An Augmented Reality Virtual Guide Museum Multatuli Rangkasbitung Based on Android

Dentik Karyaningsih[1*), Donny Fernando[2], Agus Rulli Sofian[3], Fuad Luthfi[4],
[1]Informatics Engineering Study Program, Faculty of Information Technology, Serang Raya University
[2]Informatics Engineering Study Program, Faculty of Information Technology, Serang Raya University
[3]Lebak Regency Culture and Tourism Office
[4]The Pancasila Ideology Development Agency of the Republic of Indonesia

Email: [1]karya.tiek@gmail.com , [2]mr.donny2008@gmail.com , [3]rulliserver@gmail.com, [4]fuad.lutfi@bpip.go.id

Abstract— Multatuli Museum has been established for several years and is visited by many tourists. However, in practice the Multatuli Museum often lacks museum guides when there is an increase in visits, so that visitors who are not accompanied by a tour guide do not get complete information. In addition, the lack of interest of the younger generation in visiting museum attractions so that by applying Augmented Reality technology to the Multatuli Museum is expected to attract visitors, especially the younger generation. Augmented Reality (AR) is a technology that is able to insert 3D and 2D objects into a real environment in real-time to display a Virtual Guide at the Multatuli Museum. The author creates an animation in the form of a virtual guide for the Multatuli Museum using Blender software to create 3D animations and using Unity software to build the application as well as the Vuforia extension for Unity with C# programming language. The author uses the prototype method as the application development method and uses the Unified Modeling Language (UML) as the system design. This research produces an Augmented Reality Application that can be used on Android smartphones. This application is capable of displaying 3D animations that provide information about the showrooms in the Multatuli Museum. Based on black box testing all features in the application are 100% running well. with this application visitors feel helped when the tour guide is limited and feel happy because there is still a Virtual tour guide who helps in the museum.

Keywords – Augmented Reality, Virtual guide, Multatuli Museum, Android

I. INTRODUCTION

Technological developments are currently developing in all fields, including tourism, and one of the technologies currently developing is Augmented Reality (AR) Technology which is entering a new phase that allows for increased user experience to the perception of reality. Augmented Reality (AR) is a combination of real and virtual objects in a real environment, running interactively in real time and there is integration between objects in three dimensions, namely virtual objects integrated in the real world.[1][2]Information about objects and the environment around us will be added to the Augmented Reality system, which will then be displayed on the real-world layer in real-time as if the information is real.[3]Then, these virtual objects are projected in real time directly through media in the form of markers or markers directed at the camera.[4]The Multatuli Museum is one of the museums in Rangkasbitung, Lebak Regency, but when visiting the Multatuli Museum visitors have difficulty finding information about the available showrooms because there is no tour guide in the museum, there is only one officer who receives visitors. A Tour Guide is a person who provides explanations and pointers to tourists and other travelers about everything that they want to see, witnessed by the tourists concerned when they visit a particular object, or area.[5]In addition, the lack of interest of the younger generation, especially in Lebak Regency, in visiting the Multatuli museum is one of the factors for the lack of visitors to the Multatuli museum.

Based on the above background, the author develops and implements an Android-based Augmented Reality Virtual Guide Museum Multatuli application. Android is an operating system developed for Linux-based mobile devices.[6]This application is developed uses Blender software to create 3D animations, Unity software to build its applications and Vuforia Engine extensions the most widely used platform for AR development, with support for phones, tablets and VR glasses with C# programming language.[7]The system development method used is a prototype which is a system development method where the results of system analysis are directly applied to a model without waiting for the entire system to be completed, producing a prototype of the software that is used as an intermediary between developers and users to interact.[8]System design using UML (Unified Modeling Language) is a language based on graphics/images for visualizing, specifying, building, and documenting a software development system based on OO (Object-Oriented).[9]In this study, the authors started the stages of data collection through observation, design, implementation and testing. The test used is Black Box testing is a software testing technique that focuses on the functional specifications of the software.[10]In addition, testing the quality of the system that was built was done by distributing questionnaires to respondents, managers and visitors to the Multatuli museum.

The research used as a reference is research[11]Augmented Reality-Based Learning Application in the Wudhu Guide for Children, this application is able to increase the average value of student learning outcomes. Study[3]Application of Augmented Reality Applications for Android-Based Baby Stimulation Recognition, this research is able to make it easier for parents to stimulate their babies properly. Study[12]Application of Augmented Reality Technology in Android-Based Home Catalog Applications. This study concludes that this application makes it easier for buyers to see a house virtually in the catalog provided before buying a house. Study[1]Augmented Reality Markerless Tour

Guide System Utilizing GPS Based Tracking With Android Platform". This research provides ease of use and can be used anywhere because it is applied in Android smartphones. As well as research[13]Tour Guide Application Using Android-Based Location Based Service (LBS) Method (Case Study in Ende Regency - East Nusa Tenggara). The result of this application is that it can provide directions or routes to tourist sites, hotels, and restaurants in Ende Regency.

Therefore, one way to increase the attraction of young generation visitors to the Multatuli Museum is to combine Augmented Reality technology with objects in the Museum so that the enthusiasm of the younger generation to visit the museum becomes greater.

II. RESEARCH METHODOLOGY

This research on the implementation of the Augmented Reality virtual guide application at the Multatuli Rangkasbitung Museum uses methode experiment. This study has the aim of exploring the museum, looking for new ideas about museum guides. The steps of this research are:

Figure 1. Research steps

A. Data collection

Collecting data through interview techniques, namely with the Secretary of the Culture and Tourism Office of Lebak Regency, the Head of the Multatuli Museum and the Guards of the Multatuli Museum as well as several visitors to the Multatuli Museum. Various questions about the history of the Multatuli Museum Exhibition Room with the curator of the museum, to obtain an overview, explanation and explanation to assist in making the output of the Augmented Reality application. And the next technique is field observation by researchers to see directly the activities in the Multatuli Museum by making direct observations on the object being studied. The objects studied are 7 exhibition rooms in the Multatuli Museum, Lebak Regency.

B. Design

At the design stage of this application, the system design uses UML (Unified Modeling Language) in the form of use case diagrams and activity diagrams and the development method uses the prototype method.
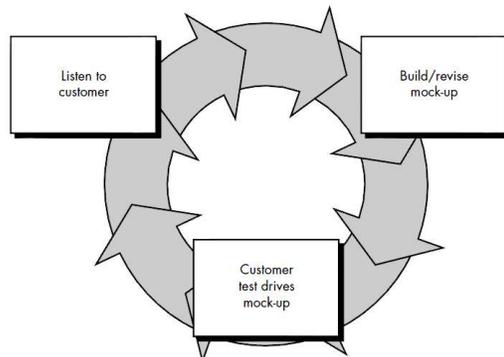
Figure 2. Prototype method.

This application was created using the Blender software to create 3D animations and using the Unity software to build the application as well as the Vuforia extension for Unity with the C# programming language.

C. Implementation

This application is implemented for visitors and managers of the Multatuli Rangkasbitung Museum, Lebak Regency.

D. Test

In this study, the author uses Black Box testing to test the suitability of the input provided with the output generated by the system to IT experts. Black-Box Testing is a test that focuses on the funx`x`ctional specifications of the software, the tester can define a set of input conditions and perform tests on the program's functional specifications.[14]In addition, the authors tested the quality of the system by distributing questionnaires using a Likert Scale to visitors and the manager of the Multatuli Museum.

III. RESULTS AND DISCUSSION

The results of this study include:

A. Data collection

As an illustration of the system currently running at the Multatuli Museum, it can be seen in Figure 3 below:

Figure 3. Overview of the Running System

The flow of a visit to the Multatuli Museum starts with filling out the guest book by visitors, and assisting the museum guide to see the collections in the Museum. When you have finished exploring the museum then visitors leave the location of the Multatuli Museum.

B. Design

At the design stage of this Augmented Reality Virtual Guide application, use case diagrams and activity diagrams are used.

1. Use case Application Diagram

Use case (UC) diagrams, explain visually the context of the interaction between the actor and the system. Each use case states a specification of the behavior (functionality) of the system being described that is needed by the actor to fulfill his goals.[15]The following is the use case diagram of the application:

Figure 4. Use case diagram

In this use case there is only one actor, namely the user who is a passive actor who can only use this application. the user scans using an AR camera to visual objects in the form of image targets that are available in each room. Next the system will process according to the target image that has been planted on the android system, when the system recognizes the appropriate target image, the display on android will display 3D animation objects complete with audio related information about the room the user is going to, including Image Image 1 to 7.

2. Activity Diagrams

*Activity Diagrams*describes the various flow of activities in a system that is being designed.[16]The following is an Augmented reality application activity diagram.
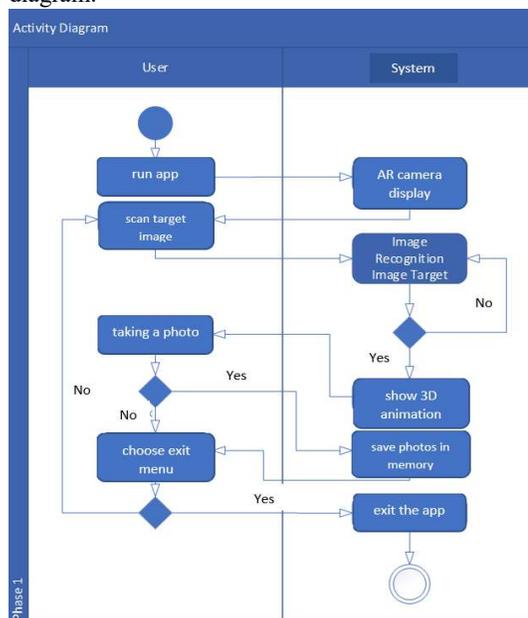
Figure 5. Activity Diagram

*user*can take photos on the AR camera, so users can take 3d animation and reality photos at the same time.

C. *Implementation*

This stage is the implementation of the system which is the result of the design in the form of application screenshots.

1. Application Installation

Before operating an application that uses Augmented Reality techniques on the Android platform, it is necessary to make sure we already have an Image (marker) which will be used as an object to be scanned by the AR camera. To operate this application, it can be done directly by opening the application that is already installed on the Android platform.

To install the Augmented Reality Museum Multatuli application on Android devices, you can do 2 ways:

a). Building directly through the Unity Application provided that the Android device must be in developer mode and enable usb debugging mode, so that the device can be read by Unity

b). Direct application installation that the author has uploaded   via: https://drive.google.com/file/d/10AIckMWlmmtSo qI62O1VorI_HB3rO0Vi/view?usp=sharing. Or you can directly scan the QR Code below:

Figure 6. QR Code Application Download AR Virtual Guide Museum Multatuli

2. Application Usage

3D Animation Display is a display that will appear when the user scans a visual object in the form of a predetermined Image in each Showroom using an AR camera. The display of the Multatuli Museum's AR Virtual Guide when finding markers and displaying 3D animation can be seen in Figure 7 below:

Figure 7. Augmented Reality Tour Guide Multatuli Museum

When 3D animation appears on the display, then the information in each room in the museum in the form of audio will be played. Information in the form of audio can be heard clearly, but it is recommended to use a headset so as not to disturb other visitors.

Following are the results of images for each room from rooms 1 to 7 in each museum with different audio information for each room. Image Target is a visual object that is used by AR as a marker when 3D objects are displayed on the display. The image targets used in this study can be seen in the following figure:
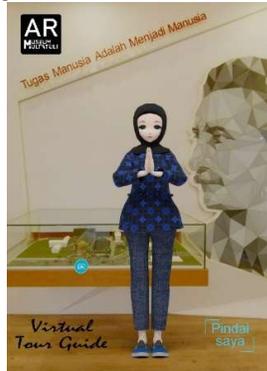
Figure 8. Image Room 1

An image in room 1 of the multatuli museum with audio information "Welcome to the Multatuli Museum, Lebak Regency. Introduce my name is Adinda Virtual Guide who will accompany you while exploring the Multatuli Museum. The Multatuli Museum is the first anti-colonialism museum in the world, inaugurated on February 11, 2018 at the former Rangkasbitung Treasury building, on Jalan Alun-Alun Timur Rangkasbitung, Lebak Regency, Banten Province.

The name Multatuli is taken from the pen name of Eduard Douwes Dekker when writing the novel Max Havelaar. This museum has a land area of 1834 square meters and a building area of approximately 314 square meters. With 7 exhibition rooms consisting of the Welcome room, the room for the early arrival of Europeans to the archipelago, the Forced Cultivation Room, the Multatuli room, the Banten room, the Lebak room, and the temporary Museum room.
Currently you are in the Welcome room, in this room there is a statue of Multatuli as well as a mosaic of Multatuli's face and a mockup of the Multatuli museum building which is integrated with the Saija Adinda library"

Figure 9. Image Room 2

An image in room 2 of the Multatuli Museum with audio informat: "You are in the second room of the Multatuli museum, which is the first room for Europeans to come to the archipelago. This room displays a 2 minute 40 second documentary which tells about the arrival of the Dutch to Banten, there is also a replica of the ship d'batavia used by Cornelis de Houtman who came to Banten in 1596 and a replica of the ship used by Jacob van Neck in in 1598. This room is also equipped with displays of various spices such as pepper, nutmeg, cloves, and cinnamon which were the initial destination of Europeans coming to the archipelago".

Figure 10. Image Room 3

This is an image in room 3 of the Multitali Museum with audio information: "You are currently in the third room or the forced cultivation room. You can see a map of forced coffee plantations from 1830 to 1840, in this room also displays a display of the plantation atmosphere at that time. In addition, there is a replica of the coffee pot. During the forced cultivation period, residents were not allowed to drink coffee from the seeds, but from the leaves because the coffee beans had to be handed over to the Dutch colonial government. There are also displays such as a horse saddle which is a means of transportation for plantation supervision on forced cultivation. There was also a government structure during the colonial period in which Multatuli was an assistant resident of Lebak at that time."

Figure 11. Image Room 4

This is an Image in room 4 of the Multatuli Museum with audio information:" "This is the fourth room or the Multatuli room, in this room you can see Multatuli's masterpiece, the original Max Havelaar book, which is the Masterpiece of this museum, as well as several other works by Multatuli. shown here, there is also an original collection of a tile or

floor of Multatuli's house. This room is equipped with audio and visuals that explain more or less about Multatuli, then there is also Multatuli lithography imported directly from the Netherlands, which is estimated to be in 1864, there is also a replica of the painting of King William III who received a letter from Multatuli on January 18, 1860, where at the end of his letter Multatuli said: "Does Your Majesty know that 30 million people in the East Indies were tortured and oppressed in His Majesty's name?" This room is also equipped with displays of evaluations of Multatuli from people inspired by Multatuli's work, starting from Raden Ajeng Kartini, President Soekarno, Ahmad Subarjo, Pramoedya Ananta Toer, and Mr. Philippines Jose Rizal.

Figure 12. Image Room 5

This is an image in room 5 of the Multiatuli Museum with audio information: "Currently you are in the fifth room, namely the Banten room, in this room the rebellion against the invaders, especially those that occurred in Banten until the seconds of independence. These rebellions included the Haji Wakhia rebellion in 1854, there was also a rebellion in Jasinga Bogor in 1825-1830, then there was a rebellion carried out by farmers in Banten led by Haji Wasid in 1888. There is also a history of national movements such as the Sarekat Islam in 1912, Budi Utomo in 1908, Indisch Partij as the first political party in Dutch India which was founded by the triad in 1912. There was also Romusha forced labor during the Japanese colonial period,

Figure 13. Image Room 6

This is an image in room 6 of the multi-tasking museum with audio information: "This is the sixth room or the Lebak room, in this room it tells about

the beginning of the formation of Lebak Regency in 1828. This room also tells the development of Lebak from the leadership of the first Regent, namely RTA. Kartanegara in 1830. With a timeline display or based on the chronology of time to current developments. Not to forget also the remains of artifacts so that Lebak's natural wealth, in this room also exhibited local products, namely Baduy weaving.

Figure 14. Image Room 7

This is an image in room 6 of the Multatuli Museum with audio information: "You are in the 7th room or temporary room and the last one to go to the exit of the Multatuli Museum. Currently there are several Max Havelaar books that can be read by visitors, as well as several profiles of people who have stories in Rangkasbitung. In accordance with the name of the room, this room can change its display layout according to the needs of the museum. Thank you for visiting the Multatuli Museum, Lebak Regency, and maintaining order while you are at the Museum, We look forward to your next visit. Lebak Unique, work with heart.

D. *Application Testing*

At the stage of testing the system using the Black Box, and also testing the quality of the system by distributing questionnaires to respondents, namely visitors and managers of the multitatu museum.

1. Black Box Testing

Testing is carried out to evaluate the results of the system that has been made. Application testing was carried out on several devices with the Android operating system with 2GB RAM specifications, 16GB ROM, octa core processor @ 1.95 GHz with GPU. This is done to find out the functionality of several different devices. The image that has been prepared for this test is A3 size (29.7 cm x 42.0 cm). This application was tested using 4 different android devices. Installation testing is carried out to ensure the application is installed on the device that is the object of the test

Table 1. Device Installation Test

Indicator	Test	Device	Success	
			Yes	Not
Success in Installation	Was the application successfully installed on the device	Device 1	√	
		Device 2	√	
		Device 3	√	

Device 4	√

The loading time response test is carried out to test how long it takes the device to display 3D Animations calculated from the first time the AR camera points to the Image. The following are the results of the loading time response test:

Table 2. Time Loading Response Test Results

Indicator	Test	Device	Length of Time (Second)			
			1	2	3	>3
Response Time Loading	How long does it take for the 3D Animation to appear	Device 1		√		
		Device 2			√	
		Device 3	√			
		Device 4		√		

Button function testing is done to test whether the exit button and take a photo button work or not. the following are the test results:

Table 3. Test Results for Button Functions

Indicator	Test	Device	Success	
			Yes	Not
Button Function	Does the Exit Button work?	Device 1	√	
		Device 2	√	
		Device 3	√	
		Device 4	√	

Table 4. Results of Testing the Function of Take Photos and Save Photo Results

Indicator	Test	Device	Success	
			Yes	Not
Button Function	Does the Take photo button work, and the photos are stored in the device memory?	Device 1	√	
		Device 2	√	
		Device 3	√	
		Device 4	√	

This animation and audio motion test is carried out to test whether the 3D Animation moves and audio is heard. Here are the test results:

Table 5. Test results for animation and audio motion

Indicator	Test	Device	3D Animation Motion	
			Yes	Not
3D Animation Motion	Can 3d animation move well?	Device 1	√	
		Device 2	√	
		Device 3	√	
		Device 4	√	

Table 6. Audio Test Results

Indicator	Test	Device	Audible Audio	
			Yes	Not
3D Animation Motion	Can the audio be heard well	Device 1	√	
		Device 2	√	
		Device 3	√	
		Device 4	√	

AR camera testing is carried out to measure the effective distance between the device and the prepared image. Measurements are taken from the minimum distance of the device to display the 3D Animation to the maximum distance of the 3D Animation until it disappears:

Table 7. Results of Testing Effective Distance between Device and Image

Indicator	Test	Device	Effective Distance (Cm)	
			Mini mum	Maxi mum
Effective Distance	How far is the effective distance between Device and Image Target to bring up 3D Animation	Device 1	45	490
		Device 2	55	470
		Device 3	40	500
		Device 4	40	520
		Average	45	495

2 . System Quality Testing

This test was carried out by distributing questionnaires to 10 respondents with 9 questions, and 5 value scales ranging from 1 to 5, namely strongly disagree, disagree, undecided, agree and strongly agree, shown in Table 8.

Table 8. Results of the Linkert Skala Scale Assessment

No.	Assessment Aspect	Evaluation				
		SS	S	RG	TS	ST
1	This application can be installed on Android smartphones	10				
2	Button function works fine	9	1			
3	Smooth moving animation	7	2	1		
4	Audio is heard clearly	7	2	1		

178

5	This application can take and save photos	10		
6	The interface is not confusing	8	2	
7	This application can help visitors understand the contents of each Multatuli Museum showroom	7	2	1
8	The application provides a new experience in visiting museums	9	1	
9	This application is interesting for the younger generation	7	1	2

So it can be concluded according to the results of respondents through the Linkert Scale Assessment that this application is very good in terms of benefits with a result of 93.33%.
.

IV. CONCLUSION

Based on the results of research conducted regarding the implementation of the Android-based Augmented Reality Virtual Guide Museum Multatuli Rangkasbitung Application, it can be concluded that this study produces a virtual guide for the Multatuli museum with the results of application testing using the black box testing method showing that this application can run well with a distance between 46 - 495 cm with a response time of loading between 1-3 seconds depending on the available ram capacity on the device and this research can attract the interest of the younger generation in visiting the Multatuli museum with the results in terms of benefits of 93.33%.

REFERENCES

[1] Akbar, A. A. M. (2017). *Sistem Pemandu Wisata Berbasis Augmented Reality Markerless Memanfaatkan GPS Based Tracking Dengan Platform Android (Studi Kasus : Lokasi Wisata di Kota Makassar)*. Universitas Islam Negeri Alauddin Makassar.

[2] Rawis, Z. C., Tulenan, V., & Sugiarso, B. A. (2018). Penerapan Augmented Reality Berbasis Android Mengenalkan Pakaian Adat Tountemboan. *E-Journal Teknik Informatika Vol.*, *13*(1), 30–37. https://doi.org/10.1080/0163638980190306

[3] Yazid, A. R. (2017). *Penerapan Aplikasi Augmented Reality Untuk Pengenalan Stimulasi Bayi Berbasis Android* (Vol. 1, Issue Strata 1). Institut Informatika dan Bisnis Darmajaya.

[4] Mauludin, R., Sukamto, A. S., & Muhardi, H. (2017). Penerapan Augmented Reality Sebagai Media Pembelajaran Sistem Pencernaan pada Manusia dalam Mata Pelajaran Biologi. *Jurnal Edukasi Dan Penelitian Informatika (JEPIN)*, *3*(2), 117. https://doi.org/10.26418/jp.v3i2.22676

[5] Anggraeni, R. (2017). *Perilaku Pemandu Wisata dalam Meningkatkan Kualitas Pelayanan PT. Narasindo Tour and Travel*. Universitas Sumatra Utara.

[6] Maiyana, E. (2018). Pemanfaatan Android Dalam Perancangan Aplikasi Kumpulan Doa. *Jurnal Sains Dan Informatika*, *4*(1), 54–65. https://doi.org/10.22216/jsi.v4i1.3409

[7] Vuforia. (2021). *Vuforia Engine Library 10*.

[8] Tsani, R. H., & Kurniawan, R. (2021). Perancangan Sistem Informasi Akuntansi Desa Wisata Pentingsari Menggunakan Metode Prototyping. *Automata*, 7.

[9] Mubarak, A. (2019). Rancang Bangun Aplikasi Web Sekolah Menggunakan Uml (Unified Modeling Language) Dan Bahasa Pemrograman Php (Php Hypertext Preprocessor) Berorientasi Objek. *JIKO (Jurnal Informatika Dan Komputer)*, *2*(1), 19–25. https://doi.org/10.33387/jiko.v2i1.1052

[10] Setiawan, D., Fadhillah, M. A., Wibawa, A., Sugiarto, I., Mulyana, A., & Kusyadi, I. (2020). Pengujian Black Box pada Aplikasi Perpustakaan Berbasis Web Menggunakan Teknik Equivalence Partitioning. *Jurnal Teknologi Sistem Informasi Dan Aplikasi*, *3*(2), 95. https://doi.org/10.32493/jtsi.v3i2.3955

[11] Jazilah, N. (2016). *Aplikasi Pembelajaran Berbasis Augmented Reality Pada Buku Panduan Wudhu Untuk Anak*. Universitas Islam Negeri Maulana Malik Ibrahim.

[12] Rizal, M., Afijal, A., & Azmi, D. (2021). Aplikasi Pemandu Wisata Berdasarkan Local Based Service Berbasis Android. *Jurnal Tika*, *6*(01), 53–60. https://doi.org/10.51179/tika.v6i01.414

[13] Wolo, Y. E. (2017). Aplikasi Pemandu Wisata Menggunakan Metode Location Based Service(LBS)

Berbasis Android (Studi Kasus Di Kab. Ende-Nusa Tenggara Timur). *Jurnal Mahasiswa Teknik Informatika*, *1 No.2*(2), 24–31.

[14] Hidayat, T., & Muttaqin, M. (2018). Pengujian Sistem Informasi Pendaftaran dan Pembayaran Wisuda Online menggunakan Black Box Testing dengan Metode Equivalence Partitioning dan Boundary Value Analysis. *Jurnal Teknik Informatika UNIS JUTIS*, *6*(1), 2252–5351.

[15] Kurniawan, T. A. (2018). Pemodelan Use Case (UML): Evaluasi Terhadap beberapa Kesalahan dalam Praktik. *Jurnal Teknologi Informasi Dan Ilmu Komputer*, *5*(1), 77. https://doi.org/10.25126/jtiik.201851610

[16] Kirana, C., & Wahdaniyah, R. (2018). Implementasi Aplikasi Alumni Berbasis Mobile Application. *Jurnal Edukasi Dan Penelitian Informatika (JEPIN)*, *4*(2), 179. https://doi.org/10.26418/jp.v4i2.25752