with the research objectives and outlining the factors that hinder the achievement of these objectives. By doing so, a clear solution is presented, forming a research workflow that leads to the expected final results, as depicted in Fig. 3. This approach makes the research logical, illustrating the sequence from problems to solutions and demonstrating how the issues can be resolved through the use of the mobile application developed.

Fig. 3 below illustrates several variables that hinder the business development of historical tourism objects, including conventional business process models, technological disruption, and business value. The challenge lies in enhancing the appeal of historical tourist attractions for both domestic and foreign tourists, thereby stimulating interest in visiting and increasing income from a business perspective. To address the challenges of the digital world and enhance competitiveness, the use of technology is something that cannot be avoided.

Based on the three factors that hinder the process of enhancing the attractiveness of historical tourist attractions, it is crucial to address them to support increased tourist interest in visiting. Three supporting factors serve as a medium for the evolution of historical tourism: digitalization, AR as an information and navigation system and multi-language support. These three factors are a response to the three previous inhibiting factors, as shown in Fig. 3.

The three factors that serve as the solution medium can be realized through a mobile application called GWIDO. This application addresses the challenges of the digital world by increasing income through enhanced interest from domestic and foreign tourists. It does so in an educational manner, providing historical insights as the main attraction of a historical tourist site. Additionally, it is informative, offering details about tourist attractions, such as the traditional activity calendar indicating the traditional events scheduled throughout the year, tour packages, and more. Moreover, the application is interactive, breaking away from the monotonous tourism paradigm associated with historical tourism. This interactivity is made possible through Augmented Reality technology, enabling interaction between tourists and virtual objects, such as historical relics.
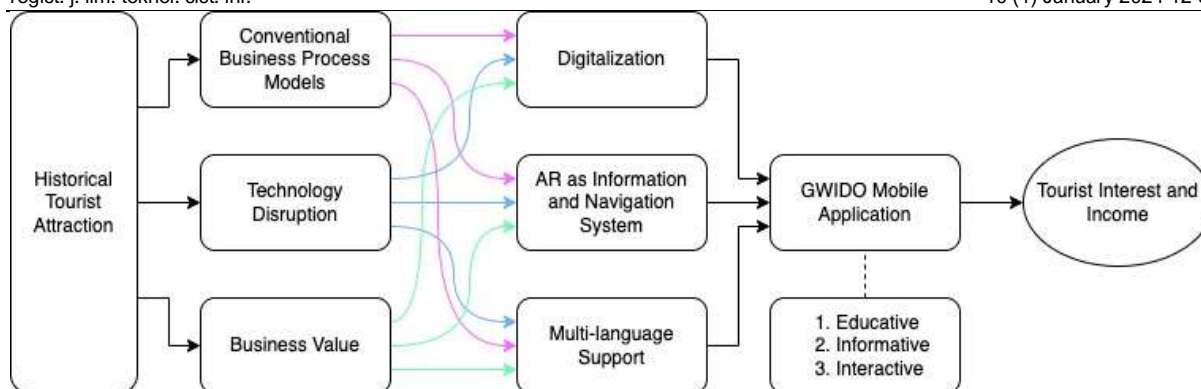
Fig. 3. Conceptual Framework

## 2.3. Technology and Architecture

Augmented reality (AR) is a rapidly evolving technology with the potential to revolutionize how we interact with our surroundings. At its core, AR overlays digital information onto the physical world in real-time. This is achieved using devices like smartphones, tablets, or head-mounted displays equipped with sensors and cameras to detect and track the user's environment. AR enhances the user's perception of reality by providing additional layers of information and context [15]. This can be in the form of visual, auditory, or haptic feedback, and can be used to create immersive and interactive experiences that engage the user in a more meaningful way. The applications of AR span various fields, including education, entertainment, industry, and medicine. In education, for example, AR can be used to create interactive learning experiences that allow students to visualize complex concepts in a more engaging way. In entertainment, AR can be used to create interactive games and experiences that bring people together in new and exciting ways. In industry, AR enhances productivity by providing real-time information and guidance to workers. In medicine, it assists in surgical procedures, training, and patient care. As AR technology advances, its impact on industries and daily life is expected to grow significantly. It has the potential to transform how we learn, play, work, and receive medical care [14]. It is evident that AR has the potential to revolutionize a wide range of industries and create new opportunities for growth and innovation. As technology continues to advance, it will be interesting to see how AR is used in the future and what impact it has on our world.

Global Positioning System location-based services (GPS LBS) represent a technology that enables users to access information and services based on their current geographical position. These services are made possible through the use of GPS technology, which is a satellite-based navigation system that can determine the precise location of a device on the Earth's surface. A key advantage of GPS LBS is its capacity to deliver location-specific information and services in real-time. This functionality finds application in diverse fields such as navigation, emergency response, location-based advertising, and location-based social networking. In the field of navigation, GPS LBS offer turn-by-turn directions to guide users to their intended destinations. This feature is particularly valuable for drivers, allowing them to concentrate on the road while receiving precise and up-to-date directions. Furthermore, GPS LBS can play a crucial role in emergency response scenarios, aiding in the localization and rescue of individuals in distress during natural disasters or missing person cases. Another significant application of GPS LBS is location-based advertising, where businesses can target their advertisements more effectively by tracking user locations. This ensures that advertisements reach the intended audience at the right moment [26]. Additionally, location-based social networking is an emerging application of GPS LBS, facilitating user connections based on shared locations. Overall, GPS location-based services represent a pivotal and increasingly prevalent technology with the potential to revolutionize our lifestyles and work practices. As the application of GPS LBS continues to grow and evolve, we will likely see even more innovative and useful applications in the future. [16], the potential for GPS LBS is vast, and this technology will continue to play a major role in our daily lives for years to come.

In Fig. 4, the technology and architecture implemented at Keraton Kasepuhan Cirebon, involving the Administrator, Cloud, AR camera, 3D Artifacts, and GPS, along with a barcode scanner, underscore a concerted effort to leverage technology for enriching visitor experiences at the site. The integration of GPS technology enables the storage of 3-dimensional object markers at specific coordinates, essentially

functioning as a virtual navigator. The Administrator's role likely encompasses the management and upkeep of the technology, while the Cloud presumably serves as a repository for storing and accessing site-related data and information. The AR camera enhances visitor experiences by offering augmented reality features, enabling them to engage with virtual elements within the physical setting. Similarly, 3D artifacts may serve a similar purpose or may consist of digitized physical objects accessible for viewing or interaction through technological means [25]. The barcode scanner may be used to scan tickets or other types of passes, or it may be used to access information about the site or its artifacts. Overall, this integration and collaboration among these components are poised to enhance the efficiency and immersive quality of visitor experiences at Keraton Kasepuhan Cirebon.
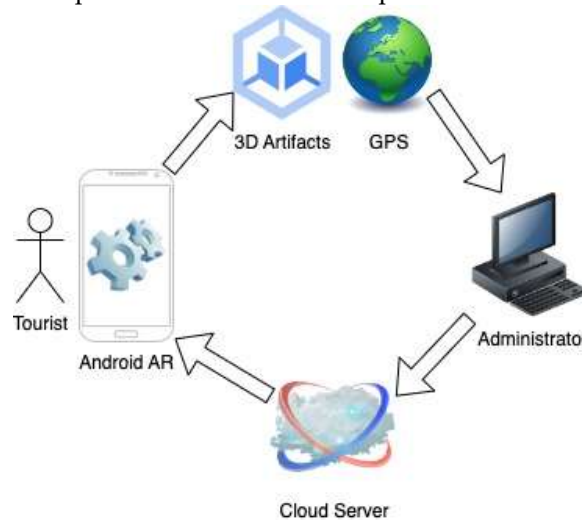


Fig. 4. Technology Structure for AR Application

## 2.4. Application View from a Scientific Perspective

The development process of an AR camera mobile application for historical tourism at Keraton Kasepuhan Cirebon involves several fundamental steps and technologies. The application was developed using the Java programming language, a widely utilized language for mobile app development. Additionally, the app used the ARCore development framework, which equips developers with essential tools and libraries for crafting AR experiences on mobile platforms. Furthermore, the application incorporates 3D modeling and animation software to design the virtual objects and animations, enriching the AR content with artifact information.

Subsequently, the application was designed to communicate with the device's GPS receiver to determine the user's location and furnish location-specific information and services. This functionality is typically facilitated through the utilization of APIs (Application Programming Interfaces) that enable the application to access and engage with the device's GPS as well as other hardware components such as motion and other sensors. The application is also structured to interface with multimedia elements and diverse data sources, including image, sound, and video files, which will be leveraged to furnish information and enrich the immersive experience. Furthermore, the application must be configured to utilize a database management system for storing and retrieving information concerning historical sites, landmarks, and other points of interest. Finally, the application is subjected to testing and evaluation methodologies including user testing, expert review, and statistical analysis to verify its functionality and user experience quality. Continuous testing, improvement, and optimization are required throughout the development process.

In general, the programming mechanism of an AR camera mobile application for historical tourism at Keraton Kasepuhan Cirebon encompasses the utilization of various components including programming languages, development frameworks, 3D modeling and animation software, APIs, multimedia elements, and a database management system. These components collaborate to facilitate the delivery of an immersive and informative experience for tourists.

Augmented reality (AR) technology allows users to overlay digital content in the real world through their device's camera. By combining 3D artifact images created using Autodesk Maya 2020 with AR technology, users can view and interact with historical artifacts in a highly immersive and

interactive way. For example, an application that utilizes AR technology could enable users to scan a physical object or location and view a 3D rendering of a cultural treasure, such as Singa Barong or Gamelan, overlaid onto the real world. The 3D artifact image, created using Autodesk Maya 2020, could exhibit intricate detail and precision, providing users with a realistic and lifelike experience. In conclusion, AR 3D artifact images created using Autodesk Maya 2020 can offer a unique and engaging way to experience and learn about historical artifacts, providing users with a new level of immersion and understanding.
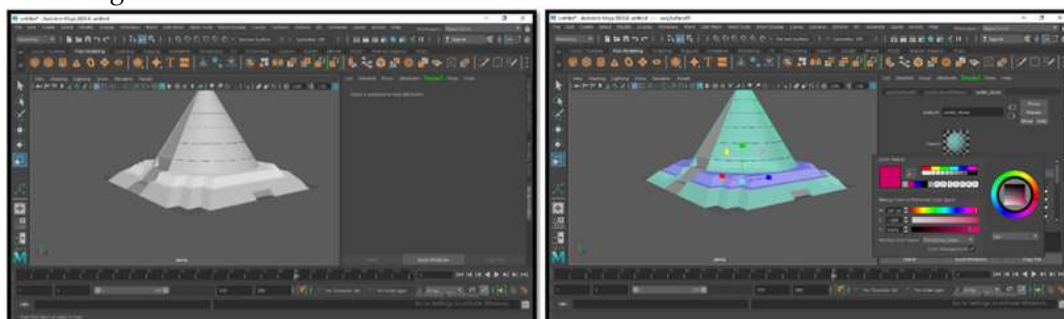


Fig. 5. AR 3D Artifacts using Autodesk Maya 2020



(a)                                    (b)

Fig. 6. Object 3D Artifacts (a) Gong (b) Peti Jamu

To distinguish itself from other AR applications, the scientific side of an AR camera mobile application for historical tourism at Keraton Kasepuhan Cirebon will be focused on the following areas: (1) User experience: The research will investigate the user experience of the app and how it compares to other AR applications, looking at factors such as engagement, enjoyment, ease of use, and impact on understanding of the site and artifacts. (2) Cultural sensitivity: The research examines how the app handles cultural sensitivity, looking at issues such as representation, interpretation, and the use of traditional knowledge. (3) Technical aspects: The research will investigate the technical aspects of the app and how it compares to other AR apps, looking at factors such as performance, reliability, and security. (4) Educational value: The research assesses the educational value of the app and how it compares to other AR apps, looking at factors such as the quality and relevance of the content, the effectiveness of the learning experience, and the impact on knowledge retention.

## 2.5. Developing Application Features

These are explanations of the features of the augmented reality application for Cirebon historical tourism explained with graphical information. Using a schematic diagram on Fig. 7 to represent the functionality of an AR camera mobile application for historical tourism at Keraton Kasepuhan Cirebon, we can visualize how the app works to provide a 3D immersive experience for visitors. The process begins when a visitor scans a barcode using the application on their mobile phone, triggering communication between the multimedia elements and the AR framework within the application. Subsequently, the AR framework processes the input and generates an output in the form of 3D immersive artifact objects for the user to experience. This action transports the visitor to a virtual world where they can engage with and explore the 3D artifact objects in an immersive manner. By utilizing AR technology and multimedia elements, the application creates a distinctive and interactive experience for the visitor, enhancing their comprehension and admiration of the historical site and its artifacts. The

schematic diagram illustrates the intricate interplay among the various components of the app, which collaboratively deliver a rich and captivating experience for the visitor.
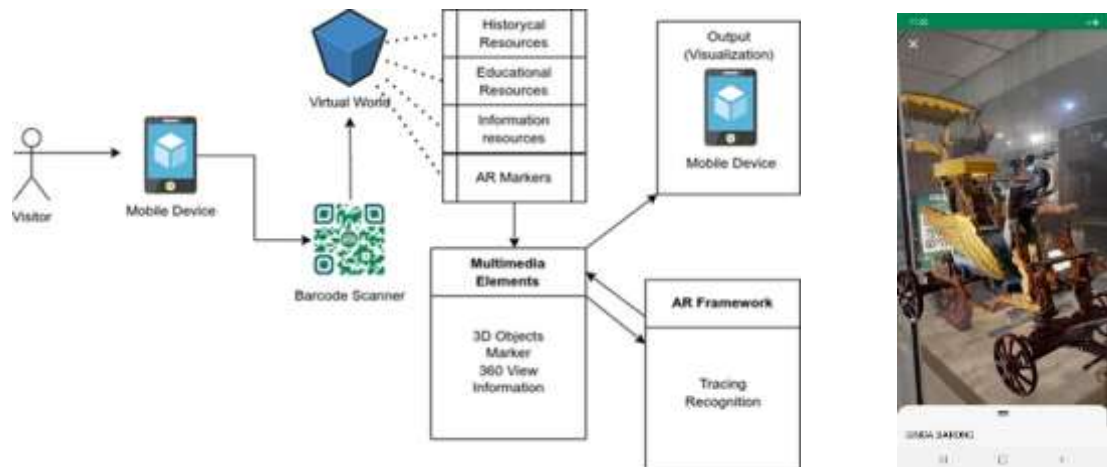


Fig. 7. (a) Schematic Diagram of AR Camera App Kasepuhan Cirebon (b) Brings Up 3D Objects

Additionally, this application offers another Augmented Reality feature, namely navigation. This feature enables visitors to be directed to various locations within Keraton Kasepuhan Cirebon. The mechanism involves storing a 3D object, such as an arrow, with a predetermined direction at specific coordinates. This directional indicator serves as a virtual guide for visitors, assisting them in navigating the site.

Then, visitors simply need to open the navigation camera within the application and align it with the indicated directions, as illustrated in Fig. 8. Prior to this, they can select their desired destination within the vicinity of Keraton Kasepuhan Cirebon.
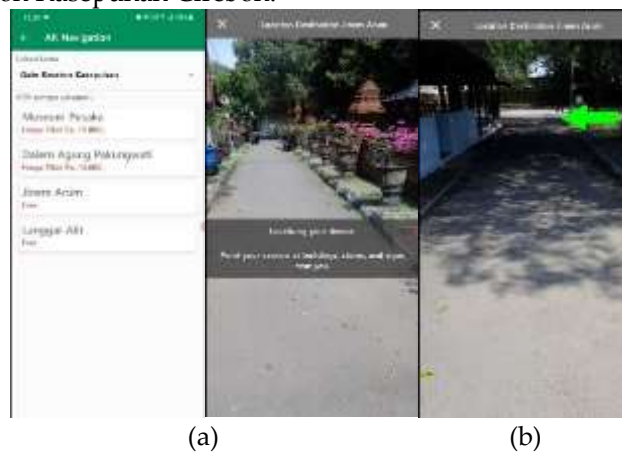


(a)                                    (b)

Fig. 8. (a) Several Destination Options (b) AR Navigation Features

## 2.6. Application User Interface Design

In this case, the mobile application menu consists of three primary options: Home, AR Camera, and Events. The Home option likely directs users to the main application screen or dashboard, offering an overview of its features and functionalities, such as Goa Sunyaragi, Denah, Silsilah, and Baluarti. In the information column, users can find details about the Company, GWIDO app, and Info Keraton. The AR Camera option allows users to access the augmented reality camera feature, enabling the application to overlay historical digital content onto the real world through their device's camera. Lastly, the Events option provides a list of upcoming events or activities associated with the application, such as meetups or workshops.

The AR camera mobile application for historical tourism at Keraton Kasepuhan Cirebon delivers a 3D immersive experience to visitors. This outcome is achieved through the integration of AR technology and multimedia elements within the application. This output has the potential to enhance the visitor's understanding and appreciation of the historical site and its artifacts. Furthermore, it opens avenues for additional income generation for the site.

Recent research on the use of AR technology in the tourism industry has identified several advantages, including the potential for income generation through the use of technology in the tourism industry, the ability to provide added value and attract potential tourists, and the potential to preserve and protect the cultural values contained within tourist objects [27]. However, the implementation of AR technology in the tourism industry also presents certain limitations. Its success relies heavily on stakeholders' comprehension of the concept, and it remains primarily theoretical, grounded in perception. Additionally, research in this area has predominantly employed a case study method, so the proposed business models are not yet generic [28].

The novelty of this research resides in its design and reconstruction of the AR business model implemented at the Geevor Museum. This novel approach aims to enhance the utilization of technology, especially AR, in providing information systems for the digitalization of business processes [29]. The output of the AR camera mobile application for historical tourism at Keraton Kasepuhan Cirebon has the potential to provide a unique and interactive experience for visitors, enriching their visit to the historical site and helping to preserve its cultural values. Further research is needed to fully understand the potential and limitations of AR technology in the tourism industry, as well as to develop and refine business models that can be applied more broadly.



(a)          (b)

Fig. 9. (a) Application Menu Design (b) AR Menu Design

## 2.7. AR Camera Functionality Testing Validation and Sensitivity

Augmented reality (AR) is a technology that allows users as tourists to overlay digital content onto the real world through their device's camera. In the context of a mobile application, the AR Camera feature can be used to provide an immersive and interactive experience for the user. One approach to enhancing the AR Camera feature is by incorporating a barcode scanner to activate specific content displays. For example, an application intended to exhibit historical and cultural artifacts at Keraton Kasepuhan Cirebon could utilize a barcode scanner to enable users to access information about particular items in the collection.

For instance, the application will incorporate a barcode scanner enabling users to scan an artifact's barcode within the museum. Subsequently, the app will project a virtual representation of the artifact into the real world via the AR Camera. Furthermore, the application could provide details about the artifact, such as its historical background, cultural significance, and other pertinent information. This implementation of the barcode scanner feature will enhance the user's experience by providing a convenient and interactive way to access information about the artifacts in the collection. It could alsomake the application more engaging and educational for users, as they can learn about the artifacts in a more interactive and immersive way.

Overall, the incorporation of an AR Camera feature with a barcode scanner could serve as a key component of this mobile application, intended to showcase the historical and cultural artifacts housed within Keraton Kasepuhan Cirebon. This integration aims to offer users a distinctive and engaging experience, as illustrated in Fig. 10.
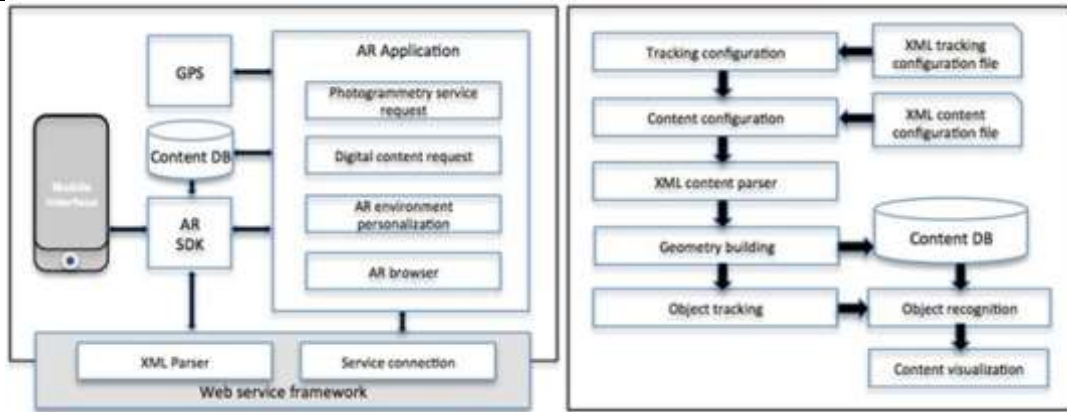
Fig. 10. Camera App Process in Background


Fig. 11. AR Camera App Validation and Sensitivity

## 3.    Results and Discussion

This section aims to determine the requirements of users regarding the tourism potential in Cirebon. The application is intended for general users or tourists who are largely unfamiliar with the specific historical tourism potential in Cirebon. By providing this information, the application aims to become a cornerstone of the tourism sector in Cirebon, thereby indirectly supporting the tourism initiatives of the Cirebon government. This concept can be formulated through the business model proposed by the author, which is based on the findings of research conducted using augmented reality technology to establish a sustainable business process, as illustrated in Fig. 12.
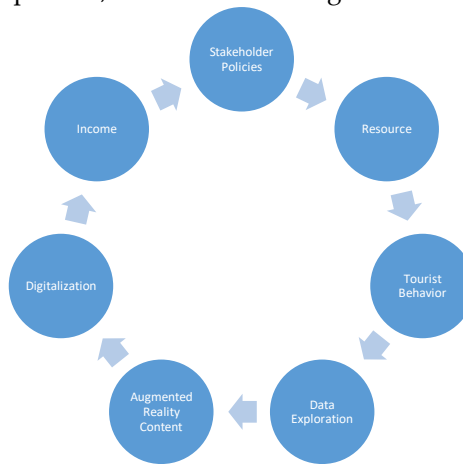

Fig. 12. Business Process Models

This business model represents a refinement of the previous model that also utilized augmented reality technology as a supporting medium, as demonstrated by Eleanor in the study titled Developing an Augmented Reality Business Model for Cultural Heritage Tourism: The Case of Geevor Museum. Eleanor's research emphasized the conceptual nature of the study, indicating that the actual impact and effectiveness of the business model could not be definitively determined or confirmed without initial implementation. However, this study aims to advance the development of a business model using augmented reality for the historical tourism sector, thereby contributing additional insights to inform

theory and practice in future research The study serves as a bridge for further exploration of augmented reality in business models. Therefore, it is recommended that future research should focus on further exploring the potential applications of augmented reality and confirming its effectiveness through practical implementation.

The GWIDO application's augmented reality feature, especially the 3-dimensional objects, can have a direct impact by enabling visitors to interact virtually with historical heritage objects that cannot be physically touched. This offers a unique experience for visitors. Additionally, the application addresses the issue of limited availability of tour guides and lack of foreign language skills. The inclusion of virtual navigators with information in Indonesian and English provides a viable alternative to serve as a guide for both domestic and foreign tourists.

In addition to the distributed questionnaire, reviews on the Google Play Store serve as a supporting indicator to measure the success of the GWIDO application implementation. The application has received an average rating of 5 stars from a total of 40 reviews, indicating positive user feedback. This response suggests an enhanced user experience, especially for those who previously found historical tourism to be uninteresting. The integration of augmented reality technology has transformed this perception, as it enables 3-dimensional objects to serve as navigation aids and interactive elements with heritage objects. Moreover, no other tourism application combining these two features with augmented reality technology has been identified for comparison.

This research was carried out through observation, implementation, and testing stages at Kasepuhan Palace, which serves as a representative historical tourism site in Indonesia and globally. This assertion is supported by the outcomes of modeling trials conducted over the past year. Policy adjustments were made based on the behavior of application users, who are visitors utilizing the provided applications to support tourism activities. Data collection on user interactions was then evaluated to measure the impact of implementing the adapted business process model. The results of this process are detailed in the evaluation section, presented in Figs 13, 14, and 15.

Furthermore, testing of the Augmented Reality features in this application, specifically, object tracking and navigation, was conducted to identify errors or deficiencies in the software. This testing is crucial for ensuring that the software aligns with its design objectives. This test aims to determine whether the software created meets the criteria in accordance with the design objectives or not. The object tracking method was employed for these tests, with data collected from each tracking session. Objects are grouped into two groups. The results are presented in tables, with each table containing data only from the front view, as other views (bottom, top, right side, left side and back) did not yield successful results. Each tracking test was conducted 30 times, and the average time for the 3D object to appear was recorded in each table. Table 1 presents the response time results for objects measuring 0.1 to 0.5 meters, while Table 2 shows the response times for objects measuring 0.5 to 1 meter. Tests for objects measuring less than 0.2 meters and more than 1 meter were unsuccessful, as these objects exceeded the specified maximum limit.

Table 1. Object Response Time Results 0.1 Meters to 0.5 Meters

| No. | Test Sequence | Response Time |
|---|---|---|
| 1 | Test 1 | 2.44 s |
| 2 | Test 2 | 3.14 s |
| 3 | Test 3 | 1.11 s |
| 4 | Test 4 | 1.09 s |
| 5 | Test 5 | 0.77 s |
| … | … | … |
| 30 | Test 30 | 2.01 s |
| | Confidence Interval (95%) | 1.76 s ± 0.31 s |

Table 2. Object Response Time Results 0.5 Meters to 1 Meters

| No. | Test Sequence | Response Time |
|---|---|---|
| 1 | Test 1 | 4.21 s |
| 2 | Test 2 | 4.66 s |
| 3 | Test 3 | 6.03 s |
| 4 | Test 4 | 3.79 s |
| 5 | Test 5 | 2.12 s |
| … | … | … |
| 30 | Test 30 | 4.02 s |
| | Confidence Interval (95%) | 3.93 s ± 0.78 s |

Based on the test results from Table 1 and Table 2, the average response time for object distances ranging from 0.1 meters to 0.5 meters was between 1.45 to 2.07 seconds with a 95% confidence level. For object distances from visitors, the average response time ranged from 3.15 to 4.71 seconds with a 95% confidence level. However, testing the navigation features using augmented reality is highly dependent on the internet signal used on the user's device. The accuracy of objects placed at certain coordinates is determined by the performance of the internet network, ensuring that objects appear precisely according to their coordinates.

### 3.1. Evaluation

Validating and assessing the sensitivity of the output of an AR camera mobile application for historical tourism at Keraton Kasepuhan Cirebon through the use of a Play Store app analytics dashboard and a KPI (Key Performance Indicator) dashboard can provide a comprehensive understanding of the performance and usage of the app. The Play Store app analytics dashboard can provide data on a range of metrics, including the number of app downloads, the number of active users, the average session length, and the user retention rate. This data can help to identify any trends or patterns in the app's usage, and allow for necessary improvements to be made. In addition to these metrics, the analytics dashboard can also provide data on the app's crash rate and user feedback. The crash rate data can help identify any issues or problems with the application's stability and performance, while user feedback can provide valuable insights into the user experience and any problems or issues users are encountering. The KPI dashboard can provide additional data on the app's performance, such as the number of page views, the conversion rate, and the revenue generated. This data can help identify the most important metrics for the app's success and allow for necessary improvements to be made.

Overall, employing a Play Store app analytics dashboard and a Key Performance Indicator (KPI) dashboard to validate and assess the sensitivity of the output of the AR camera mobile application for historical tourism at Keraton Kasepuhan Cirebon can offer a comprehensive understanding of the application's performance and usage. This approach enables developers to make necessary improvements, ensuring the reliability and accuracy of the applicaition's results. Ultimately, this leads to a high-quality and engaging experience for visitors, as illustrated in Fig. 13.



Fig. 13. GWIDO Play Store KPI for Effectiveness Evaluation

In Fig. 14 and 15, the effectiveness of Augmented Reality (AR) Mobile Applications for Historical Tourism was evaluated through a questionnaire administered to 30 visitors of Keraton Kasepuhan Cirebon. AR technology has the potential to enhance the visitor experience at cultural and historical sites by providing additional information and interactive elements. This study aimed to evaluate the effectiveness of AR camera mobile applications for historical tourism at Keraton Kasepuhan Cirebon, a royal palace and cultural heritage site in Indonesia.

A questionnaire was developed and administered to 30 visitors at Keraton Kasepuhan Cirebon. Table 3 presents the demographic profile of all respondents who participated in filling out the

questionnaire for this study. The profiles are categorized based on tourists' origin and further segmented by gender and age to represent the questionnaire results used by researchers. The demographic profile indicates that domestic tourists outnumber foreign tourists, with 53% female and 47% male respondents. The data also suggests that the average tourist is part of a family group. The questionnaire included inquiries about the utilization and perceived effectiveness of the AR camera mobile application, as well as its content, user interface, navigation system, and overall value to the visitor experience. Responses were analyzed using descriptive statistics.

Table 3. Demographic Profile of Respondents

| Tourist Classification | Gender | 15-25 years old | 26-35 years old | 36-45 years old | 46-55 years old | 56-65 years old | Over 65 years old |
|---|---|---|---|---|---|---|---|
| Domestic Tourist | Male | 4 | 1 | 5 | 2 | 0 | 0 |
| | Female | 7 | 1 | 2 | 2 | 1 | 1 |
| Foreign Tourist | Male | 0 | 1 | 0 | 1 | 0 | 0 |
| | Female | 0 | 1 | 0 | 1 | 0 | 0 |

Based on the demographic data, it is evident that individuals of nearly all ages can accept AR applications. However, it is advisable to provide assistance to older age groups initially to enhance their fluency and utility in using AR applications. The speed of comprehension of AR applications is also influenced by prior experience with the technology. With experience, individuals can increase their level of exploration without feeling awkward or hesitant. Moreover, the cultural background, as identified through the grouping based on origin (domestic tourists and foreign tourists), does not significantly influence the acceptance of this AR application. Typically, the acceptance of technology is more influenced by the age factor. However, based on the responses from the existing respondents, it can be concluded that the GWIDO application exhibits good accessibility and is considered universal.

Here are some graphical representations of the scientific data generated from the results of a questionnaire on the use of AR camera mobile applications for historical tourism at Keraton Kasepuhan Cirebon, grouped by the types of questions. These graphs can be observed in Fig. 14 and 15:
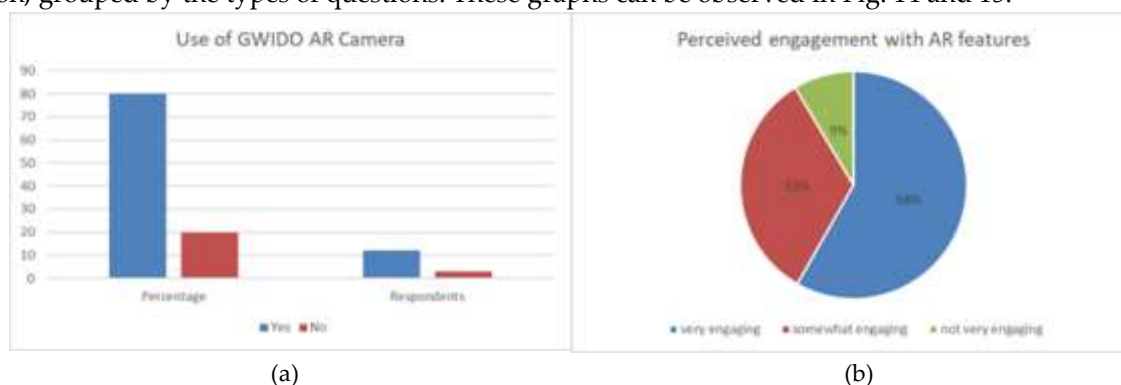


(a)        (b)

Fig. 14. Grouped Graphical Questioner (a) Use of GWIDO AR Camera and (b) Perceived Engagement with AR Features
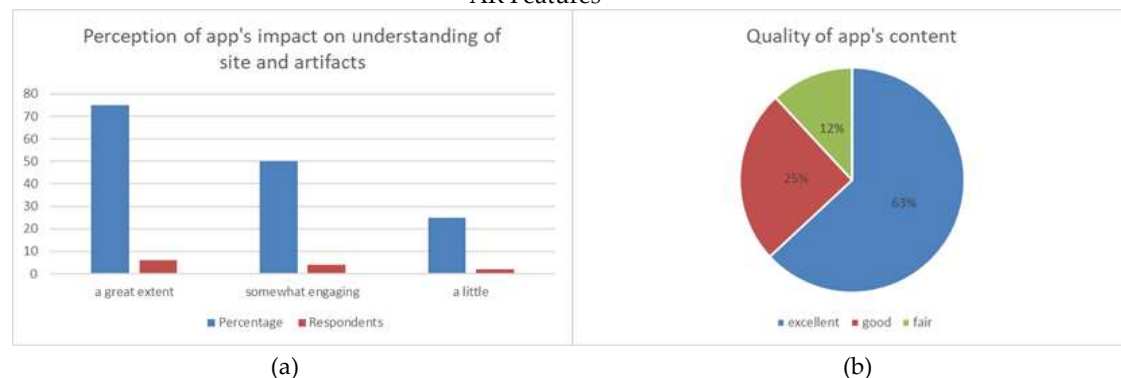


(a)        (b)

Fig. 15. Grouped Graphical Questioner (a) Perception of App's Impact on Understanding of Site and Artifacts and (b) Quality of App's Content

### 3.2. Results

Evaluating the effectiveness and impact of an AR camera mobile application for historical tourism at Keraton Kasepuhan Cirebon can provide valuable insights. One method for evaluating the app is

**27**
F. Akbar, et.al
regist. j. ilm. teknol. sist. inf.
ISSN 2502-3357 (online) | ISSN 2503-0477 (print)
10 (1) January 2024 12-30

through user testing and expert review. User testing involves recruiting users to test the app and provide feedback on their experience, which can include completing tasks or exercises with the app while their performance and responses are recorded and analyzed. This process helps identify any issues with functionality or usability, enabling necessary improvements. Statistical analysis can also evaluate the app's results by collecting data on its usage and performance, then using statistical techniques to analyze trends or patterns. This helps to identify performance issues and guide improvements [30][31].

Overall, evaluating the results of the AR camera mobile application for historical tourism at Keraton Kasepuhan Cirebon through user testing, expert review, and statistical analysis can provide valuable insights into its effectiveness and impact, guiding necessary improvements. This research sheds light on technology's crucial role in business process models within E-Tourism, illustrating the transformation of conventional services into digital ones for efficiency and effectiveness. It also examines the profitability of implementing online applications derived from business process models due to their sustainable nature. Furthermore, it explores how designing business process models using technological media can strengthen infrastructure for greater financial stability, potentially reducing tourism budgets, which are typically high. Lastly, it addresses how modeling business processes, particularly in regional tourism areas, can drive policy updates or formulation, focusing on tangible and measurable outcomes within specific time frames. This integration of modeling and technology can help predict policy directions.

With the business process model presented in Fig. 12, it is evident that the implementation of the AR application can be adapted by other historical tourism sites. This adaptation considers the unique selling points of each site, identifying challenges as opportunities that need resolution. Utilizing similar augmented reality technology is crucial for successful implementation, as it offers extraordinary potential when used effectively. This technology can become a source of additional income for the site managers.

The ideal respondents for the questionnaire about an AR camera mobile application for historical tourism at Keraton Kasepuhan Cirebon would be the visitors of the Keraton. The population of interest comprises tourists who visit Keraton Kasepuhan Cirebon. Targeting the visitors ensures that the sample is representative of this population. It is essential to note that the sample size must be sufficient, and a recommended method is to use stratified sampling. By selecting the right respondents, the researcher can ensure that the collected data will be valid and reliable. This data can provide valuable insights into how the AR camera mobile application is used by Keraton visitors and how it impacts their experience of historical tourism at Keraton Kasepuhan Cirebon. A sample size of 30 respondents has been selected as an illustrative example.

Based on the responses of the 30 respondents, 24 (80%) reported using the AR camera mobile application during their visit to Keraton Kasepuhan Cirebon. Among those who used the app, the majority (26 out of 30, or 88%) found the AR features to be very engaging, while an additional 15 out of 30 (50%) found them somewhat engaging. Furthermore, most respondents (21 out of 30, or 70%) reported that the AR camera mobile application enhanced their understanding of the site and its artifacts to a great or some extent. In terms of usability, all 30 respondents (100%) found the application easy to use, with all 30 (100%) rating it as either very easy or somewhat easy. Only 4 out of 30 respondents (13%) reported experiencing technical issues with the app. The overall quality of the application's content was rated as excellent or good by 24 out of 30 respondents (80%), while the overall design of the user interface was rated as excellent or good by 22 out of 30 respondents (73%). Similarly, the overall effectiveness of the navigation system was rated as excellent or good by 22 out of 30 respondents (73%). When asked to rate the overall value of the AR camera mobile application to their visit to Keraton Kasepuhan Cirebon, 24 out of 30 respondents (80%) rated it as excellent or good.

## 4. Conclusion

The results of this study indicate that the AR camera mobile application is a valuable tool for enhancing the visitor experience at Keraton Kasepuhan Cirebon. Most respondents who used the app found its AR features engaging and stated that it improved their understanding of the site and its artifacts. The application was also generally perceived as easy to use and was considered to add significant value to the visitor experience. These findings suggest that implementing AR technology through mobile

applications can effectively enhance the visitor experience at cultural and historical sites. However, further research is needed to determine if these findings are applicable to other sites and to explore the long-term effects of AR mobile applications on visitor engagement and learning.

Based on the findings in this research, the GWIDO mobile application is designed to offer users an immersive and interactive experience centered around historical artifacts in the Keraton Kasepuhan Cirebon area. The app's AR camera feature, which utilizes a barcode scanner to access augmented reality content related to specific physical objects, appears to be a crucial component of this experience. Besides the AR camera feature, the app may include other functionalities such as a historical timeline and information regarding the cultural significance of the artifacts. These additional resources could enhance the tourists' understanding of the cultural riches of the Kasepuhan Cirebon area and their historical context. Overall, the GWIDO mobile application has the potential to serve as a valuable resource for individuals interested in exploring the cultural treasures of the Kasepuhan Cirebon area, offering an engaging and interactive experience through its AR camera feature.

If we consider the tangible aspect, this presentation reveals several research parameters that can serve as determining factors for the success of implementing the offered business model. A digital product, particularly one utilizing augmented reality, can be assessed based on tangible aspects, including enhancing brand engagement to drive effective sales or visits and providing an interactive model. This opens up avenues for further research on how to leverage this technology as a new revenue stream. The evident enthusiasm of visitors for augmented reality suggests its inherent value to visitors. Further examination could determine whether augmented reality could be developed into a separate paid tourist attraction, thereby increasing revenue beyond visitor entrance tickets.

To enhance tourists' experiences, it is essential to offer various conveniences that streamline different types of tourism activities efficiently. This can include increasing the effectiveness of routine expenses through the support of new business processes, enhancing the flexibility of providing information services anytime and anywhere. The integration of technology in regional tourism areas can attract tourists' attention, thereby increasing profits, expanding the reach to various potential tourists, and helping cultivate stronger relationships with tourists.

### Author Contributions

F. Akbar: Conceptualization, data curation, formal analysis, investigation, methodology, project administration, resources, software, validation, visualization, writing – original draft, and writing – review & editing. H. Hadiyanto: Conceptualization, formal analysis, methodology, resources, supervision, and writing – review & editing. C. E. Widodo: Conceptualization, formal analysis, methodology, resources, supervision, and writing - review & editing.

### Declaration of Competing Interest

We declare that we have no conflict of interest.

### References

[1] Vargas, D. G. M., Vijayan, K. K., & Mork, O. J. (2020). Augmented reality for future research opportunities and challenges in the shipbuilding industry: a literature review. Procedia Manufacturing, 45, 497-503.

[2] Muhammedrisaevna, T. M., Mubinovna, R. F., & Kizi, M. N. U. (2020). The role of information technology in organization and management in tourism. Academy, (4 (55)), 34-35..

[3] Buhalis, D., Harwood, T., Bogicevic, V., Viglia, G., Beldona, S., & Hofacker, C. (2019). Technological disruptions in services: lessons from tourism and hospitality. Journal of Service Management, 30(4), 484-506.

[4] Jamal, S., & Habib, M. A. (2020). Smartphone and daily travel: How the use of smartphone applications affect travel decisions. Sustainable Cities and Society, 53, 101939.

[5] Dorcic, J., Komsic, J., & Markovic, S. (2019). Mobile technologies and applications towards smart tourism–state of the art. Tourism Review, 74(1), 82-103.

[6] Buhalis, D. (2020). Technology in tourism-from information communication technologies to eTourism and smart tourism towards ambient intelligence tourism: a perspective article. Tourism Review, 75(1), 267-272.

**29**
F. Akbar, et.al
regist. j. ilm. teknol. sist. inf.
ISSN 2502-3357 (online) **|** ISSN 2503-0477 (print)
10 (1) January 2024 12-30

[7]   Dunn, J. L., Nusem, E., Straker, K., Gregory, S., & Wrigley, C. (2019). Human factors and user experience issues with ventricular assist device wearable components: a systematic review. Annals of Biomedical Engineering, 47, 2431-2488.

[8]   Wong, J. W. C., Lai, I. K. W., & Tao, Z. (2020). Sharing memorable tourism experiences on mobile social media and how it influences further travel decisions. Current Issues in Tourism, 23(14), 1773-1787.

[9]   Siang, T. G., Ab Aziz, K. B., Ahmad, Z. B., & Suhaifi, S. B. (2019, December). Augmented reality mobile application for museum: A technology acceptance study. In 2019 6th International Conference on Research and Innovation in Information Systems (ICRIIS) (pp. 1-6). IEEE.

[10]  Jiang, S., Moyle, B., Yung, R., Tao, L., & Scott, N. (2023). Augmented reality and the enhancement of memorable tourism experiences at heritage sites. Current Issues in Tourism, 26(2), 242-257.

[11]  Elshafey A, Saar C C, Aminudin E B, Gheisari M, Usmani A (2020). Technology acceptance model for Augmented Reality and Building Information Modeling integration in the construction industry. Journal of Information Technology in Constuction, ITcon Vol. 25, pg. 161-172, https://doi.org/10.36680/j.itcon.2020.010.

[12]  Hakim, I. N. A., & Mohamad, U. H. (2023). Augmented Reality Frameworks for Object Recognition in Learning Application Domain: A Systematic Review. Journal of Advanced Research in Applied Sciences and Engineering Technology, 32(2), 175-188.

[13]  Tabone, W. (2020). The effectiveness of an augmented reality guiding system in an art museum. In Rediscovering Heritage Through Technology: A Collection of Innovative Research Case Studies That Are Reworking The Way We Experience Heritage (pp. 197-214). Cham: Springer International Publishing.

[14]  Sattarov, A. R., & Khaitova, N. F. (2019). Mobile learning as new forms and methods of increasing the effectiveness of education. European Journal of Research and Reflection in Educational Sciences Vol, 7(12).

[15]  Zairon, I. Y., Wook, T. S. M. T., Salleh, S. M., Dahlan, H. A., & Rahmat, M. (2021, October). Analysis of Behaviour and Learning Style on Education 4.0 in Virtual Mentoring using Gamification. In 2021 International Conference on Electrical Engineering and Informatics (ICEEI) (pp. 1-6). IEEE.

[16]  Estriegana, R., Medina-Merodio, J. A., & Barchino, R. (2019). Student acceptance of virtual laboratory and practical work: An extension of the technology acceptance model. Computers & Education, 135, 1-14.

[17]  Díaz, J., Saldaña, C., & Avila, C. (2020). Virtual world as a resource for hybrid education. International Journal of Emerging Technologies in Learning (iJET), 15(15), 94-109.

[18]  Draxler, F., Labrie, A., Schmidt, A., & Chuang, L. L. (2020, April). Augmented reality to enable users in learning case grammar from their real-world interactions. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (pp. 1-12).

[19]  Kovoor, J. G., Gupta, A. K., & Gladman, M. A. (2021). Validity and effectiveness of augmented reality in surgical education: a systematic review. Surgery, 170(1), 88-98.

[20]  Jayanegara, I. N., Setiawan, I. N. A. F., & Putri, G. A. M. (2020). Design of interactive multimedia learning vocabulary for students communication disorder and deafness during the Covid-19 pandemic. Indonesian Journal of Disability Studies, 7(2), 239-248.

[21]  Lampropoulos, G., Keramopoulos, E., Diamantaras, K., & Evangelidis, G. (2022). Augmented reality and gamification in education: A systematic literature review of research, applications, and empirical studies. applied sciences, 12(13), 6809.

[22]  Cranmer, E. E., tom Dieck, M. C., & Fountoulaki, P. (2020). Exploring the value of augmented reality for tourism. Tourism Management Perspectives, 35, 100672.

[23]  Moreno-Guerrero, A. J., Alonso García, S., Ramos Navas-Parejo, M., Campos-Soto, M. N., & Gómez García, G. (2020). Augmented reality as a resource for improving learning in the physical education classroom. International journal of environmental research and public health, 17(10), 3637.

[24] Azizah, N. H., & Setyaningrum, W. (2022, December). Edutainment based on augmented reality: Development of learning media with students' learning interest oriented. In AIP Conference Proceedings (Vol. 2575, No. 1). AIP Publishing.

[25] Ens, B., Cordeil, M., North, C., Dwyer, T., Besançon, L., Prouzeau, A., Liu, J., Cunningham, A., Drogemuller, A., Satriadi, K. A., & Thomas, B. H. (2022, April). Immersive analytics 2.0: Spatial and embodied sensemaking. In CHI Conference on Human Factors in Computing Systems Extended Abstracts (pp. 1-7).

[26] Brata, K. C., & Liang, D. (2019). An effective approach to develop location-based augmented reality information support. International Journal of Electrical and Computer Engineering, 9(4), 3060.

[27] Yin, C. Z. Y., Jung, T., Tom Dieck, M. C., & Lee, M. Y. (2021). Mobile augmented reality heritage applications: Meeting the needs of heritage tourists. Sustainability, 13(5), 2523.

[28] Yang, F., Kalloori, S., Chalumattu, R., & Gross, M. (2022, February). Personalized information retrieval for touristic attractions in augmented reality. In Proceedings of the Fifteenth ACM International Conference on Web Search and Data Mining (pp. 1613-1616).

[29] Cranmer, E. E. (2019). Designing valuable augmented reality tourism application experiences. Augmented reality and virtual reality: The power of AR and VR for business, 73-87.

[30] Ammirato, S., Felicetti, A. M., Linzalone, R., & Carlucci, D. (2022). Digital business models in cultural tourism. International Journal of Entrepreneurial Behavior & Research, 28(8), 1940-1961.

[31] Graziano, T., & Privitera, D. (2020). Cultural heritage, tourist attractiveness and augmented reality: insights from Italy. Journal of Heritage Tourism, 15(6), 666-679.

[32] Szromek, A. R. (2022). Value Propositions in Heritage Tourism Site Business Models in the Context of Open Innovation Knowledge Transfer. Journal of Open Innovation: Technology, Market, and Complexity, 8(3), 161.

[33] Li, P., Zhou, Y., & Huang, S. (2023). Role of information technology in the development of e-tourism marketing: A contextual suggestion. Economic Analysis and Policy, 78, 307-318.

[34] Pranoto, H., Saputra, P. P., Sadekh, M., Darmadi, H., & Yanfi, Y. (2023). Augmented reality navigation application to promote tourism to local state attraction "Lawang Sewu". Procedia Computer Science, 216, 757-764.

[35] Huang, T. L., Tsiotsou, R. H., & Liu, B. S. (2023). Delineating the role of mood maintenance in augmenting reality (AR) service experiences: an application in tourism. Technological Forecasting and Social Change, 189, 122385.

[36] Ronaghi, M. H., & Ronaghi, M. (2022). A contextualized study of the usage of the augmented reality technology in the tourism industry. Decision Analytics Journal, 5, 100136.