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How Does ARBook Promotional Media For MSME Crafts Using *Augmented Reality* Marker Tracking Works?

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Abstract

The present study aimed to develop a virtual book displaying Jogja craftwork using Augmented Reality (AR) technology as an interactive promotional media to advertise handicraft products originated from the Special Region of Yogyakarta. "*Buku Kerajinan Jogja*" (Jogja Handicraft Book) application under this research was developed through Research and Development (R&D). The first stage of its Development was needs analysis and literature study, followed by designing the application using Use Case driven object modeling. The next was the development stage of the application and its functional testing by two media experts. In the fourth stage, two-steps software testing was carried out, namely (1) verification and validation test, and (2) quality and feasibility testing to examine its functionality, usability, portability, efficiency, maintainability, and reliability (ISO 9126-1). The findings suggest that (1) the Development of the product, *Buku Kerajinan Jogja*, might have gone through a series of proper software engineering processes from design to testing consistent with the desired specifications. Secondly, (2) the overall performance of *Buku Kerajinan Jogja* seems to be "Good" with test results of 82.98%, 82.5%, 83.3%, 85.0%, 75.0%, 75.0% consecutively for usability, functionality, reliability, portability, maintainability, and efficiency (ISO 9126-1).

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I. Introduction

Micro, small, medium enterprises (MSMEs) play an important role in Indonesia's economic growth. It has been mentioned that MSMEs could absorb around 97% of employment and contribute 61.07% of total gross domestic product (GDP). The total number of MSMEs in Indonesia grew 1.98% in 2019, with about 65.46 million units of MSMEs (BPS as cited in Kementerian Koperasi dan UKM, 2019). The amount of MSMEs is predicted to grow in the next following years.

Furthermore, MSMEs are not only contributing to employment absorption but also affecting poverty reduction in Indonesia. As Nursini (2020) pointed out, directly and indirectly, MSMEs impacted the country's poverty alleviation, although it depends on the different business scales. She found that small and medium enterprises are more effective than micro and small enterprises at alleviating poverty because they minimize the number of poor people and the Poverty Gap and the Severity Index.

The potential contribution of MSMEs to the national economy is expected to rise year by year. Wibowo (2020) argued that by 2030, these businesses could contribute up to USD 140 billion to the Indonesian economy if they develop and implement digital technology. This will be a considerable number of contributions if they take this opportunity.

There are several challenges to MSMEs, especially innovation. Pachouti & Sankalp (2016) mentioned that the constraints to innovation for SMEs in India consist of people and skills, financial, information, government policy, infrastructure, and market constraints. It is said that the economic challenges are the most significant barriers to SME innovation. Similarly, International Labour Office (2019) reported that SMEs' significant constraints in Indonesia are financed. Besides financial challenges, SMEs must face a non-financial issue, such as a lack of understanding of manufacturing and packaging techniques; lack of opportunity to stay up with the latest techniques leading to poor product quality control; lack of financial literacy, education, and training; SMEs have a limited understanding of marketing; SME's limited ability to supply products and services that meet market demand; lack of ability to develop human resources; and a lack of financial and accounting knowledge.

The current situation of the coronavirus disease 19 (COVID-19) pandemic also might exacerbate the MSMEs condition. MSMEs are the ones most affected by the ongoing COVID-19 crisis. Several researchers have reported the impacts of COVID-19 on MSMEs in Indonesia. The comprehensive study conducted by UNDP Indonesia/LPEM FEB UI (2020) revealed several has implications of the COVID-19 pandemic on MSMEs in Indonesia, especially in terms of supply and demand shocks and product distribution, and business revenue. First, nearly half of the MSMEs surveyed said they had trouble sourcing raw materials. Second, during the pandemic, nine out of ten MSMEs saw a drop in demand for their goods. Third, COVID-19 made it impossible for most MSMEs to sell their items due to distribution difficulties. Fourth, during the pandemic, two-thirds of MSMEs saw a drop in sales. It can be seen that the immediate strategies needed to tackle these issues.

The handicraft sector is one type of MSMEs influencing by the COVID-19. The lost number of local and foreign tourists in Bali and Yogyakarta has affected the handicraft business (Atmojo & Fridayani, 2021). Furthermore, the Indonesian Institute of Sciences (2020) reported that the economic contractions of wood and rattan handicraft due to COVID-19 are around 17.03% for micro-enterprises, 0.38% for small enterprises, and

0.01% for medium enterprises. Several attempts have been made to address these issues, such as utilizing online marketplaces for marketing. However, promoting and selling the products online is not enough. The MSMEs need more creativity and innovation to promote their products (Purwandari, 2019; Hardilawati, 2019).

The innovation of promotion media could be done by combining the advanced technology through marker tracking augmented reality (AR). Higher inventory turnover, improved average sales, decreased sales costs, lesser customer returns, higher levels of related-item selling, and better customer service outcomes are all expected benefits of a successful AR strategy for a brand or shop (Berman & Pollack, 2021). Furthermore, Kannaiah & Shanthi (2015) found a highly positive response towards the acceptance of AR as a marketing tool for both and offline sales. Little is known about the Development of the innovative media of promotion, which is book-formed, for MSMEs, especially in the handicraft sector. Thus, the purpose of this paper is to develop the promotion media (book-formed) for handicraft MSMEs, specifically in Yogyakarta, using marker tracking augmented reality.

II. Literature Review

Augmented Reality (AR) is a technology that successfully combines two-dimensional or three-dimensional virtual objects into the real world and projects these virtual objects with reality in real-time (Azuma, 1997). AR also has a unique advantage, namely can be applied to all senses (hearing, touching, and smelling). Besides, it has been harnessed in various fields, not only in health, military, and manufacturing industries but also in the world of education (Hermawan & Arifin, 2015). This AR technology can reveal specific information into the virtual world and present it in the real world with tools such as webcams, computers, Android phones, or special glasses.

AR is expected to add a large variety of exciting and interactive means of advertising (Affan, 2018; Rahimi, 2020). AR for product promotion has also been developed by several researchers, one of which is Hermawan et al. (2018), who developed AR for T-shirts to promote products. With the 3D visualization of augmented reality, multimedia applications can be used as promotional media. Promotional activities function as a communication tool between companies and consumers and as a media to influence consumers in purchasing activities relative to their wishes and needs. This is all done using promotional tools. In short, AR seems to be the best choice of promotional instrument in the era of technological advances as it is today (Rangkuti, 2009).

In general, there are two types of AR, Marker Based Tracking and Markerless Augmented Reality. The former approach employs black and white graphics in a square with a thick black border on a white background. In this type of AR, three main axes will be used, namely X, Y, and Z, with the help of coordinate points (0, 0, 0) and 3-dimensional virtual. This method was developed in the 1980s but has become known to the public since the early 1990s (Azuma, 1997). At this time, the Marker Tracking Augmented Reality method is being actively developed. The advantage of this method is simple and easy to use.

III. Methodology

This study was carried out within the scheme of Research and Development (R&D). According to Sugiyono (2009), Research and Development is a research approach used to produce specific items and test their effectiveness. Borg and Gall devised the stages employed in R&D, and they are as follows:

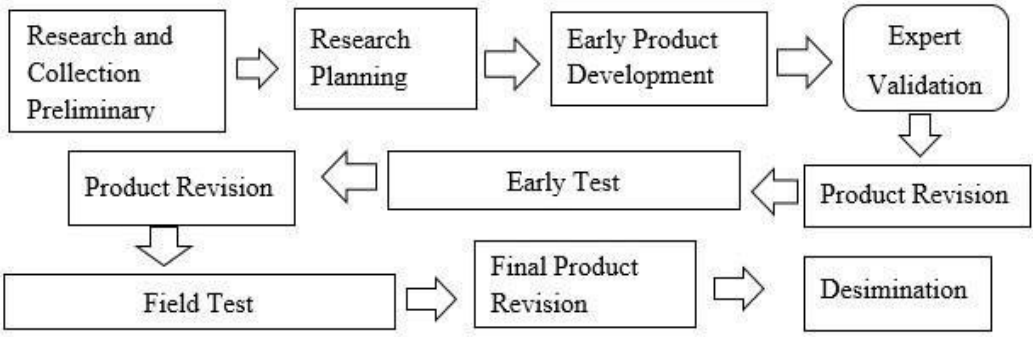

Figure 1. Research and Development Stages

The Development of the MSME handicraft book named "Buku Kerajinan Jogja" using Markerless Tracking AR under this study was carried out at the Laboratory of the Informatics Engineering Study Program, the Muhammadiyah University of Surakarta in January – April 2021. The research object examined was "Buku Kerajinan Jogja" and its Augmented Reality application as a promotional media for MSME products. "Buku Kerajinan Jogja" is available in the paper-based type and computer application format. As this paper is more focused on developing its application, the paper version of the book will not be thoroughly elaborated. Meanwhile, a user trial was carried out by visitors of tourist attractions around Malioboro, Yogyakarta. The research sample members vocational high school students with 60 samples.

In addition, conducting literature studies, observations, and surveys were done to collect the research data. Literature study is a form of writing that focuses on libraries as the subject of research projects. Data collection through observation has been one of the methods for gathering information by making direct observations of the object under the study. A questionnaire is a form of data collection instrument that consists of a series of questions. For this study, the 19-item list of questions for the usability testing as standardized by J.R Lewis was employed to examine the product developed.

Later, the data analysis in this study was based on the quantitative method, in which the authors harnessed the five-point Likert scale, namely "Very Poor," "Poor," "Fair," "Good," and "Very Good" in the questionnaires. According to Simamora (2005:27), the calculation of these data can be done by the following formula:

$$RS = \frac{m - n}{b}$$

Where:
m = highest score on the scale n = lowest score on the scale
b = number of classes or categories created

The authors interpret the calculation results through a five-scale semantic differential scale, where m= 7, n=1, and b=5 (five categories), thus the calculation is:

$$RS = \frac{m-n}{b}$$
$$= \frac{7-1}{5}$$
$$= 1.2$$

Therefore, the standard for the five categories formed with the 7th pole as the positive pole is as follows:

Table 1. Score Range for Each Category

Score Range	Category
1 – 2.2	Very Poor
2.2 – 3.4	Poor
3.4 – 4.6	Fair
4.6 – 5.8	Good
5.8 – 7.0	Very Good

Then the interval category can be made on a continuum as appear in Figure 2.

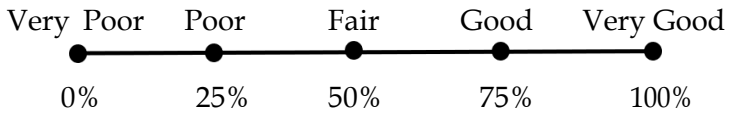

Figure 2. The Percentage for Each Category in an Interval Line

The interval line above shows the categories of data as processed into percentages. The results obtained were then categorized into "Very Poor," "Poor," "Fair," "Good," or "Very Good."

IV. Results and Discussion

4.1. Development Process

The following subheading presents the development process. In the first part, some terms and use case scenarios were defined and would appear in the developed computer application.

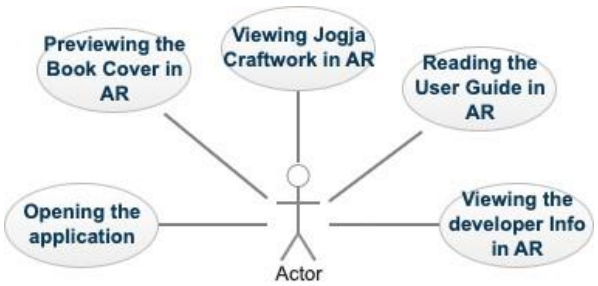

Figure 3. The Use Case Diagram of *Buku Kerajinan Jogja*

Use case diagrams were used to determine what functions are in a system and who has the right to operate these functions.

Table 2. Definition of the Actor

No	Actor	Description
1.	User	The person who runs the application

Table 3. Definition of the Use Case

No	Use Case	Description
1.	*Membuka Aplikasi* (Opening the application)	It is displaying the initial page when opening theapplication.
2.	*Melihat InformasiCover Buku* (Previewing the Book Cover)	It is displaying the information on the cover page of *Buku Kerajinan Jogja.*
3.	*Membaca halaman petunjuk* (Reading the User Guide)	I demonstrated how to use the *Buku Kerajinan Jogja* application by directing the printed User Guidepage to the computer screen.
4.	*Melihat Kerajinan Jogja* (Viewing Jogja Craftwork)	They are displaying information about the crafts available in Jogja. When the marker pages are directed to the computer application, they will display 3D objects through Augmented Reality.
5.	*Melihat info pengembang* (Viewing the developerInfo)	It is displaying information about the applicationdeveloper on the Developer Info book page.

Table 4. Use Case Scenario: Pointing the Computer Camera at the Printed Book Cover and Opening the Application

No	Actor's Action	Description
1.	Opening the application	Displaying a page to adjust the screen size and frame rate
		Displaying the computer camera screen
2.	Pointing the computer camera at the cover page of *Buku Kerajinan Jogja*	Displaying information available on the cover of *Buku Kerajinan Jogja* through AR

Table 5. Use Case Scenario: Viewing Jogja Craftwork

No	Actor's Action	Description
1.	Pointing the Marker at the page of *Buku Kerajinan Jogja* as appear on the computer screen	Displaying types of Jogja Crafts through AR
2.	Moving the Marker on the page to the right, left, up, and down	Demonstrating the craft on 3D viewpoints fromright, left, top and down view

Table 6. Use Case Scenario: Viewing the Developer Info

No	Actor's Action	Description
1.	Pointing the Marker at the developer info page to the computer screen	Displaying the app developer info in the form ofAR

Table 7. Use Case Scenario: Viewing the User Guide

No	Actor's Action	Description
1.	Pointing the Marker at the User Guide page to the computer screen	Displaying information about how to use *BukuKerajinan Jogja* in the form of AR

In this study, the generated software is a computer application named *Buku Kerajinan Jogja, developed using AR technology. T*he other one is the printed version of *Buku Kerajinan Jogja*. The application was created using the ARToolkit development tool. The following is the system's work performance and presentation.

4.1.1. The Printed Version of *Buku Kerajinan Jogja*

The *Buku Kerajinan Jogja* is a book that is used as a promotional media for Jogja handicrafts which contains 1) Yogyakarta handicrafts, 2) Instructions for use, and 3) developer information based on Augmented Reality technology. The on-paper versionof *Buku Kerajinan Jogja* is printed on 150 gr Main papers, as shown in Figure 4.

Figure 4. *Buku Kerajinan Jogja*

The book contains a craft marker on the right side of its pages. On the left side of the page is information about the products, specifically the craft name, description, category, material, price, address, and the craftsman's contact person, as seen in Figure 5. The function of the Marker on each page is to display 3D craft

objects individually through AR when directed to the computer screen.

Figure 5. A Page in *Buku Kerajinan Jogja*

4.1.2. The Application *Buku Kerajinan Jogja*

The application *Buku Kerajinan Jogja* becomes one package with the printed version of *Buku Kerajinan Jogja*. This application serves to read the Marker on the book's printed pages as it is programmed and contains a database of Jogja crafts. When the application is opened, the application will display a computer camera, as shown in Figure 6. When the Marker on the book page is directed to the computer camera, the Marker on the book page will display a 3D object following the craft featured on the page.

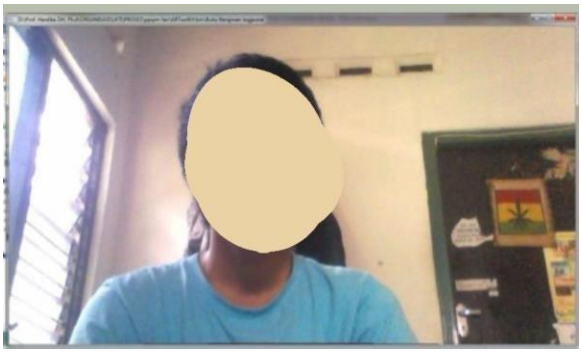

Figure 6. The Camera Screen on the Computer

4.1.3. How *Buku Kerajinan Jogja* Works

1. A user can click the *Buku Kerajinan Jogja* application shortcut on the computer.

Figure 7. *Buku Kerajinan Jogja* Application Shortcut

2. The initial setup (Property Sheet Properties) will appear after the application is opened, as shown in Figure 8. After that, the user is requested to manage the camera screen settings. The frame rate, color space/compression, and output size must all be set.

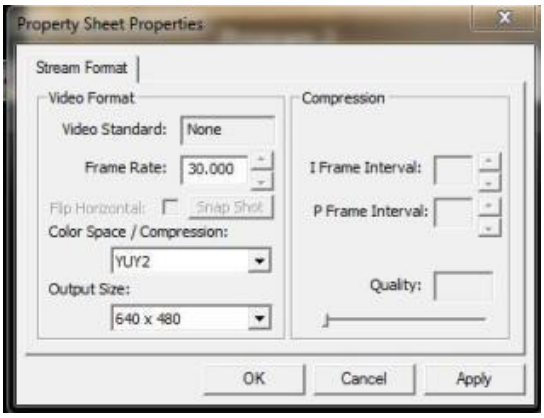

Figure 8. The Settings Page of *Property Sheet Properties*

3. The computer camera will turn on as soon as the user has set the computer screen to be viewed, as shown in Figure 9.
4. As the user holds the printed book and points its cover at the camera screen, the surface will display the text and information through AR, as shown in Figures 9 and 10.

Figure 9. Before being directed to the Computer Screen

Figure 10. After being directed to the Computer Screen

5. Then, the user may open the first page that contains instructions for using the book. As they run the page on the camera screen, it will display the AR User Guide, Figure 11.

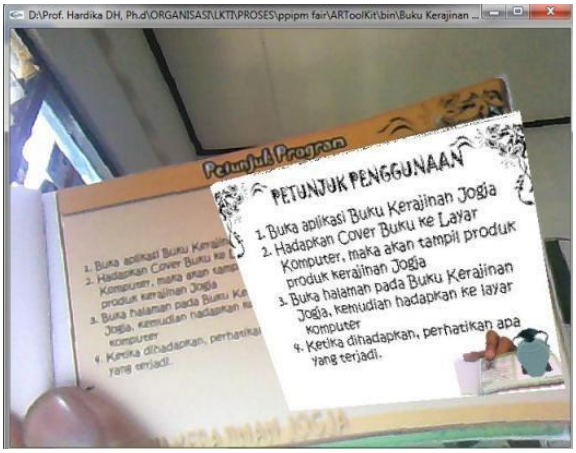

Figure 11. The User Guide

6. The following pages contain various Jogja crafts. As the user opens the pages containing the vessel and wishes to display the 3D objects, they can direct the page to the computer camera. Then, as seen in Figures 14 and 15, 3D objects will appear. The 3D objects on the pages can be rotated to the right, left, up, and down as the user wishes.

Figure 12. *Tas Wangi* (Vetiver Grass Handicraft) Page View

Figure 13. Multiple Craft Pages When Directed to the Camera Screen(The 3D Object Appears above the Marker)

4.2. Alfa and Beta Testing

Alpha testing was carried out to examine the quality of the software developed. The results of this test are in the form of research questionnaire responses by media experts who analyzed the product from its functionality, reliability, portability, maintainability, and efficiency (ISO 9126-1). The app developer, assisted by two experts in software engineering, carried out the software testing. The results of media testing in terms of functionality, reliability, portability, maintainability, and efficiency are listed in table 8 below.

Based on the Alpha testing results by media experts, the percentages of the test scores in terms of functionality, reliability, portability, maintainability, and efficiency consecutively are 82.5%, 83.3%, 85%, 75%, and 75%. Overall, the mean score of the application quality based on the testing is 80.17% and places the software in the "Good" category.

Table 8. Media Testing Results

No.	Testing	Response No.	Media Expert		Total	Percentage	Category
			Expert 1	Expert 2			
1.	Functionality	1	4	5	9	82.5%	Good
		2	4	4	8		
		3	3	4	7		
		4	4	5	9		
2.	Reliability	5	4	4	8	83.3%	Very Good
		6	4	4	8		
		7	4	4	8		
3.	Portability	8	4	5	9	85.0%	Very Good
		9	4	4	8		
4.	Maintainability	10	3	4	7	75%	Good
		11	4	4	8		
5.	Efficiency	12	4	4	8	75%	Good
		13	3	4	7		
					Means	80.17%	Good

Beta testing was carried out to examine the feasibility of the application in terms of usability. The test was done by harnessing Jr. Lewis's usability questionnaire. Therefore, the application's performance would be known after the 19-item questionnaires were successfully administered to sixty purposively selected app users from a vocational school in Indonesia.

Figure 14. User Trial by Grade X Students Majoring in Informatics Engineering

The following is the result of the calculation of the means obtained from the questionnaire. The total score for the questionnaire items is 6,622, and then it is divided by the number of respondents, sixty users. Thus, the mean score of the responses for each respondent is 110.37 for a total of 19 questions. To find out the mean score for each questionnaire item, X, the following calculation was performed.

$$X = \frac{110.37}{19}$$
$$= 5.81$$

As indicated, X equals 5.80, meaning that the mean score is the "Very Good" category based on Table 1. Then the percentage of the interval category was taken by calculating the proportions of the total data. Calculation of the maximum score of responses was made by 7 x 19 x 60 = 7980, with seven as the highest score for each item, 19 as the number of things, and 60 as the number of respondents. As previously stated, the total score for all item responses is 6,622. According to data collected from sixty respondents, the usability of the developed *Buku Kerajinan Jogja* is (6,622:7,980) x 100%, which equals 82.98 percent.

4.3. Discussion

This section consists of a critical discussion on the findings, an explanation of the novelty of the study's results, justifications of the results, and discussions on how the results differ or equate to other related studies.

Table 9. Interpretation of the Test Results

No.	Aspect	Results	Category
1.	Functionality	• The application can correctly perform82.5% of the existing functions. • Existing functions can run precisely and accurately.	Good
2.	Reliability	• The application seems to obtain a reliabilityscore of 83.3%. • The application may not hang,crash or stop unexpectedly. • The application can survive and recover from component or environmental failures.	Very Good
3.	Portability	• The application seems to gain a portabilityscore of 85%. • The application can run on variouswindows operating systems. • The application can run on multiple computer screen sizes.	Very Good
4.	Maintainability	• The application has a score of75% for maintainability. • The application can undergo version changes and upgrades.	Good

5.	Efficiency	• The application appears to get an efficiency score of 75%. • The application does not require excessive memory. • The application seems to have an efficient programming algorithm.	Good
6.	Usability	• The application likely gains a usability score of 82.98% • Overall, it is expected that users felt satisfied with *Buku Kerajinan Jogja* as a promotional media	Very Good

From design to testing, the Buku Kerajinan Jogja using AR technology went through various software engineering processes in compliance with specifications. A list of functional requirements as defined in the form of use cases throughout the design stage. The design's outputs were then integrated with development tools such as ARToolkit. The developed product was then put to Alpha and Beta testing before being made available to end-users.

Alpha testing involved the app developers and media experts in analyzing the quality of the software. Functionality, reliability, portability, maintainability, and efficiency are all quality criteria of the software examined in the Alpha test. Beta testing was undergone to investigate the usability of the computer software. Sixty teenagers from vocational school students conducted the test. Table 9 shows the results of Alpha and Beta testing.

V. Conclusion

From the result and discussion, several conclusions can be drawn. First, the Development of ARBook *Buku Kerajinan Jogja* as a promotional media has possibly gone through a series of proper software engineering processes from design to testing in compliance with the specifications. Secondly, *Buku Kerajinan Jogja* as a promotional media for handicraft products of Yogyakarta MSMEs, in general, was somewhat "Good" (with a means of 80.17%) as specified in its scores for functionality (82.5%), reliability (83.3%), portability (85%), maintainability (75%), and efficiency (75%). In addition, *Buku Kerajinan Jogja* has been deemed viable by its users, receiving a usability score of 82.98%. Finally, the study suggests that *Buku Kerajinan Jogja* developed using Augmented Reality technology can serve as a feasible promotional media for advertising Yogyakarta MSME handicrafts.

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