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The usefulness of an Augmented Reality-based Interactive 3D Furniture Catalog as a Tool to Aid Furniture Store Sales Operations

Ismail[*1], Evan Syaputra[2], Benny Dwika Leonanda[3], Nur Iksan [4], Azmi Shawkat Abdulbaqie[5], Mohd Razimi Husin[6], Hishamuddin Ahmad[7], Ismail Yusuf Panessai[8]
[1,2] Program Studi Teknik Informatika, Fakultas Teknik; Batam, Indonesia.
[3] Fakultas Teknik, Universitas Andalas; Padang, Indonesia.
[4] Fakutas Teknik, Universitas Riau Kepulauan; Batam, Indonesia.
[5] University of Anbar. Al Anbar, Iraq.
[6,7] Faculty of Human Development. Universiti Pendidikan Sultan Idris, Malaysia.
[8] Fakulti of Art, Computing & Creative Industry, Universiti Pendidikan Sultan Idris; Malaysia.
e-mail: *[1]**ismailyusuf.panessai@yahoo.com**

Abstrak

Krisis global yang diakibatkan oleh merebaknya Covid-19 berdampak pada seluruh aspek kehidupan sehari-hari. Akibat daya beli masyarakat yang buruk, beberapa toko ternama seperti Toko Mebel-XYZ terpaksa menutup beberapa cabangnya. Untuk mengatasi hal ini maka diperlukan inisiatif dan mengadopsi hal-hal unik yang akan membantu menarik pengunjung dan meningkatkan penjualan dan dengan tetap mengikuti protokol kesehatan yang ditetapkan. AR-Furniture adalah teknologi yang ideal untuk mengatasi masalah ini. AR-Furniture adalah teknologi berbasis Augmented Reality yang memungkinkan penggunaan katalog furnitur 3D untuk menyajikan gambaran lengkap sebuah furnitur dalam bentuk virtual yang tampak nyata dan identik dengan aslinya. Proses pengembangan MDLC digunakan pada aplikasi mobile AR-Furniture yang telah dievaluasi oleh 13 orang. Menurut temuan penelitian, 100% responden sangat setuju bahwa AR-Furniture membantu responden menjadi lebih efektif, membantu pengguna menjadi lebih produktif, dan memberikan ide inovatif kepada pengguna. 70% responden sangat setuju bahwa AR-Furniture memudahkan pengguna untuk mencapai tujuan mereka dan bahwa AR-Furniture memungkinkan pengguna untuk melakukan apa pun yang mereka inginkan. 100% responden sangat yakin bahwa AR-Furniture bermanfaat dan pembeli dapat menghemat waktu saat memilih furnitur yang tepat. Selain itu, AR-Furniture memudahkan konsumen untuk memilih furnitur pilihan tanpa harus banyak berinteraksi dengan pekerja penjaga toko..

Kata kunci*—Augmented Reality, Katalog berbasis 3D, Kegunaan*

Abstract

The global crisis, that has resulted from the outbreak of Covid-19, influences all aspects of daily life. Due to the people's poor purchasing power, several major stores, such as Furniture Store-XYZ, were forced to close several branches. To counter this, it will be required to adopt unique initiatives that will assist attract visitors and enhance sales while still adhering to the established health protocols. AR-Furniture is the ideal technology to solve this problem. AR-Furniture is an Augmented Reality-based technology that enables a 3D furniture catalog to present a complete picture of a piece of furniture in a virtual form that appears natural and identical to the original. The MDLC development process used in the AR-Furniture Mobile App.

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According to the study's findings, 100% of respondents agree that AR-Furniture helps to sell and to buy process be done effectively and productively and gives the users innovative ideas. 70% of respondents strongly agree that AR-Furniture makes it easier for users to reach their goals and that AR-Furniture allows users to do whatever they want. 100% of respondents strongly believe that AR-Furniture is helpful and that shoppers can save time while picking the right furniture. Furthermore, AR-Furniture makes it simple for consumers to select preferred furniture without engaging with shopkeeper workers.

Keywords— *Augmented Reality, Catalog 3D Based, Usefulness,*

1. INTRODUCTION

People's attitudes toward the usage of cellular communication technologies are changing quickly. These fosters changes in people's perspectives. Cellular communication media are regarded as an efficient requirement in society. Practically everyone has a cellular communication device [1]. This encourages business owners to embrace cellular communication media to assist the long-term success of their products [2].

Augmented Reality technology is rapidly evolving alongside the development of cellular communication tools. Augmented Reality is a technology that integrates natural and virtual objects in a natural environment, runs interactively in real-time, and integrates objects in three dimensions, namely virtual objects integrated into the real world [3] [4]. An android mobile communication tool combines real and virtual objects in a natural environment.

It is unavoidable that you will need to use furniture. The use of furniture is increasing in tandem with societal development and income growth. The global recession caused by the Covid-19 outbreak has an impact on people's purchasing power. To overcome this, creative approaches that attract visitors to increase sales are required. Furthermore, the innovative steps taken will assist in reducing the use of large rooms to display the furniture sold. Applications based on augmented reality technology are ideal for overcoming this. This technology enables the use of furniture catalogs, which can provide a complete 3D image of a piece of furniture, resulting in a actual picture that looks exactly like the original piece of furniture, compared to a 2D image on conventional catalogs.

2. FUNDAMENTAL CONCEPTS

2.1 Augmented Reality

Augmented Reality is a technology that integrates virtual objects (2D and 3D) into a real-world environment and then projects these virtual objects in real-time [5]. Augmented Reality can overlay or combine graphic, alphanumeric, or symbolic data with the user's perception of the natural world [6].

The methods used to create Augmented Reality are classified based on the need for marker images.

1. Augmented Reality that necessitates the use of markers (Marker Based Tracking)
   This method necessitates the use of a marker image, which is typically a black-and-white square illustration with bold black borders and white background. The computer will then recognize the position and orientation of the marker object and generate a 3D display with the coordinates (0, 0, 0) and an axis made up of X, Y, and Z [7]. The camera is pointed at the marker image and recognizes the marker image and then displays a 3D object based on the recognized marker image.

2. Augmented Reality without the use of markers (Markerless Tracking)
   A marker image is not required in this method to display a 3D object. Face recognition [8], object recognition [9], and gesture recognition [10] are some of the techniques used.

2.2 Android

Android is a mobile device platform based on open-source Linux. The Android operating system is written by the C programming language, every application that runs on it is written by the Java programming language, with Apache Harmony serving as its library. Dalvik Virtual Machines are virtual machines that Android uses to run its applications. Android is a crucial component of augmented reality technology [11] [12].

2.3 Life Cycle Development Method for Multimedia Development

ADDIE [13] [14] [15], Evolutionary Prototype Model [16], Rapid Application Development [17], Rapid Prototyping [18], waterfall [19], Multimedia Development Life Cycle [20] [21], Prototyping [22] [23], Object Oriented Analysis and Design [24] are some of the development methods used in previous studies. Multimedia Development Life Cycle (MDLC) is chosen as the method used for application development in this study based on input from several experts and considering the current needs and constraints.

This application's method of development follows the Multimedia Development Life Cycle (MDLC), which consists of six stages: conceiving, designing, material collecting, assembling, testing, and distributing. In practice, these six stages of an MDLC are not nessesarily done in sequential; they can be switched places. However, the drafting stage have to be the first step. Figure 1 depicts the MDLC scenes.

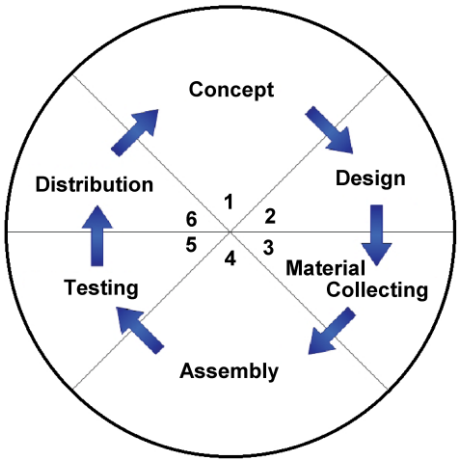

Figure 1 MDLC Stages

3. RESEARCH METHODOLOGY

This section discusses the steps taken to complete this research correctly. These are include the specifications of the used hardware and software and also the research instruments used in developing the application.

The research framework is shown in Figure 2. The preliminary analysis is the first stage. In this stage, the analysis is done by reviewing and analyzing the earlier studies on integrating appropriate computer-based technologies used to solve research problems. The second stage entails the developing of AR-Furniture as a tool using the Multimedia Development Life Cycle (MDLC) model. The analysis data is then used for designing and developing AR-Furniture content. The last phase is conducting and evaluating the usability research.

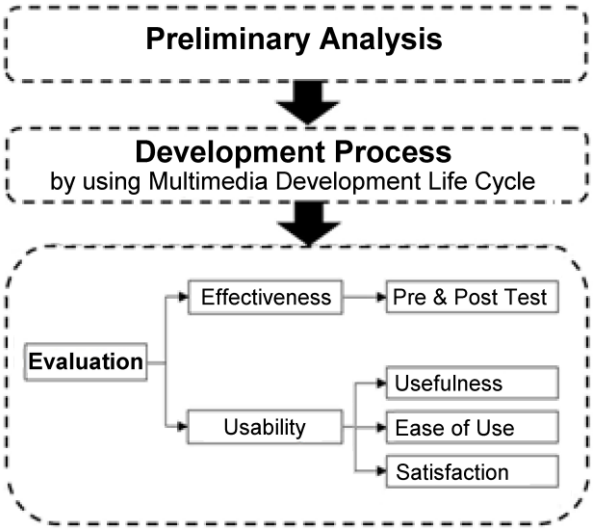

Figure 2 Research Framework

The last stage of this research's implementation is evaluation process. The evaluation process consists of effectiveness and usability. Usability testing is used to determine how easily a product can be used by specific users to achieve particular goals effectively, efficiently, and satisfactorily in the context of how it is used [25] [26]. The usability is assessed using the USE (Usefulness, Satisfaction, and Ease of Use) instrument. The USE questionnaire is divided into three sections: Usefulness, Ease of Use, and Sufficiency. In this study, usability testing was performed to determine how the AR-Furniture Mobile App can assist the Furniture Store-XYZ in introducing the furniture sold.

3.1 Software

Unity 3-Dimensional, SketchUp, Vuforia SDK, and Android Software Development Kit (SDK) are the four essential software tools used in the development of AR-Furniture applications:

1. Unity 3D. Unity 3D is the world's best real-time development platform. It has a robust ecosystem built to support system success. This development platform works on various media, including iOS, Android, Windows, and Xbox One. This platform is a component of an integrated development environment (IDE) that allows users to use simple programming languages such as C and JavaScript [27] [28]. Unity will be helpful in developing AR-Furniture Mobile Apps for designing and creating 3D images/objects on AR-Furniture. The primary components of Unity 3D, namely [29] [30]:
    - Resources. It is a storage location in Unity for sounds, images, videos, textures, and anything else you want to use in Unity.
    - Set pieces. It is a section of the game that contains in-game content such as creating levels, menus, waiting displays, and so on.

- Objects in the game. When an asset is moved into the scene, it transforms into a game object. Where the object can be moved, resized, and rotated in a controlled manner.
- Constituents. Components can be inserted into game objects to generate new reactions such as collisions, particle spawning, and so on. Elements, in essence, cause new respons to in-game things.
- Screenplays. Unity supports three scripting languages: javascript, C#, and Python. However, there is no way to use the script in Unity. Scripting in Unity is straightforward because the script text is short and to the point, pointing directly to the action you want to perform. Script users in Unity must use other programs provided by Unity.
- Prefabrication Prefabs are places to store a specific type of game object so that it can be easily replicated. Prefabs also make complex objects easier to create, but their primary purpose is to make it easier to create multiple things at once.

2. SketchUp is a modeling program that creates 3D objects, the output of which is a 3D graphic sketch. SketchUp is appropriate for use in pre-designs because it is simple to use to create 3D objects with a ratio of length, width, and height that does not have a definite size [31]. Editing is more superficial than with other software [32].
3. Vuforia SDK. Vuforia is a mobile Augmented Reality Software Development Kit (SDK) used to create AR Apps. Vuforia can also store data and act as a database for applications. Vuforia has functions in the developing AR-Furniture Mobile Apps, such as tracing images, providing different image adjustment angles, and allowing the creation of objects from different perspectives. [33] [34] Formalized paraphrase
4. Android SDK. The Android Software Development Kit enables developers to quickly and easily create applications. One of the most effective development tools for creating market-leading applications and accelerating performance. Debuggers, emulators, libraries, and documentation are examples of development tools. The studio-developed Android apps are compatible with a wide range of intelligent devices. The Android SDK is vital in the developing mobile AR-Furniture applications for 3-D drawing centers and building easy-to-use applications [35].

3.2 Hardware

Running programs requires much hardware. A computer with Android supports the operating system, namely Windows 10.1, an Intel Core i7 processor, a 1 TB hard drive, and 16 GB of RAM required for processing high-resolution 3D images, which is necessary for developing the AR-Furniture Mobile App. Additionally, a webcam is needed for tagging.

3.3 Research Instrument

It is critical to have a thorough understanding of an application's basic functional requirements to create a satisfactory and practical application. Questionnaires and semi-structured interview sessions are two essential tools in AR-Furniture.

The questionnaire used was modified from Panessai et al. [25] [26]. The purpose of the questionnaire is to learn about user expectations and needs for the AR-Furniture Mobile App. The number of respondents is 12 who work at the Furniture Store-XYZ from July 24, 2021, to August 23, 2021.

3.4 Process of AR-Furniture Mobile App Development

The developer uses the information related to the instructional that has been collected to design the content. The design of the storyboard and the interface of the AR-Furniture Mobile App were then continued. Figure 3 depicts the detailed flowchart used in the developing the AR-Furniture Mobile App.

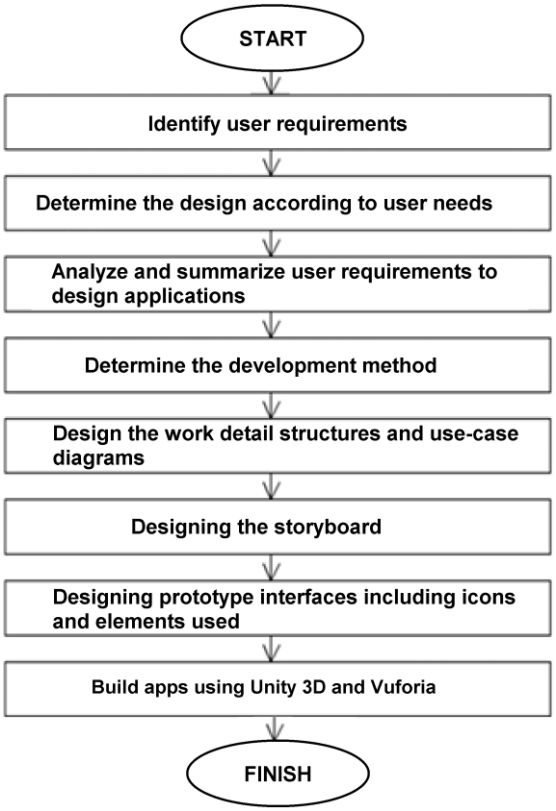

Figure 3 Flowchart used in the development of the AR-Furniture Mobile App

The MDLC method was used in this study to develop applications because it is suitable for system development in multimedia applications, and the stages can be exchanged according to research needs [36]. The following steps comprise the application development process:

- The concept. Conceptualization is carried out at this stage to determine goals, identify users, and describe the application concepts required at the XYZ Furniture Store.
- Design (Style). At this stage, specifications for the program architecture, style, appearance, and material requirements for developing applications are developed.
- Material Collection. This is the stage in which materials required for the application process, such as furniture images, are gathered.
- Assembly (Construction). This is the stage of application development that includes all multimedia objects or materials. The result of this application is based on design stages such as storyboards, flow charts, and navigation structures.
- Testing (Examining). This stage includes both alpha and beta testing. Alpha testing is performed in the development environment, and if the application is functioning correctly, beta testing is initiated. End-user testing is included in beta testing.

- Distribution. At this point, the application is saved to a storage medium.

4. RESULT AND DISCUSSION

Twelve employees from the Furniture Store-XYZ took part in an evaluation study that included two types of tests:

1. the effectiveness of the AR-Furniture mobile app, and
2. the overall usability of the AR-Furniture mobile app.

The effectiveness of the AR-Furniture Mobile App was evaluated using a quasi-experimental design. There were two groups in this study: the treatment group and the control group. Employees in the control group used a standard catalog, whereas employees in the treatment group used the AR-Furniture Mobile App as a catalog, which used AR technology.

Both groups were subjected to a pre-and post-test. After the post-test, employees in the treatment group were given a System Usability Scale (SUS) questionnaire to evaluate usability and gain insight into their perceptions and reactions to the AR-Furniture Mobile App.

4.1 The Effectiveness of the AR-Furniture Mobile App

The analysis of covariance (ANCOVA) was used to test the research hypothesis at a significant level of 0.05. The experimental design reduces bias by adjusting the pretest as a covariate, so ANCOVA was chosen.

The null hypothesis (H0) states that there is no significant difference in average employee performance between the treatment and control groups after using the AR-Furniture Mobile App versus the traditional method.

The ANCOVA calculation results show that the value of F (1.51) = 133.91 with p = 0.00, p 0.05, then H0 is rejected. The results revealed a statistically significant difference in average employee performance between the treatment and control groups after using the AR-Furniture Mobile App versus traditional methods.

According to the Marginal Means Estimation results, the control group has a slightly lower mean value (estimated mean score = 53.48), and the treatment group has a slightly higher mean value (estimated mean score = 70.69). If the covariate pretest with value = 53.06 were held constant across groups, this would be the mean score.

Employees in the treatment group performed better using the AR-Furniture Mobile App than employees in the control group who used catalogs using traditional methods, according to the results. These findings are consistent with Wedel et al. [14], who demonstrated the positive impact of incorporating AR technology into a product's marketing environment.

4.2 AR-Furniture Mobile App Applications

The questionnaire was designed to assess the usability of the AR-Furniture Mobile App. Figure 4 depicts the appearance of the AR-Furniture Mobile App and the questionnaire results, as shown in Table 1.

Table 1 Questionnaire: Usefulness

		1	2	3	4	5	SUM
The usefulness of AR-Furniture							
Q-A1	AR-Furniture Mobile App makes me more effective.	0	0	0	0	13	13

Q-A2	AR-Furniture Mobile App helps me more productive.	0	0	0	0	13	13
Q-A3	AR-Furniture Mobile App is useful.	0	0	0	0	13	13
Q-A4	AR-Furniture Mobile App gives me the idea of being creative and innovative.	0	0	0	0	13	13
Q-A5	AR-Furniture Mobile App makes the things I want to accomplish easier to get done.	0	0	3	3	7	13
Q-A6	AR-Furniture Mobile App saves me time when I use it.	0	0	0	4	9	13
Q-A7	AR-Furniture Mobile App meets my needs.	0	0	0	0	13	13
Q-A8	AR-Furniture Mobile App does everything I would expect it to do.	0	0	0	0	13	13

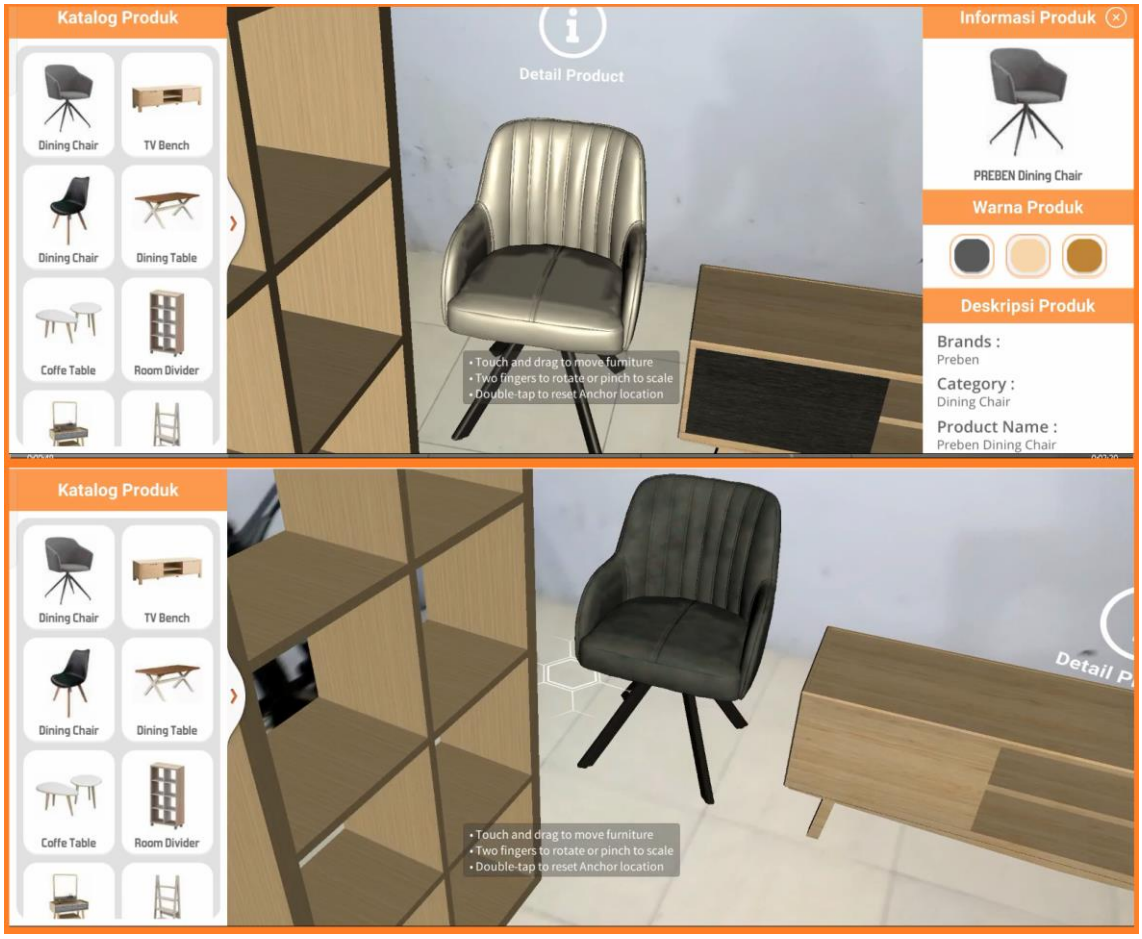

Figure 4 AR-Furniture Mobile App Display: Chair Type Selection

This stage collects data on what needs to be done to improve the performance of the AR-Furniture mobile app. The questionnaire is made up of eight questions that were graded by the respondents. Figure 5 depicts the responses of respondents to AR-Furniture.

According to the responses, 100 percent of respondents strongly agree with the statement that the AR-Furniture Mobile App helps respondents to be more effective (Q-A1), more productive (Q-A2), and helpful for users (Q-A3). Furniture inspires users to be creative and innovative (Q-A4).

Respondents' responses to Q-A5 questions about the AR-Furniture Mobile App making things easier for users to do are as follows: 54 percent strongly agree, 23 percent approve, and

23 percent are average. In response to the Q-A6 statement about the AR-Furniture Mobile App saving visitors time when selecting appropriate furniture, 70% strongly agreed, and 30% agreed. While Q-A8 claims that the AR-Furniture Mobile App does everything the user expects (visitors can choose the desired furniture without interacting with store employees), 100 percent of respondents strongly agree.

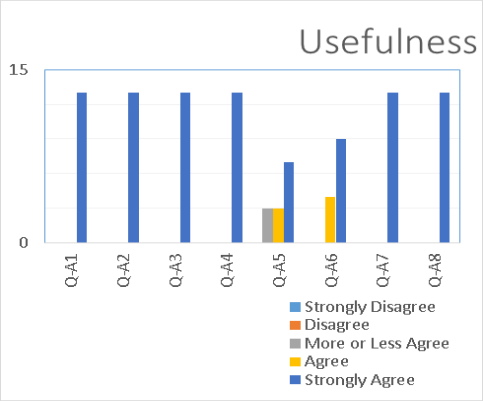

Figure 4 Respondent's Response: Usefulness

Based on the data gathered, it is possible to conclude that the AR-Furniture Mobile App is highly beneficial to users, in this case, the employees of the XYZ Furniture Store. In general, all users find the AR-Furniture Mobile App to be very exciting, which makes it easier for them to explain the details of the displayed furniture. They can assist enthusiastic visitors in mixing and matching furniture types and colors to create a harmonious look without interacting directly with potential furniture buyers.

According to follow-up interviews with respondents, four employees aged 31-40 years (30 percent of the respondents) claimed to have difficulty using the AR-Furniture Mobile App. They all agree, however, that using the AR-Furniture Mobile App is very appealing to visitors to the XYZ Furniture Store.

5. CONCLUSIONS

This study expands our understanding of integrating creative and innovative technology into everyday life and can be used to simplify daily tasks. The existence of the AR-Furniture Mobile App can answer the challenges of modern technology, which requires minimal use of time and space. The creation of this interactive application encourages the use of scientific and technological elements, as well as creativity and innovation, in everyday life. Based on the usability evaluation, it is possible to conclude that the AR-Furniture Mobile App is effective for solving problems at the XYZ Furniture Store, namely attracting visitors and increasing sales while respecting the health protocols that have been established. Shop visitors can be creative and innovative in selecting the desired furniture without interacting with shopkeepers excessively.

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