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Tour Experience with Interactive Map Simulation based on Mobile Augmented Reality for Tourist Attractions in Banjarmasin City

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Abstract−Tourist attractions are one of the attractions in the tourism sector, especially in the city of Banjarmasin. Along with the progress of the tourism sector, it is necessary to develop, provide facilities, management, and promotion. The purpose of this research is to build an application to identify tourist attractions in the City of Banjarmasin using Augmented Reality (AR) visualization by creating an interactive map simulation as a marker that will bring up three-dimensional objects, the application is called AR-AyoKeBanjarmasin. The method used in this research consists of Extreme Programming (XP) as a method in the software development process, Marker-Based Tracking as the main method in pattern detection techniques in marker images that will display three-dimensional objects that have been programmed in AR applications, A/B Testing method is used to select the interface design expected by potential users, Black- Box Testing as a method of testing application functionality, and User-Experience Questionnaire (UEQ) as a technique and instrument to evaluate User Experience (UX) when using the AR application. The results show that the design chosen for the user interface is design A so that it can be continued to the coding stage. Functional testing gives the result that all features in the application have functioned as expected and non-functionally involving 50 respondents using a UX approach stating that the application has implemented the user convenience aspect with an average value of 2.93 with the predicate of Excellent. So that the AR-AyoKeBanjarmasin application can be recommended for use by tourists.

Keywords: A/B Testing; Augmented Reality; Extreme Programming; Interactive Map Simulation; Marker-Based Tracking; Tourist Attractions; User Experience

1. INTRODUCTION

Historic buildings and buildings that become icons of a city, as well as a heritage owned as a tourist attraction, are some of the attractions in the tourism sector. Many tourists visit to be able to see historical buildings in a city. One of them is the city of Banjarmasin which has many historical buildings and tourist attractions, including the Menara Pandang (Banjarmasin Plaza Smart City Building), Masjid Sabilal Muhtadin, Patung Bekantan, Pasar Terapung, Pulau Kambang, Jembatan Merdeka, Museum Wasaka, Taman Kamboja, and other tourist attractions.

Along with the progress in the tourism sector, it is necessary to have development related to the provision of facilities and facilities, management, and promotion. Promotion or introduction of tourist attractions to the general public has a very important role in increasing the number of visitors, both local and foreign tourists. This is also welcoming Floating Market Cultural Festival 2021, Visit South Borneo 2021, and South Kalimantan Travel 2022 which will bring in many local and foreign tourists but still adhere to health protocols [1]. In addition, Banjarmasin is one of the cities that plays a role in realizing a smart city as a movement launched by the Ministry of Communication and Information of the Republic of Indonesia, therefore the role of this promotion is very important. Furthermore, South Kalimantan will become the Gateway to the State Capital which will indirectly bring in many tourists. With these issues and the increasing support for media promotion technology, it is certainly an opportunity to increase the number of tourists who will visit the city of Banjarmasin.

Usually, tourists who visit Banjarmasin are confused in finding references to tourist attractions owned by the City of Banjarmasin. Meanwhile, tourists can search for it via google maps, but the drawbacks are the inaccuracy of the information possessed by google maps, the presentation of information that is too monotonous and incomplete and visualization is limited because it can only display two-dimensional images. Therefore, to help tourists find the location of tourist attractions in the city of Banjarmasin, it is recommended that an interactive location map simulation be made as a media aid and also promotion with the support of the application of Augmented Reality (AR) technology with the Marker-Based Tracking method. The development of this application is projected as a tourism promotion innovation that can be interesting, informative, and interactive because it can present imitations of three-dimensional (3D) objects, complete information with sound and location pointers, as well as real-time animation so that tourists seem to be can see firsthand the beauty of the attractions on offer.

As for several similar studies that were carried out related to the use of AR technology for the introduction of tourist attractions, including by [2] who built an application for the introduction of tourist attractions in Bengkulu Province by utilizing AR technology used to promote tourist attractions in Bengkulu Province. is when the marker is detected, the available video appears without visualizing the 3D object, things like this can be directly linked to youtube media only, then the next drawback is that there has not been any testing related to application performance, user interface evaluation,

and user experience evaluation. Research from [3] promotes the Ancient City of Lopburi by applying AR technology that is useful for informing tourist attractions data to tourists. The drawback in this study is that the AR application cannot be installed on mobile devices because it is website-based, if you want to use it on a mobile device, you must first access a web browser and type in a URL, then the next drawback is that this AR application only displays panoramas of the original image without any 3D objects.

The next research conducted by [4] which discusses the mobile application of tour guides using cloud computing, machine learning, the use of AR technology, and other features of AR that can be used by users to get experiences related to Point of Interest (PoI). Some of the shortcomings of this research are that testing and validation have not been carried out regarding the functionality of all features in the application, route analysis to predict the best route to be recommended to users needs to be considered and improved, and user experience needs to be explored further. Furthermore, from research [5] is to build an application to identify Purbalingga Regency attractions by utilizing location-based AR technology. The drawback of this research is that the evaluation of the interface and user experience has not been carried out so that it is not possible to recommend this application so that it can be used by the general public. Research from [6] who has succeeded in building an AR technology application with a location-based Point of Interest (PoI) method that can be installed on a smartphone device so that it can display 3D visuals of Padang City tourist attractions that match the points that have been set. determined. The weakness in this study is that the application cannot capture the entire environment and only certain parts will be displayed according to predetermined points, then in this study, an evaluation of the interface and user experience has not been carried out.

Intersecting research related to culture and tourism in the City of Banjarmasin by utilizing AR technology, namely from [7], [8] who have built a translator application from Banjar Language into Indonesian and from Indonesian into Banjar Language by utilizing Mobile Augmented Reality Technology with Optical Character Recognition (OCR) method, this application is useful to be able to help tourists who will visit the city of Banjarmasin in communicating using the local language. The drawback of the research that has been carried out is the lack of words in the Banjar Language and it is necessary to increase the number of words in the database and can produce sounds from the Banjar Language pronunciation which has been validated by linguists.

Based on the issues and potential sources that have been described, the researchers built an application called AR-AyoKeBanjarmasin to be used as a media aid and introduction of tourist attractions in the city of Banjarmasin based on AR technology with interactive map simulations, then testing and evaluating the application so it is hoped that it can be recommended to help tourists.

2. RESEARCH METHODOLOGY

The research methodology used is a software development method with the type of Extreme Programming (XP). XP is an agile process that is most widely used in today's era and is agile to any changing requirements [9] then will be organized as four main activity frameworks namely planning, design, coding, testing, and complemented by software increment activities [10], [11] (See Figure 1). XP is one type of Agile Method which has become a very popular software development approach, especially for developing mobile-based applications with a relatively small number of programmers, demanding quick action in dealing with many changes to user needs [12]. XP emphasizes the technical aspects of software development. One of the main advantages of the XP method is that it can reduce the risks associated with coding activities and project failure. The XP method attempts to ensure that clients get what they need. Another advantage of projects using XP is its simplicity and practicality [13]. In practice, XP is very agile in that it welcomes changes quickly, compared to traditional methods which are very rigid. XP avoids long-term processes, including iterative design stages rather than large designs in the early, irreversible steps.

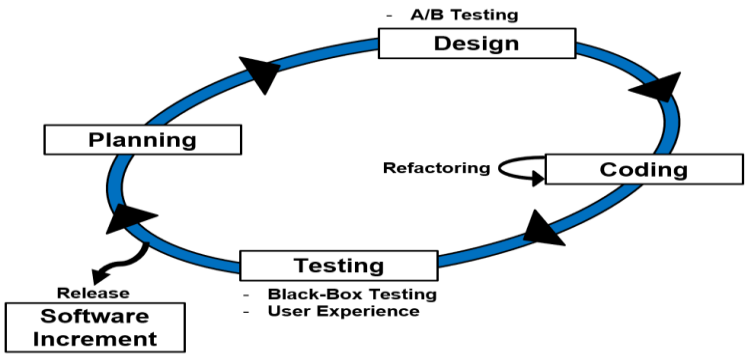

Figure 1. XP Development Method

In Figure 1, there are sub-sections in the Design activity, namely A/B Testing which is used to select the user interface design to proceed to the coding stage, the A/B Testing method was adopted from [14] with the main condition that the average value of one of the designs exceeds 75%, the user interface design can proceed to the coding stage.

Coding activities, it has a sub-section, namely Refactoring which aims to improve the structure and errors of the program code. Furthermore, the Testing activity has a sub-section, namely the Black-Box Testing Method which aims to test the functionality of the features in the application by adopting test techniques from [15] and User Experience which aims to extract user experience when using the application, excavation techniques used is the User Experience Questionnaire (UEQ) adopted from [16], [17] to evaluate user experience. The user interface and experience are important things to evaluate when proposing an AR-based application [18]. UEQ is an easy and efficient tool or questionnaire to use in measuring UX evaluation. UEQ contains six rating scales, namely: 1). Attractiveness = Does the user like or dislike the software ?; 2). Perspicuity = Is it easy to get to know the software? Is it easy to learn how to use the software ?; 3). Efficiency = Can users complete their tasks without simple effort ?; 4). Dependability = Does the user feel in control of the interaction ?; 5). Stimulation = Is it interesting and motivating to use the software ?; 6). Novelty = Is the software innovative and creative? Does the software capture user interest ?. UEQ has 26 question components and seven answer choices using a positive and negative Likert scale [16], [17].

Then there is an additional activity, namely Software Increment, which is an activity to evaluate all kinds of application deficiencies and fix them as a way to quickly meet user needs. The term Release is also found in XP activities which aim to quickly release applications to users, even though there are still errors in the application features, so that they can be identified and handled directly.

The three XP principles most highlighted in this study are also related to small changes made step by step work better than large changes made all at once in the software development process. Responsive to changes, where if they sense that the software needs to be changed, the programmer must be able to support this decision and plan how to implement the new requirements. Cooperation and communication between teams is also very important to support the success of the software being built.

3. RESULT AND DISCUSSION

3.1 Planning

This planning stage begins by outlining what system activities are required by business needs, user needs, and system requirements. Some of the things that are done at this stage are as follows:

The activities carried out in the planning are conducting observations, namely direct observations of historical/heritage building objects that are icons of the City of Banjarmasin as well as a tourist attraction. Some of the objects include the Menara Pandang, Masjid Sabilal Muhtadin, Patung Bekantan, Pasar Terapung, Pulau Kambang, Jembatan Merdeka, Museum Wasaka, Taman Kamboja, and other tourist attractions. Observations were made by documenting the building object in detail to make 3D objects and other related information.

The second stage in planning is conducting a theoretical literature review that is relevant to the scope of research, such as its relation to the introduction of tourist attractions, tourism, interactive maps, and the application of AR technology. Then the reference sources used are in the form of information related to similar research and issues from national and international journals/proceedings, books, and printed or digital articles.

The next stage is to conduct a needs analysis consisting of user requirements and software requirements. Included in the user's requirements are that the user can see the appearance of the 3D object visualization of tourist attraction buildings along with other information after the interactive map is detected as a signpost, the user can also rotate and adjust the scale of each 3D object that appears, and the user can access the features provided by the AR-AyoKeBanjarmasin application. Included in this software requirement are Corel Draw, Blender 3D, Unity 3D, Vuforia, Android System Development Kit, and Java Development Kit.

3.2 Design

This stage consists of system design and application user interface. Figure 2 is a design flow of how the application works.

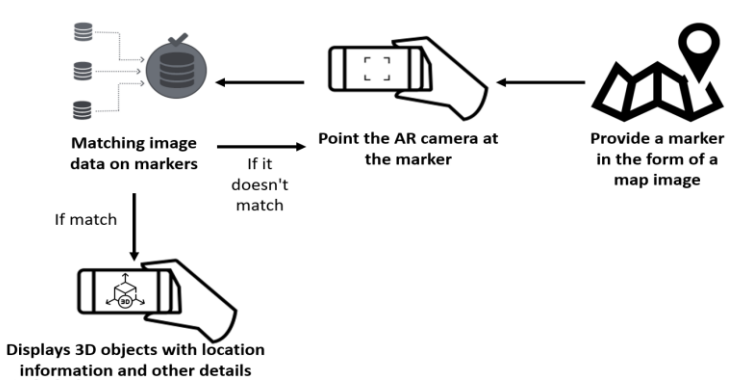

Figure 2. Application Workflow

In Figure 2, which is a general workflow of the performance design of the AR-AyoKeBanjarmasin application, the application requires a marker in the form of a map image from the City of Banjarmasin, then point the programmed AR camera at the map image marker, then it will be matched with the image owned by the AR database. If the image matches the database, it will display a 3D object from the tourist attraction building which is adapted to image detection along with location information and other detailed information that will help tourists to get to know the tourist attraction, this is what is meant by an AR-based interactive map simulation. If the image does not match the image held by the database, then repeat to point the programmed AR camera at the map image marker.

Regarding the detailed division of responsibilities (swimlane) from accessing the AR-AyoKeBanjarmasin application, it is presented in the form of an activity diagram which can be seen in Figure 3.

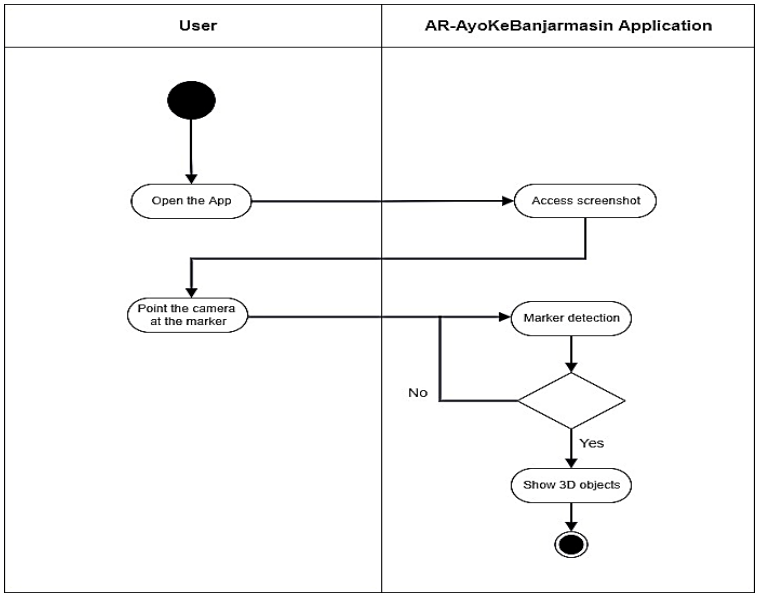

Figure 3. Activity Diagram

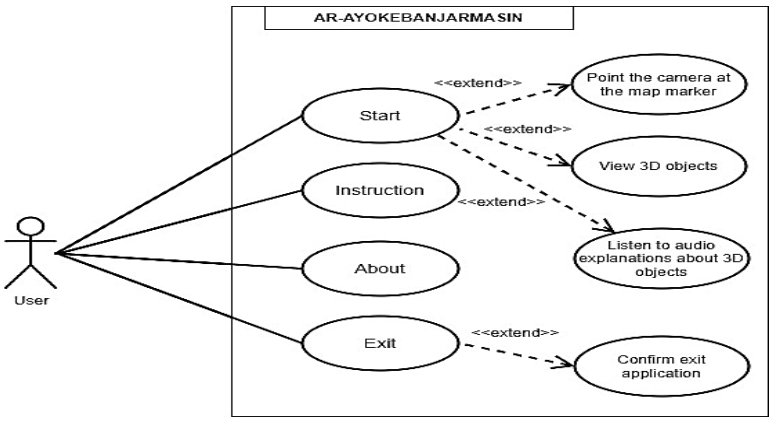

Figure 4. Use Case Diagram

Use case diagrams are used to describe a group of use cases and actors along with the relationships between them. This use case diagram describes and explains the desired behavior by the user as an actor. In this application the user can perform behavior, namely selecting menus such as Start, Instruction, About, and Exit (See Figure 4). Then there is the Use Case Realization which is presented in Table 1.

Table 1. Use case realization

ID	Use Case Realization	Description
UCR-001-01	Start	Realization of a use case that is accessed by the user to start running or open a window from the AR camera.
UCR-001-02	Point the camera at the map marker	The realization of the use case is accessed by the user, to be able to see the visualization of the 3D object. The user must point the programmed AR camera at the map image as a registered marker.

ID	Use Case Realization	Description
UCR-001-03	View 3D objects	The realization of the use case is accessed by the user to view the visualization of the 3D object from building tourist attractions according to the markers that have been detected by the database from the AR program.
UCR-001-04	Listen to audio explanations about 3D objects	The realization of the use case is accessed by the User to read and hear information related to tourist attractions along with location pointers and other detailed information with the requirement that map markers must still be detected along with visualizing 3D objects from building tourist attractions. Users can also rotate from a certain direction to see the beauty of the tourist attraction building which is presented in the form of 3D object modeling.
UCR-002-01	Instruction	The realization of the use case is accessed by the User to open information about instructions on how to use the application.
UCR-003-01	About	The realization of the use case is accessed by the User to reveal information about the purpose of the application being made and the application development team.
UCR-004-01	Exit	The realization of the use case is accessed by the user to choose the exit menu from the application in full.
UCR-004-02	Confirm exit application	The realization of the use case is accessed by the user to confirm whether he wants to continue closing the application completely or not, this notification is in the form of a pop-up.

The next design stage is to design a user interface based on user needs research, by adapting the A/B Testing method from research [14]. The A/B Testing method is used to determine and select the user interface design of the AR-AyoKeBanjarmasin application. The results of the selection of user interface designs using A/B testing involving 10 respondents as potential end-users of the application are that design A has been chosen by the respondents with a percentage of 100% and design B was not chosen by the respondents at all. In general, the reason for the responses to choosing design A is because it is quite simple and will be able to provide good interaction as needed. The results of design A from the user interface design which are presented in mockup form can be seen in Figure 5. Design A will proceed to the coding stage as a finalized user interface design.

Figure 5. App Mockups

Next, marker design is also needed so that later it can be used as a means of generating 3D objects from programmed AR applications when a marker image is detected. The marker design is in the form of a map of the City of Banjarmasin accompanied by a red dot as the main point of each tourist attraction for tracking (See Figure 6).

Figure 6. Marker Design with Map Simulation

3D object modeling designs from each tourist attraction building are also needed, which will later be used to visualize 3D objects from the results of tracking map images through markers, some examples of 3D modeling of tourist attractions can be seen in Figure 7.

Figure 7. 3D Object Modeling Design

3.3 Coding

So that the application can be run and used by end-users, the design that has been made and decided beforehand will be built using a programming language with a coding process. This stage is the implementation of the system model design that has been made into program code that produces a software prototype (See Figure 8). The application that will be used at this stage is Unity 3D, which will organize and combine all designs in Unity 3D, enter markers (map images) that have been registered in the Vuforia database so that the markers can be read by the machine, and visualize the expected 3D objects (if successful detected by the AR camera based on a predetermined target marker pattern).

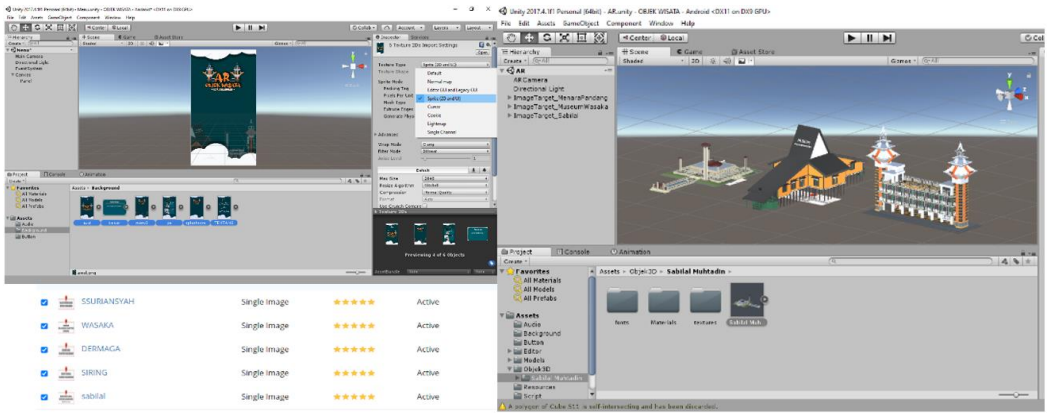

Figure 8. Coding Stages

The results of the coding by producing an application with an appropriate user interface, the implementation of the user interface of the AR-AyoKeBanjarmasin application can be seen in Figure 9 and the results of detecting map image markers through a programmed AR camera can be seen in Figure 10.

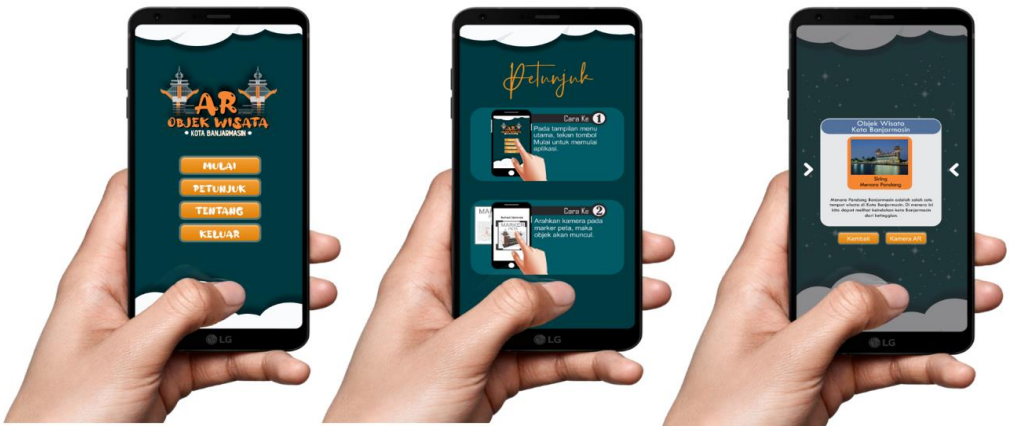

Figure 9. Application User Interface

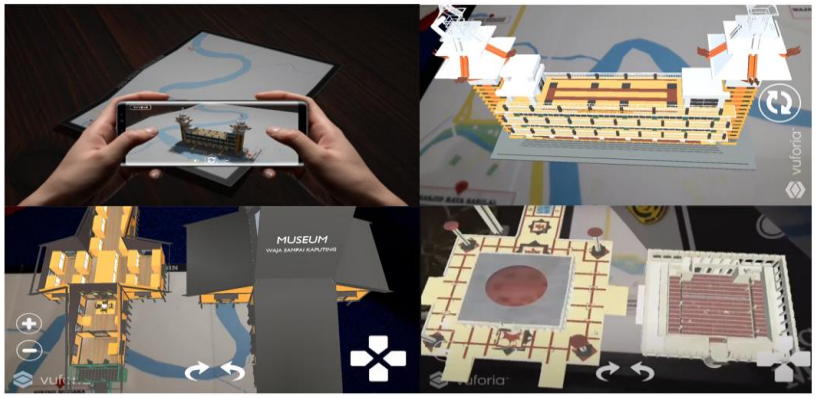

Figure 10. Visualization of 3D Objects and other information via AR Camera

Based on Figure 10, the focus of the interaction made by the user with the AR-AyoKeBanjarmasin application is that the user points the programmed AR camera at the marker from the map image, then the AR camera will scan (the process of tracking and matching it between the detected image and the database image), if detected, then 3D objects from the form of tourist attractions will be visualized one by one, the next interaction is that users can access detailed information from each tourist attraction, see the interior and exterior of the building, rotate, and find the location pointer of the existence of the tourist attraction. This makes the user experience very good in enjoying his virtual journey with AR technology.

3.4 Testing

The application testing stage that has been built focuses on testing application features as the functionality side of the entire system being run. Testing is carried out by several testers and end-users of the application by reviewing the features in the application related to their functions or if there are errors and other functions that are not working properly. They should also provide comments, criticism, and suggestions. After the test results come out, a re-evaluation will be carried out if there are deficiencies in the application and require improvement. Then it will enter the sub-stage of the software upgrade.

The results of testing the functionality of the AR-AyoKeBanjarmasin application using the Black-Box Testing method are presented in Table 2.

Table 2. Black-box testing results

ID	Features	Expected Results	Test Results
AR-AKB-1	Home Page (Opening)	Users can access the start page of the AR-AyoKeBanjarmasin application until the splash screen process is complete.	Succeeded
AR-AKB-2	Main Menu Page	Users can access the main menu page from the AR-AyoKeBanjarmasin application.	Succeeded
AR-AKB-3	Start Button	Users can access the start button to go to the AR camera page.	Succeeded
AR-AKB-4	AR Camera Page	Users can access the AR camera that has been programmed and direct it to the map image marker, so that a 3D object visualization will appear from the Banjarmasin City tourist attraction building along with other information, if the marker is successfully detected by the application.	Succeeded
AR-AKB-5	Rotation Button	Users can access the rotation button so that they can perform rotational actions on 3D objects from various directions to see views of tourist attraction buildings (interior and exterior).	Succeeded
AR-AKB-6	Back Button	Users can access the back button to act back to the main menu page.	Succeeded
AR-AKB-7	Inctruction Button	Users can access the instruction button and can access the information page of instructions from using the AR-AyoKeBanjarmasin application.	Succeeded
AR-AKB-8	About Button	Users can access the about button so that they can access information pages related to the purpose of the creation and the development team of the AR-AyoKeBanjarmasin application.	Succeeded

ID	Features	Expected Results	Test Results
AR-AKB-9	Exit Button	Users can access the exit button so that they can take full exit actions from the AR-AyoKeBanjarmasin application.	Succeeded

The results of the Black-Box Testing which have been presented in Table 2, can be concluded that all application features can function in accordance with the expected test features and by taking into account the specifications of the feature requirements of each application. Overall users can access all features in the application with a percentage of 100% and can function normally.

The test results from the non-functional side using UEQ are presented in Table 3. A total of 50 respondents who were regional tourists and some from outside the island of South Kalimantan were included to assess the user experience of the AR-AyoKeBanjarmasin application. Assessment uses a Positive Likert Scale with interpretations, namely 1 = Lower Border, 1.01-1.49 = Bad, 1.5-2 = Below Average, 2.01-2.49 = Above Average, 2.5-2.89 = Good, and 2.9-3 = Excellent.

Table 3. UEQ results

ID	Aspect	Questions	Average Answer Results
UEQ-1	Attractiveness	Do users like the AR-AyoKeBanjarmasin application?	3.00
UEQ-2	Perspicuity	How easy is it to get to know AR-AyoKeBanjarmasin? How easy is it to operate the AR-AyoKeBanjarmasin application?	3.00
UEQ-3	Efficiency	Can users use the AR-AyoKeBanjarmasin application as a promotional media and introduction to Banjarmasin City tourist attraction buildings?	3.00
UEQ-4	Dependability	Can users interact with the AR-AyoKeBanjarmasin application well?	2.79
UEQ-5	Stimulation	Is the appearance and visualization of the AR-AyoKeBanjarmasin application interesting? Can it motivate users to use the AR-AyoKeBanjarmasin application as a media application for promotion and introduction to Banjarmasin City tourist attraction buildings?	3.00
UEQ-6	Novelty	Has the AR-AyoKeBanjarmasin application been innovative and creative?	2.76
		UX average value	2.93

The benchmark graph of the assessment using UEQ can be seen in Figure 11 which adopts [19] as a graphical presentation visualization that can be learned about UX quality.

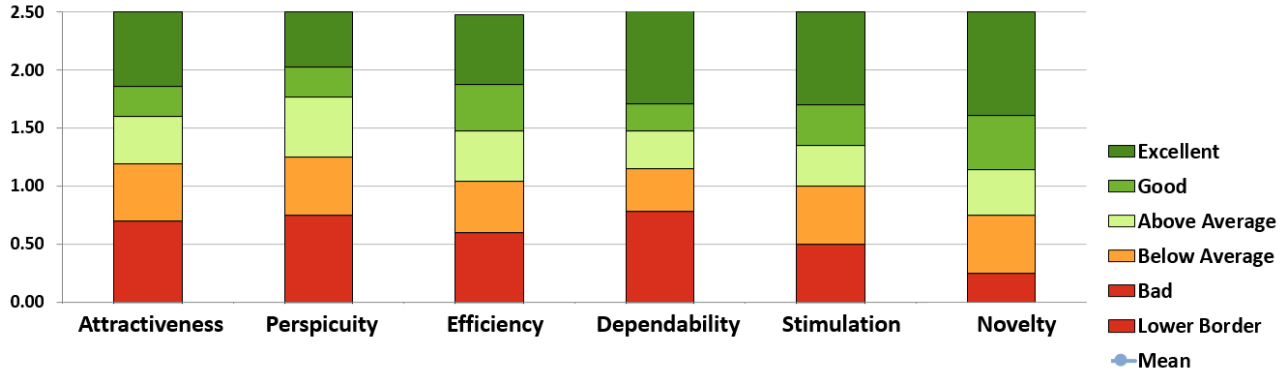

Figure 11. Benchmark Graph of UEQ Results

The results of the UEQ test based on Table 3 and Figure 11 obtained the highest score in the aspects of Attractiveness, Perspicuity, Efficiency, and Stimulation with a value of 3.00 with the predicate Excellent. Then the lowest score was on the Novelty aspect with a score of 2.76 with the predicate Good, which means that this aspect needs to be improved regarding the elements of creativity and further innovation from the AR-AyoKeBanjarmasin application. The overall average value of the user experience test using UEQ is at a score of 2.93 with the predicate of Excellent and it can be ascertained that the elements of the user experience aspect have been very well fulfilled by the AR-AyoKeBanjarmasin application. Users also feel happy and enjoy every interaction and experience when using the AR-AyoKeBanjarmasin application and have an impact on interest in visiting tourist attractions directly using the AR-AyoKeBanjarmasin

application as a location guide. There are no significant obstacles from using this application and even users feel a very extraordinary experience with this AR technology-based tour. However, furthermore, the AR-AyoKeBanjarmasin application requires innovation regarding the presence of visitor density information features and also for the accuracy of location instructions.

3.5 Software Increment

Based on the results of Black-Box Testing, there is no feature of the AR-AyoKeBanjarmasin application that does not work. However, there are some suggestions for improvements/additions for future applications, namely increasing the accuracy of tracking the location of each tourist attraction, adding visitor density information, increasing interaction, and further developing it into Virtual Reality (VR) and Extended Reality (XR) applications.

4. CONCLUSION

The application of Mobile Augmented Reality in the introduction of tourist attractions in the City of Banjarmasin can realize the virtual world into the real world, through interactive map simulations as images which are tracking media to visualize 3D objects accompanied by other supporting information in the form of audio and additional text, after functional testing is carried out with the result that all features in the AR-AyoKeBanjarmasin application can function as expected and can be accessed through mobile device-based applications. Based on non-functional testing with the evaluation of user experience, the average value generated is 2.93 with an Excellent predicate and it can be stated that the application built has met the user experience aspect very well. Furthermore, the AR-AyoKeBanjarmasin application can be a means of tourism promotion, attracting tourists, and making it easier for tourists to find tourist attractions interactively. It can be recommended for further research, namely adding a location detection feature as an accurate direction indicator, visitor density information feature is also required, increasing interaction, and developing it into a more immersive Virtual Reality (VR) or Extended Reality (XR) application.

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