IIETA International Information and Engineering Technology Association
Advancing the World of Information and Engineering

Ingénierie des Systèmes d'Information
Vol. 28, No. 6, December, 2023, pp. 1577-1585
Journal homepage: http://iieta.org/journals/isi

Enhancing Tourism in Riau Province through Augmented Reality and Near Field Communication-Enabled Smart Posters

Sutoyo[1*], Arif Marsal[2], Muhammad Luthfi Hamzah[2], Stedico Anderjovi[2], Nazaruddin[3], Sarbaini[4]

[1] Department of Electrical Engineering, Universitas Islam Negeri Sultan Syarif Kasim Riau, Pekanbaru, 28298, Indonesia
[2] Department of Information System, Universitas Islam Negeri Sultan Syarif Kasim Riau, Pekanbaru, 28298, Indonesia
[3] Department of Industrial Engineering, Universitas Islam Negeri Sultan Syarif Kasim Riau, Pekanbaru, 28298, Indonesia
[4] Department of Mathematics, Universitas Islam Negeri Sultan Syarif Kasim Riau, Pekanbaru, 28298, Indonesia

Corresponding Author Email: sutoyo@uin-suska.ac.id

https://doi.org/10.18280/isi.280614

Received: 30 May 2023
Revised: 31 August 2023
Accepted: 11 October 2023
Available online: 23 December 2023

Keywords:
Internet of Things (IoT), smart poster, Augmented Reality (AR), Near Field Communication (NFC)

ABSTRACT

This research paper introduces a transformative approach to promoting tourism in Riau Province by integrating advanced technologies into smart systems. Utilizing Augmented Reality (AR) and Near Field Communication (NFC), smart posters were developed to elevate the tourist experience. AR technology was employed to overlay digital information, including historical insights, videos, and 3D visuals, directly onto tourists' smartphone screens when aimed at specific landmarks. Simultaneously, NFC technology allowed tourists to tap their smartphones on the smart posters, instantly downloading curated guides, maps, and coupons related to nearby attractions. The primary goal of this innovation was to provide tourists with a seamless and enriched experience, minimizing the often tedious task of manual information search. To validate the effectiveness of this system, user studies were conducted, analyzing interaction metrics with the smart posters and collecting direct feedback from participants. Preliminary findings showed an increased ease of information access, with tourists appreciating the intuitive nature of AR overlays and the immediate data transfer via NFC. By melding AR and NFC within smart posters, this research not only aligns Riau's tourism with contemporary Smart City concepts but also showcases the potential economic and experiential benefits for tourists and the local economy. Future implications suggest a broader application of such smart systems in tourism sectors globally.

1. INTRODUCTION

In today's technologically-driven era, the increasing interconnectedness of people, data, and machines has given rise to transformative paradigms such as the Internet of Things (IoT) and Cyber Physical Systems (CPS). These digital innovations act as the backbone for the emergent concept of Smart Cities, urban ecosystems that seamlessly integrate information and communication technology (ICT) for improved socio-economic and administrative functions. As we delve deeper into the architecture of Smart Cities, a noteworthy component emerges: the role of Near Field Communication Technology (NFC) in facilitating efficient communication. Specifically, the adaptation of NFC through Smart Posters is carving a niche for itself, particularly in sectors like tourism.

The term "Internet of Things" (IoT) and "Cyber Physical Systems" (CPS) refer to any digitally driven sectors that involve links between people, machines, data, and other things that are now commonplace. The enormous need for precise, effective, and efficient technology and information systems to enable activities in the corporate, social, and educational sectors has a significant impact on the development of information technology [1-4]. The evolution of computer technology has an impact on how well humans function as a system, which is why there is a growing trend toward information systems based on computers and cellphones. In addition to using new solutions by utilizing the Internet of Things (IoT), big data, and cloud computing technologies to generate deep knowledge, smart cities are also emerging as a result of highly inventive ICT sectors and marketplaces. how each component and the city layer are related. Building smart cities that cater to human needs requires the integration of several important technologies [5-8]. There are several factors to take into account when building a smart city. By giving benchmark results for smart cities, these factors are taken into account and used as a gauge for their success. Smart City criteria cover areas like the economy, lifestyle, government, people, mobility, and environment, as well as smart tourism [9-12].

Smart Cities can be thought of as urban innovation and transformation that aims to use knowledge resources, social infrastructure, and information and communication technology (ICT) for better city management, economic regeneration, and social cohesion. In order to make it simpler for people to access information, move fast, and be flexible, a

technology known as a "Smart City" was created by combining organizational innovation, technological innovation, and policy innovation [13-16].

Realizing the vision of smart cities requires the application of emerging information and communication technology paradigms such as data-intensive computing (Big Data), open source, large-scale distributed systems, the internet of things, physical-cyber-social computing service-oriented, and cloud computing [17, 18]. In fact, this paradigm combination enables real-world smart cities by enabling the development of applications and information systems for smart cities employing a mix of architectures (centralized, decentralized, and a combination of both) and infrastructure, such as middleware and IoT platforms [19-22].

The adoption of Near Field Communication Technology-enabled Smart Posters spread swiftly throughout the travel sector. Modern posters frequently have NFC tags attached to them so that they may communicate information, such as links or contact information, and become "smart posters" or "smart posters." Since NFC tags are placed in things, it is possible to covertly include them into smart posters. Smart posters are regarded as being extremely user-friendly since they give users digital information without requiring a lot of user engagement. There are many new opportunities for NFC users and service providers as a result of the idea of fusing physical things with digital information and service access. Smart posters enable for user engagement, the potential for dynamically updating material, the personalization of user data, and the creation of statistical reports for service providers. Additionally, compared to other dynamic displays, smart posters are inexpensive and simple to make [23, 24].

The draw of tourism can strengthen local identity. Since Riau Province is known for producing petroleum, one industry that will bring in money for the province is tourism. As a result of this potential, tourism is regarded as being well developed in Riau. There are many attractions in Riau Tourism, as well as many different cultures. As a result, the government's tourism department, which manages it, must play a part. In order to promote the superior tourism that is Riau Province's draw, the government created a tourism branding for the province called Riau Tanah Air Melayu. Riau Tanah Melayu wants to attract more tourists, make the region more competitive, and boost the local economy. Since Riau Province has not yet been ranked among the provinces that serve as the main point of reference for both domestic and international tourists, researchers there have developed a technology based on the internet of things by suggesting that in each tourist destination a smart poster be installed that works with augmented reality and near-field communication technology to make it simpler for visitors to understand all information related to the history and culture.

With this narrative, the reader is provided with a clear path: starting from the broader concepts of IoT and CPS, narrowing down to Smart Cities, and finally focusing on NFC, Smart Posters, and their potential impact on Riau's tourism.

Taking a lens to the Asian archipelago, we come across the Riau Province, an area rich in culture, yet underrepresented in the global tourism landscape. Here, a unique opportunity presents itself: Can the integration of IoT-driven Smart Posters, augmented with NFC, redefine the tourism experience in Riau?

This research paper aims to explore the potential of IoT, with a specific emphasis on NFC-enabled Smart Posters, in transforming the tourism landscape of Riau Province. We will investigate how such technological interventions can not only enhance the tourist experience but also position Riau as a leading destination in the realm of Smart City tourism.

2. LITERATURE REVIEW

In an era dominated by rapid technological advancements, the concept of a Smart City emerges as a beacon of potential for urban environments, particularly in the face of complex challenges related to infrastructure, human behavior, socio-political structures, economics, and technology. At its core, a Smart City integrates Information and Communication Technology (ICT) and various Internet of Things (IoT) solutions to address urbanization challenges.

The Smart City concept can be implemented in urban environments with challenging conditions, including Infrastructure, human behavior, technology, socio-political structures, and economics are all complex systems. Smart City provides a smart way to manage devices such as transportation, health, education, energy, home and building, environment. The structure of smart cities, which consists mainly of information and communication technology (ICT) [25-28]. It helps the world to develop, disseminate, and promoting sustainable development practices to meet the increasing urbanization challenges with wireless sensor networks, data generated from these components. Smart City Vision relies on billions of internet devices working from regular devices. The good news is that human interactions with the virtual and real worlds may now be digitized, recorded, and gathered thanks to the ongoing development of sensing and communication technology, creating new opportunities to monitor urban activities on a never-before-seen scale. As they investigated the progress, difficulties, and future opportunities in the transformation of Chinese cities into Smart Cities, they found that data is crucial to the development of smart cities in the current big data era. Cameras, sensors, big data analytics, control centers, and other devices are everywhere in a smart city. A Smart City isn't just a buzzword; it's a holistic approach that weaves together transportation, health, education, energy, and environment management using interconnected devices. Central to this network is the Internet of Things (IoT), a technology poised to address numerous societal challenges. Leading corporations, as indicated by sources [29, 30] are already harnessing the power of the IoT, embedding billions of devices and making data-driven decisions.

A practical example of this integration is seen in renewable energy systems. Users can now independently produce energy, measure and monitor consumption, and make decisions based on real-time data. With IoT, charging an electric vehicle or utilizing solar energy becomes a more informed process [31-33].

The implications of the fourth industrial revolution are vast, and the tourism sector isn't exempt. From transformations in service delivery and marketing to revolutions in lodging and accommodation, technological trends like big data analysis, cloud computing, and IoT are reshaping the industry's landscape. Research reveals that such advancements might soon facilitate robotic services, virtual tour bookings, and heightened cybersecurity in hotels [20].

In this situation, the utilization of cutting-edge technology enables producers and consumers to share a variety of creativity and experiences. Additionally, using the Indus-try 4.0 app, such approaches surely result in a variety of

modifications for customers and managers seeking various experiences in the industry's future. Finally, it appears that throughout the fourth industrial revolution, tourism will continue to promote peace, stability, and the restoration of socio-cultural links between nations. As a result, the tourism sector will experience new revolutionary processes as a result of new trends. The evolution of tourism marketing media has been the subject of numerous prior studies, one of which being Hartono and Zulandari's (2018) promotion of cultural festival traditions through the use of Twitter. Similarly, Muhardi et al. (2017) created Android-based tourism promotion media at the Pekanbaru City Tourism Office.

Nowadays, the majority of smartphones come with a variety of sensors that can be used to improve and develop a new user experience. This is true for integrated cameras that can read Near Field Communications (NFC)-related Radio Frequency Identification (RFID) and Quick Response (QR) Codes, as well as other sensing technologies. In the past ten years, the usage of QR Codes and RFID tags has increased substantially. Originally used to track products in the business, these technologies have now helped to create a number of innovative ideas that combine the real world with the virtual one. Radio waves are used in RFID, an Automatic identifying and Data Capture (AIDC) technique, to store and retrieve information from an identifying chip. RFID tags are the name for these chips. Security, access control, transportation, and supply chain management are just a few of the applications that RFID is now frequently utilized for in industry. RFID systems typically need three primary components: a reader/writer, RFID tags, and information processing software [34, 35].

The necessary hardware, which includes a radio frequency unit, a baseband processor, and an NFC controller with antenna, must be present on an NFC-capable mobile device. Additionally, it has a secure smartcard chip called a secure element that may be utilized in emulation tag mode to enable the usage of mobile devices as smart cards [36, 37].

One of the most significant developments in wireless communication technology is NFC, which was developed by Kulkani in 2021. NFC enables the integration of RFID technology into mobile devices. This technology is utilized in computing all over the world to get various information and services from many sources whenever and whenever. The creation of tools that offer all the fundamental possibilities for determining, storing, and retrieving this information and service is essential to creating an intelligent environment where we can get information from items around us utilizing NFC. Additionally, in order to communicate with various RFID devices and tags, this tool must adhere to various standards established by the NFC-Forum. This essay provides a description of the tool and how it might be used in a college setting. A variety of Smart Poster kinds, including the Faculty Smart Poster, have been created with this objective in mind. To improve the quality of life for its residents, the government is currently very concerned with the transformation of cities into smart cities. In order to carry it out, a number of projects have put forth techniques that include all aspects of urban labor, including transportation, mobility, economy, sustainability, health, and education-the latter of which is crucial for this job. When we discuss education, we mean providing a flexible and automated procedure that greatly enhances and satisfies the work that teachers and students accomplish [24].

In light of the discussion of smart campuses in the context of higher education, we now offer methodological recommendations for building a smart university campus that makes use of all management, administrative, and pedagogical procedures. The research procedure that led to the development of the presented technique was concerned with higher education institutions. Initial planning, functional schemes, and the creation and execution of proposals are the three stages that make up this process, which leaves a strong basis for the deployment of smart campus prototypes.

Smart posters are a fascinating new use for NFC and QR-Code equipped mobile devices, but there isn't typically a security feature for these technologies. A secure smart poster system called smart posters-SPAN is made up of three components: an Android application for end users, a backend server for storing and managing data, and an administrative web interface for managing posters. Only users who have been given permission to see the content can view it thanks to S-SPAN's enforcement of the integrity of smart poster data and authentication/authorization of administrators and end users. This project can be used for college homework. This method of distributing homework to students is quite secure.

A new term being used to describe the growing reliance of tourist locations, their companies, and their visitors on cutting-edge ICT that enables massive volumes of data to be translated into a value offer is "smart tourism." Its theoretical development is hampered by the fact that it is yet an undefined concept. This essay defines "smart tourism," identifies current trends in the field, and then describes the fundamentals of the field's technology and operations. A brief discussion of the advantages and disadvantages of smart tourism followed. This essay also highlights the critical necessity for research to guide the creation and administration of smart tourism. For those working in the tourism industry, NFC, particularly NFC tags and smart posters, can aid with destination service quality, branding, and marketing.

We are driven to create a three-dimensional augmented reality interface for users that equalizes the depiction of all data points and enables visual filtering of all filter dimensions on the map. Filtering with inclusion is a new technique we're developing for visually geospatially filtering data on AR maps that involves including data rather than eliminating it. We described the interface in terms of its surroundings and the best places to embed it around the metropolis. We showed how neural network models may be used to simulate human behavior and decision-making in our screening methods. We discuss how our system does not filter homes if they do not meet the filter requirements, but rather offers users with visual information so they may make judgments on their own because human choices are flexible. This is how technology should activate, not restrict users. We discussed future development on this technology and expanded some of our system's limits. In the context of smart communities and smart cities, our work has implications for user experience design in AI at the convergence of AR big data and situational interactions [38-40].

3. METHODOLOGY

This research technique incorporates a research framework that begins with scope and goal identification, goals determination, literature review, problem analysis, UML model design, design of AR and NFC Android applications, system testing, implementation, assessment, and product launch. The design of the Internet of Things implementation

in smart posters employing AR and Android-based NFC to boost Riau tourism is described in the methodology's framework. The framework of this research can be seen in the Figure 1.

(1) Scope and Goal Identification:

Begin by defining the primary goal of integrating IoT with AR in smart posters to enhance Riau tourism. This phase sets clear research boundaries and project objectives.

(2) Goals Determination:

We further refine our objectives by determining the specific outcomes we expect from our study. This includes outlining tangible results and potential impacts on Riau's tourism industry.

(3) Literature Review:

A thorough examination of existing literature helps us understand current trends, challenges, and solutions related to AR, NFC, and smart posters. It lays a foundation for our research by identifying gaps and opportunities in existing knowledge.

(4) Problem Analysis:

Using insights gained from the literature review, we delve deep into specific challenges faced by Riau's tourism industry that our AR and NFC-enabled smart posters can address.

(5) AR Environment Design and UML Model Creation:

Develop a conceptual model of the AR environment, taking into consideration real-world markers, virtual objects, and user interactions. Simultaneously, produce a Unified Modeling Language (UML) diagram to visualize the system's architecture and AR components.

(6) Design of AR and NFC Android Applications:

Construct an Android application that seamlessly integrates AR visuals and NFC capabilities, ensuring that the interface is intuitive and the AR elements align well with real-world contexts.

(7) AR Content Development:

Design and produce the AR content, ensuring it is both engaging for the user and relevant to the Riau tourism context.

(8) System Testing and AR Validation:

Conduct rigorous testing of system functionalities and validate the AR components for accuracy, usability, and real-world alignment. Adjust any misalignments or glitches based on user feedback.

(9) Implementation:

Deploy AR-enhanced smart posters across Riau's tourist hotspots, ensuring they're positioned for maximum AR effectiveness and NFC accessibility.

(10) User Experience Assessment:

After a designated period, gather data on user interactions, system performance, and the overall experience with the AR smart posters.

(11) Iterative Refinement:

Use the feedback and data from assessments to refine AR content, application performance, and NFC interactions. This iterative process ensures continuous improvement of the system.

(12) Product Launch:

After satisfactory assessments and refinements, launch the product for a broader audience, promoting its unique AR and NFC features to enhance Riau's tourism appeal.

By integrating AR with IoT in the domain of Riau's tourism through smart posters, this comprehensive methodology aims to offer tourists a next-level interactive experience, positioning Riau as a pioneer in innovative tourism solutions.

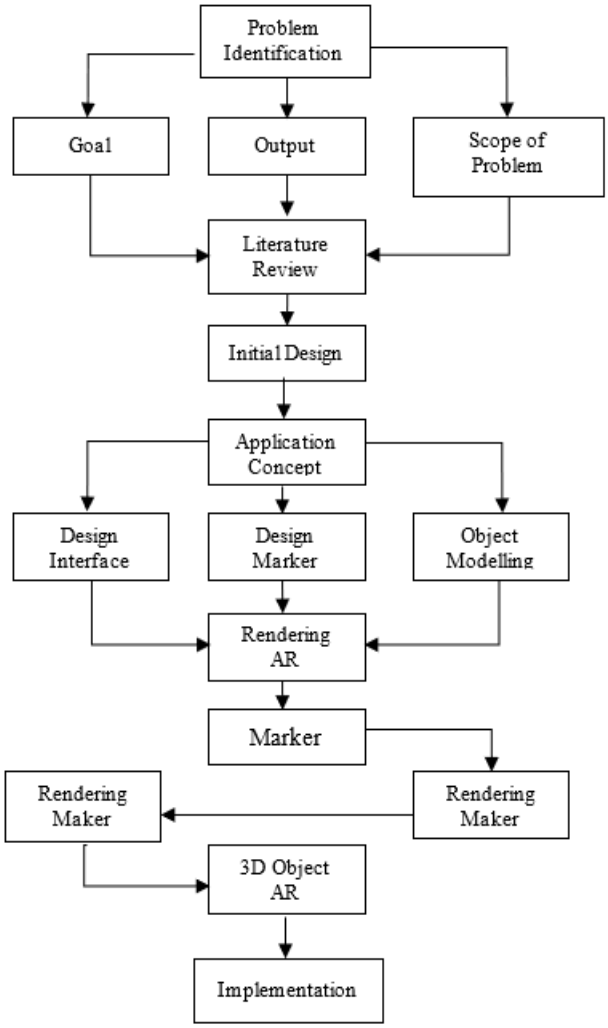

Figure 1. AR and NFC research framework

4. RESULT AND DISCUSSION

4.1 Application design results

In this study, the implementation of the Internet of Thing in Smart Posters using Android-based AR and NFC in supporting Riau Tourism begins with designing a design flowchart so that the needs in the smart poster can be found as illustrated in Figure 2.

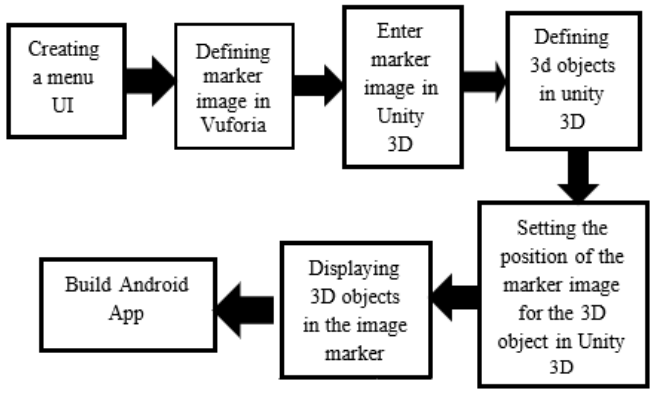

Figure 2. Program design flow chart

Figure 2 shows an application creation process that begins with creating a UI. Then proceed with creating a *marker* image that functions as a map for the image to be scanned. Making this marker uses Vuforia to create assets that can be read by Unity3D software, then place and position the 3D object into the marker image that has been created previously so that when the *marker image* is scanned, it will display a 3D object. Where the initial process to the creation of the AR android application is carried out in the *software* Unity3D as a sketch creation program. Here is the UI program of the application:

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;
public class MainMenu : MonoBehaviour
{
    public void ExitButton()
    {
        Application.Quit();
        Debug.Log("Game Closed");
    }
    public void StartGame()
    {
        SceneManager.LoadScene("SampleScene");
    }
}
```

Figure 2 illustrates the sequential process involved in creating the application, focusing on the development of an AR Android application with an emphasis on User Interface (UI) creation and marker image integration. The steps are as follows:

(1) UI Creation:

The process commences with the design and implementation of the UI of the AR Android application. This interface provides the user with visual elements to interact with the application effectively.

(2) Marker Image Creation:

Following UI design, attention shifts to crafting a marker image. This image acts as a point of reference for the application, serving as a map for subsequent interactions. The creation of the marker image involves utilizing Vuforia, a platform that generates assets compatible with Unity3D software.

(3) Integration of 3D Objects:

Once the marker image is prepared, the next step involves embedding and positioning a three-dimensional (3D) object within the boundaries of the marker. Unity3D software is employed for this task. The 3D object, when accurately placed within the marker's confines, is set to be triggered and displayed upon scanning the marker image.

This initial phase of AR application development, carried out using Unity3D as a sketch creation program, forms the foundation for subsequent stages in the development process.

4.2 Smart poster design results

The design of smart posters is carried out by making designs based on the administrative map of Riau Province.

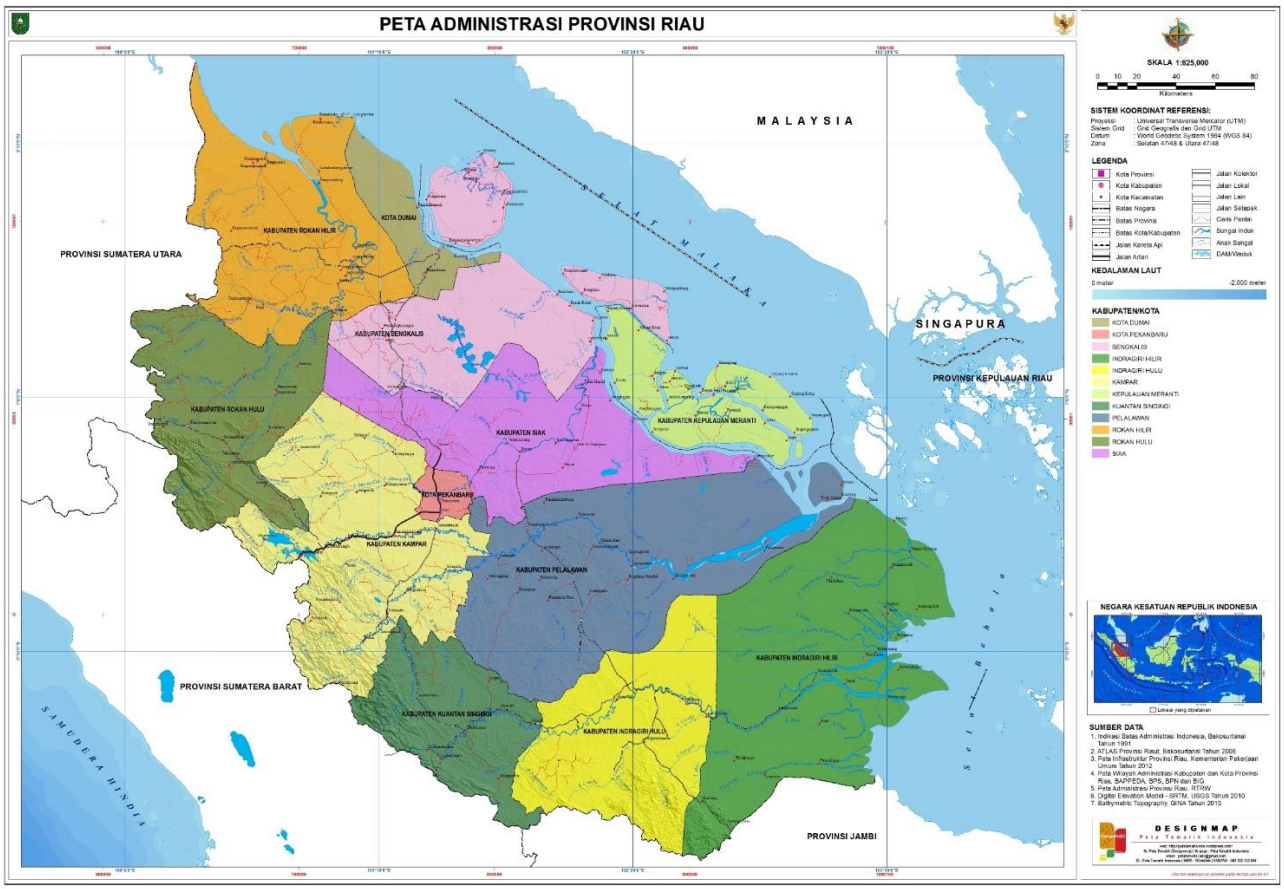

Figure 3. Administrative map of Riau Province

Figure 3 is an administrative map of Riau Province which is the basis for making maps from the *Smart Poster Tourism Map*. The Administrative Map is the cornerstone because the angular details of the Riau Province map look detailed and the scale is based on the truth.

Figure 4 is the initial map design for smart posters with different background colors from each district/city. The different colors aim to distinguish the area of one district / city from another. The color selection should not be too dark so that the reading of the tourist attraction logo will be easier to read.

Figure 5 is a smart poster map design that has been equipped with the object logo of each tourist motorcycle taxi in the regency/city of Riau province. The placement of the logo is based on the representative of the tourist attraction from the district/city. The tourist attraction logo as a marker image uses high resolution so that the poster printout is clear.

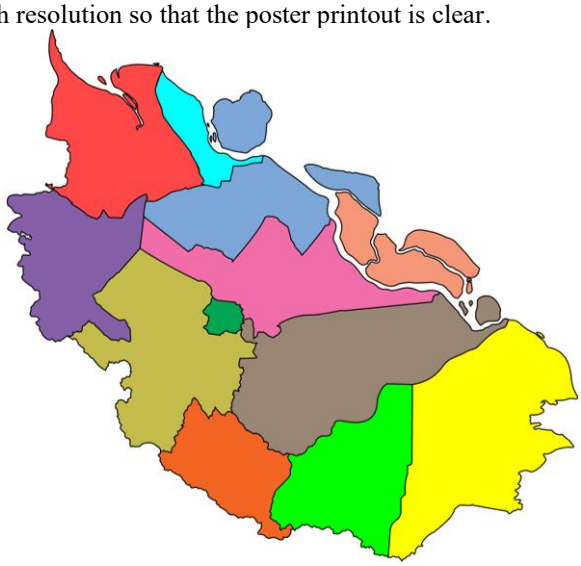

Figure 4. Initial map design

Figure 5. Design with attraction logo

Figure 6. QR code to download android app

Figure 6 is a QR code that can be scanned to download the smart poster application on an Android smartphone. The QR code is generated by filling it with a google drive link. The Google drive contains a smart poster application for Riau Tourism Map that has been built previously. Users can scan the QR code to be directed to the google drive link to download the smart poster application on an Android smartphone.

4.3 UI design results

Figure 7 is a UI display in the AR application. Where when the application is first opened it will display the UI as shown above. The designed UI has a simple appearance because it only displays 2 options/options, namely "PLAY" and "EXIT". When the "PLAY" option is pressed, the application will automatically open the smartphone camera where the smartphone camera functions to scan the marker image and then the 3d object will appear on the smartphone screen. Then if you press the "EXIT" option, the AR application will be closed which indicates that the application is no longer used.

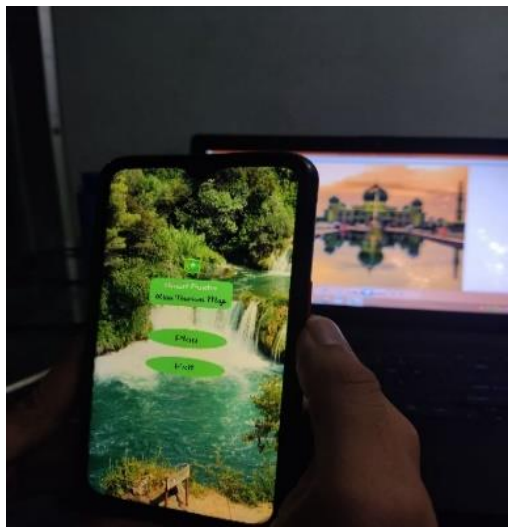

Figure 7. Initial UI design

4.4 Riau tourism map multi-object poster design results

Figure 8. Design smart poster of Riau tourism map uses AR and NFC

Figure 8 is a poster display after placing a multi-object marker image from each regency / city of Riau Province, placing a QR code to scan android application downloads,

poster titles, cardinal directions and a glimpse of how to use. Users can scan the QR code that already contains a link to download the Smart Poster Tourism Map android application. In the application, users can scan each marker image that already represents 3D objects from each tourist attraction regency / city of Riau province. And also on Figure 8 is a poster after the addition of Arduino-based NFC to each logo of the district / city tourist attraction. Users can make NFC contacts on smart posters by turning on the NFC feature on android smartphones and bringing them closer to posters. NFC contains links to access in detail about the tourist attraction sites of each regency / city in Riau Province.

4.5 Smart poster test results on an Nur Mosque (Masjid An Nur)

Figure 9 is a test of the Annur Mosque marker image that has been installed in the AR application. The marker image used is an image of the Nur Mosque. When the Nur Mosque image is scanned using the AR application that has been made, it will display a 3D object in the form of an Annur Mosque that will appear on the smartphone screen.

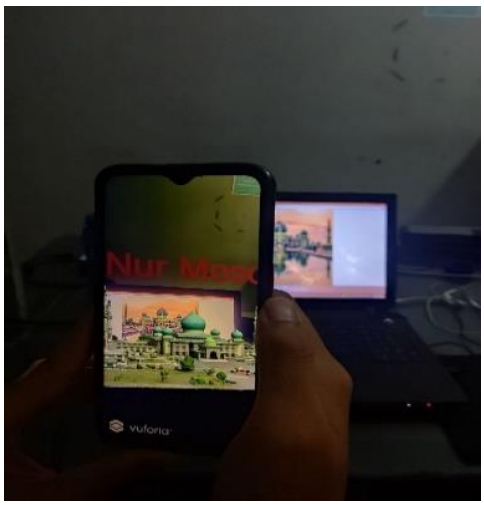

Figure 9. Annur Mosque 3D object testing results

5. CONCLUSIONS

In the pursuit of creating an innovative solution to provide comprehensive information about tourist destinations in Riau Province, the process of developing a Smart Poster emerged as a pivotal endeavor. Commencing with the meticulous design of a map encompassing the various districts within Riau Province, each housing unique tourist attractions, a repository of names and locations was curated. These distinct elements were then ingeniously transformed into informative 3D animations. This integration of AR and NFC technologies culminated in the manifestation of the Smart Poster - a dynamic platform that simplifies users' navigation and understanding of Riau Province's diverse tourist hotspots.

In effect, the Smart Poster not only furnishes users with swift and accurate access to essential tourist-related information but also holds the potential to foster economic growth within the tourism sector. By seamlessly merging AR visuals with NFC capabilities, the Smart Poster has the capacity to elevate user experiences, encouraging heightened engagement and exploration of the region's offerings.

Moreover, this innovation transcends the realms of tourism. The concept of smart posters finds application in diverse sectors, exemplified by the potential utilization in laboratory settings. The prospect of adapting smart posters to facilitate laboratory information services underscores the versatility of this technology beyond its current realm. As future research endeavors unfold, avenues to enhance the Smart Poster's functionality and adaptability remain promising. For instance, exploring the challenges and solutions associated with integrating new tourist destinations into the Smart Poster ecosystem stands as a potential direction. By effectively addressing the dynamic nature of the tourist landscape, the Smart Poster's relevance can be perpetuated, ensuring that users continue to glean valuable insights.

In conclusion, the creation of smart posters represents a technological stride towards simplifying information dissemination, fostering engagement, and augmenting the tourist experience in Riau Province. As this technology continues to evolve, its impact may extend to an array of contexts, promising a future marked by enhanced accessibility and engagement.

ACKNOWLEDGMENT

The authors appreciate the Lembaga Penelitian dan Pengabdian kepada Masyarakat (LPPM): Universitas Islam Negeri Sultan Syarif Kasim, Riau, Indonesia for partially funding this research. They also extend this appreciation to the Telecomunication Laboratory, Department of Electrical Engineering Faculty of Sains and Technology, Universitas Islam Negeri Sultan Syarif Kasim, Riau, Indonesia for their technical assistance in conducting the research.

REFERENCES

[1] Popkova, E.G., Egorova, E.N., Popova, E., Pozdnyakova, U.A. (2019). The model of state management of economy on the basis of the internet of things. In Ubiquitous Computing and the Internet of Things: Prerequisites for the Development of ICT, pp. 1137-1144. https://doi.org/10.1007/978-3-030-13397-9_116

[2] Irawan, Y., Wahyuni, R., Muhardi, M., Fonda, H., Hamzah, M.L., Muzawi, R. (2021). Real time system monitoring and analysis-based internet of things (IoT) technology in measuring outdoor air quality. International Journal of Interactive Mobile Technologies, 15(10): 224-240. https://doi.org/10.3991/ijim.v15i10.20707

[3] Wijaya, R.F., Putri, A., Hermansyah, Mayasari, N., Hardinata, R.S., Perangin-Angin, M.I. (2022). Applications Know Preparation for Earthquakes for Elementary School Students. Journal of Applied Engineering and Technological Science, 4(1): 168-179. https://doi.org/10.37385/jaets.v4i1.995

[4] Abidin, A.R., Irawan, Y., Devis, Y. (2022). Smart trash bin for management of garbage problem in society. Journal of Applied Engineering and Technological Science, 4(1): 202-208. https://doi.org/10.37385/jaets.v4i1.1015

[5] Hartomi, Z.H., Zulkifli, A. (2022). T-BOT as an effort to overcome speech delay in children. Journal of Applied Engineering and Technological Science, 4(1): 307-311.

https://doi.org/10.37385/jaets.v4i1.1048
[6] Motlagh, N.H., Mohammadrezaei, M., Hunt, J., Zakeri, B. (2020). Internet of things (IoT) and the energy sector. Energies, 13(2): 494. https://doi.org/10.3390/en13020494
[7] Nguyen, D.C., Ding, M., Pathirana, P.N., Seneviratne, A., Li, J., Vincent Poor, H. (2021). Federated learning for internet of things: A comprehensive survey. IEEE Communications Surveys and Tutorials, 23(3): 1622-1658. https://doi.org/10.1109/COMST.2021.3075439
[8] Yulisman, Rahmalisa, U., Fikri, K., Linarta, A. (2022). Implementation of IoT-based hydroponics for slb pembina pekanbaru students. Journal of Applied Engineering and Technological Science, 4(1): 312-317. https://doi.org/10.37385/jaets.v4i1.1074
[9] Nord, J.H., Koohang, A., Paliszkiewicz, J. (2019). The internet of things: Review and theoretical framework. Expert Systems with Applications, 133: 97-108. https://doi.org/10.1016/j.eswa.2019.05.014
[10] Singh, R.P., Javaid, M., Haleem, A., Suman, R. (2020). Internet of things (IoT) applications to fight against COVID-19 pandemic. Diabetes and Metabolic Syndrome: Clinical Research and Reviews, 14(4): 521-524. https://doi.org/10.1016/j.dsx.2020.04.041
[11] Taruna, M.A., Mulyono, Susanti, R., Sutoyo. (2022). Lte optimization using the electrical tilt method at the mandau site. Journal of Applied Engineering and Technological Science, 4(1): 578-585. https://doi.org/10.37385/jaets.v4i1.1320
[12] Yunefri, Y., Sutejo, Fadrial, Y.E., Anggraini, K., Ramadhani, M., Hardianto, R. (2022). Implementation of object detection with you only look once algorithm in limited face-to-face times in pandemic. Journal of Applied Engineering and Technological Science, 4(1): 400-404. https://doi.org/10.37385/jaets.v4i1.1161
[13] Ahad, M.A., Paiva, S., Tripathi, G., Feroz, N. (2020). Enabling technologies and sustainable smart cities. Sustainable Cities and Society, 61: 102301. https://doi.org/10.1016/j.scs.2020.102301
[14] Camero, A., Alba, E. (2019). Smart City and information technology: A review. Cities, 93: 84-94. https://doi.org/10.1016/j.cities.2019.04.014
[15] Kirimtat, A., Krejcar, O., Kertesz, A., Tasgetiren, M.F. (2020). Future trends and current state of smart city concepts: A survey. IEEE Access, 8: 86448-86467. https://doi.org/10.1109/ACCESS.2020.2992441
[16] Lai, C. S., Jia, Y., Dong, Z., Wang, D., Tao, Y., Lai, Q.H., Wong, R.T.K., Zobaa, A.F., Wu, R., Lai, L.L. (2020). A review of technical standards for smart cities. Clean Technologies, 2(3): 290-310. https://doi.org/10.3390/cleantechnol2030019
[17] Imran, A., Yantahin, M., Mappalotteng, A.M., Arham, M. (2022). Development of monitoring tower using gyroscope sensor based on Esp32 microcontroller. Journal of Applied Engineering and Technological Science, 4(1): 405-414. https://doi.org/10.37385/jaets.v4i1.1327
[18] Sari, R.P., Henim, S.R. (2022). Measurement and analysis of tourism website user experience using usability techniques. Journal of Applied Engineering and Technological Science, 4(1): 539-546. https://doi.org/10.37385/jaets.v4i1.1343
[19] Chettri, L., Bera, R. (2020). A comprehensive survey on internet of things (IoT) toward 5G wireless systems. IEEE Internet of Things Journal, 7(1): 16-32. https://doi.org/10.1109/JIOT.2019.2948888
[20] Dai, H.N., Zheng, Z., Zhang, Y. (2019). Blockchain for internet of things: A survey. IEEE Internet of Things Journal, 6(5): 8076-8094. https://doi.org/10.1109/JIOT.2019.2920987
[21] Habibzadeh, H., Dinesh, K., Rajabi Shishvan, O., Boggio-Dandry, A., Sharma, G., Soyata, T. (2020). A Survey of healthcare internet of things (HIoT): A clinical perspective. IEEE Internet of Things Journal, 7(1): 53-71. https://doi.org/10.1109/JIOT.2019.2946359
[22] Villa-Henriksen, A., Edwards, G.T.C., Pesonen, L.A., Green, O., Sørensen, C.A.G. (2020). Internet of Things in arable farming: Implementation, applications, challenges and potential. Biosystems Engineering, 191: 60-84. https://doi.org/10.1016/j.biosystemseng.2019.12.013
[23] Hamzah, M.L., Purwati, A.A., Sutoyo, S., Marsal, A., Sarbani, S., Nazaruddin, N. (2022). Implementation of the internet of things on smart posters using near field communication technology in the tourism sector. Computer Science and Information Technologies, 3(3): 194-202. https://doi.org/10.11591/csit.v3i3.p194-202
[24] Kuka, C.S., Hu, Y., Xu, Q., Alkahtani, M. (2020). An innovative near-field communication security based on the chaos generated by memristive circuits adopted as symmetrical key. IEEE Access, 8: 167975-167984. https://doi.org/10.1109/ACCESS.2020.3023049
[25] Darmayunata, Y., Siswati, L., Aryanto, A. (2021). Pekanbaru city livestock marketing with android-based applications. Journal of Applied Engineering and Technological Science, 3(1): 40-52. https://doi.org/10.37385/jaets.v3i1.292
[26] Irawan, Y., Sabna, E., Azim, A. F., Wahyuni, R., Belarbi, N., Josephine, M.M. (2022). Automatic chili plant watering based on internet of things (IoT). Journal of Applied Engineering and Technological Science, 3(2): 77-83. https://doi.org/10.37385/jaets.v3i2.532
[27] Rahmadoni, J., Akbar, R., Wahyuni, U.M. (2022). Web-Based cooperation information system at the science techno park technology business development center. Journal of Applied Engineering and Technological Science, 3(2): 156-167. https://doi.org/10.37385/jaets.v3i2.806
[28] Wulansari, R.E., Sakti, R.H., Ambiyar, A., Giatman, M., Wakhinuddin, Syah, N. (2022). Expert system for career early determination based on howard gardner's multiple intelligence. Journal of Applied Engineering and Technological Science, 3(2): 67-76. https://doi.org/10.37385/jaets.v3i2.568
[29] Hamzah, M.L., Anisa Hultari, L., Ayu Purwati, A., Nazaruddin, N. (2022). Analysis of e-library based on level of user satisfaction using EUCS and IPA methods. Journal of Applied Engineering and Technological Science, 4(1): 599-610. https://doi.org/10.37385/jaets.v4i1.1426
[30] Nauman, A., Qadri, Y.A., Amjad, M., Zikria, Y.B., Afzal, M.K., Kim, S.W. (2020). Multimedia internet of things: A comprehensive survey. IEEE Access, 8: 8202-8250. https://doi.org/10.1109/ACCESS.2020.2964280
[31] Alsharari, N. (2021). Integrating blockchain technology with internet of things to efficiency. International Journal of Technology, Innovation and Management, 1(2): 1-13. https://doi.org/10.54489/ijtim.v1i2.25

[32] Kumar, S., Tiwari, P., Zymbler, M. (2019). Internet of Things is a revolutionary approach for future technology enhancement: A review. Journal of Big Data, 6(1): 111. https://doi.org/10.1186/s40537-019-0268-2
[33] Purwati, A.A., Hamzah, M.L. (2022). Instrument readiness analysis of technology-based businesses. Journal of Applied Engineering and Technological Science, 4(1): 611-617. https://doi.org/10.37385/jaets.v4i1.1434
[34] Loseto, G., Scioscia, F., Ruta, M., Gramegna, F., Ieva, S., Pinto, A., Scioscia, C. (2020). Knowledge-based decision support in healthcare via near field communication. Sensors, 20(17): 4923. https://doi.org/10.3390/s20174923
[35] Zhao, J., Li, X.Y. (2020). SCsec: A secure near field communication system via screen camera communication. IEEE Transactions on Mobile Computing, 19(8): 1943-1955. https://doi.org/10.1109/TMC.2019.2913412
[36] Javan-Khoshkholgh, A., Farajidavar, A. (2019). An implantable inductive near-field communication system with 64 channels for acquisition of gastrointestinal bioelectrical activity. Sensors, 19(12): 2810. https://doi.org/10.3390/s19122810
[37] Martín, A.Q., Lantada, A.D. (2020). An open source medical passport based on an Android mobile application and near-field communication. SoftwareX, 11: 100492. https://doi.org/10.1016/j.softx.2020.100492
[38] de Souza Cardoso, L.F., Mariano, F.C.M.Q., Zorzal, E.R. (2020). A survey of industrial augmented reality. Computers and Industrial Engineering, 139: 106159. https://doi.org/10.1016/j.cie.2019.106159
[39] Hamzah, M.L., Ambiyar, Rizal, F., Simatupang, W., Irfan, D., Refdinal, R. (2021). Development of augmented reality application for learning computer network device. International Journal of Interactive Mobile Technologies, 15(12): 47-64. https://doi.org/10.3991/ijim.v15i12.21993
[40] Miller, M.R., Jun, H., Herrera, F., Villa, J.Y., Welch, G., Bailenson, J.N. (2019). Social interaction in augmented reality. PLoS ONE, 14(5): e0216290. https://doi.org/10.1371/journal.pone.0216290