The Implementation of Augmented Reality in E-Commerce Customization: A Systematic Literature Review

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Abstract—The rapid change in technology has turned the interaction between the customer and e-commerce application into more realistically. One of the advanced technologies in e-commerce is Augmented Reality (AR). The implementation of AR in e-commerce has been vast and diverse. One of these is to help customizing products based on customer needs. In understanding the extent of implementation for customization in AR e-commerce and its limitations, a systematic literature review was carried out from previous papers. From five paper databases whose publication dates range from 2012 to 2021, 32 papers discuss AR customization in e-commerce. The explanation of this result is divided into six research objectives, such as customer experience, behavioral response, purchase intention, adoption and acceptance, brand love, and attitude toward risk. In this paper, the explanation of customization in AR e-commerce will be divided into the implementation and future works.

Keywords—augmented reality, e-commerce, online shopping, customization, systematic literature review

I. INTRODUCTION

Retail e-commerce sales has been globally increased and forecasted to grow up until 2023 [1]. But because of Coronavirus, which was first found in Wuhan, China, in late 2019, e-commerce's website traffic is affected and hit the worst in the first month of 2020. But then the rate is getting higher in May 2020 with the growth rate of 2.73% [2]. This growth showed that e-commerce is still being used and needed by people.

Digital technology has impacted e-commerce as the media and other industries transformed. The digital technologies that change the e-commerce industries are 3D, the Internet of Things, Virtual Reality, Augmented Reality, and Artificial Intelligence. The changes impact not only the e-commerce business like marketing and relationship with customers, but also the operations to get more efficient [3].

One of the improving usage of digital technology is Augmented Reality or AR as it solves the complete product information of consumers' bodies in real time. This AR feature has been implemented in e-commerce, such as IKEA, eBay, DeBeers, Mini, Snap, L'Oreal, Akzo Nobel, Nike, and Zugara. With this AR try-on sensory effects, AR's advance allows

consumers to use gestures freely and various bodily actions and directly interact with virtual products based on personal preference [4].

AR is an interactive technology that has been widely used and has been popular in retail as its ability to provide enjoyment and deliver convenience value to customers [5]. The widespread adoption of retail has been conducted in many studies to understand AR usage factors in different contexts [5].

Although the research of reality technology has been done since early 2000, it is still in an exploratory phase when it comes to its usage and still needs much technological advancement because there is still a lack of scientific information and empirical research [3]. Furthermore, a report stated that most of the returned products from e-commerce come from apparel with around 70% because of the wrong size or color [6].

However, a survey by DigitalBridge in 2017 stated that most firms (51%) fail to take full advantage of the technology and one of the main reasons firms are not successfully integrating digital online and offline customer experience [7].

This research is about a review of the AR implementation in e-commerce, especially in customization. Besides the implementation, some limitations and future studies written in the previous articles are also described in this paper. In getting detailed information, we propose some research questions. The research questions are:

1. How is the implementation of AR in e-commerce customization?
   a. How many papers have discussed about customization using AR in e-commerce?
   b. What are the objectives and motivations in using AR in customization in e-commerce?
   c. What methods and technology used in implementing AR in e-commerce customization?
   d. What are the implications of using AR in customization in e-commerce?

2. What are the research directions for future works in AR customization in e-commerce?

This paper consists of five sections. First is the introduction, which explains the background of the research. Second is related work about 3D technology in e-commerce and the difference between VR, AR, and MR. The following section is the research methodology explanation, the fourth describes the results and discussion, and the last is a conclusion.

II. RELATED WORK

A. 3D Technology in E-Commerce

Digital technology transformation in industry has moved into many sectors, not only media and entertainment industries, but also e-commerce, m-commerce, and social media [3]. The transformation changes the way the business runs, like the marketing, the relationship with customers, and the operations to achieve a more efficient value chain [3]. One of these technologies is 3D.

The implementation of 3D technology in retail is different between in conducting interaction with customers and in industry. In e-commerce, 3D is a transformative and disruptive technology in the way products are designed and developed, while 3D in the industry is used as 3D virtual prototypes and 3D printed prototypes [3]. Besides, online stores also use 3D to arrange their environment store layout to enhance customer service in online shopping [8].

3D in e-commerce has many benefits. It increases the functionality and interactivity, improves direct interaction between customers and products, and enhances the details of sensory depth perception. The sensory depth also makes products more realistic and engages better experience to customers [9]. 3D technology is a primary element of Virtual Reality, Augmented Reality, and Mixed Reality [10].

B. Virtual Reality, Augmented Reality, and Mixed Reality

There are different types of technology to use and apply in experiential retailing. These technologies are VR, AR, and MR in which they are different in multiple ways. The distinction among these three technologies is explains in Table 1.

TABLE I. THE DIFFERENCE AMONG VR, AR, AND MR

Difference	VR	AR	MR
Definition	An integration of digital information and actual world [11]	A complete 3D virtual representation of actual world [11]	A merger of computer-generated constructs with real-world virtual constructs [11]
Electronic Tool	Webcam or smartphone camera, or smart glasses [11]	Monitors, screens, smartphone, Head Mounted Display, and cubes [12]	Head Mounted Display [13]
Human Involvement	Still find themselves in actual, physical world [11]	Fully Immersive [11]	Still find themselves in actual, physical world [11]

III. RESEARCH METHODOLOGY

This paper uses SLR guidelines proposed by Kitchenham [14] and Kitchenham and Charters [15] with three main steps. First, it identifies the research problem and builds a research protocol for defining research questions, boolean search, database source, inclusion and exclusion criteria, and assessment criteria. The next step is implementing the research protocol and getting the results from inclusion and exclusion criteria, quality assessment, data extraction, and data synthesis. Then writing the results is the last step.

A. Defining Research Question

The research questions have been written in the introduction section before.

B. Boolean Search and Database Selection

There are five databases used in this research: ACM Digital Library, Emerald Insight, IEEE Xplore, ScienceDirect, and Scopus. These databases were accessed from Universitas Indonesia's online library website. Almost all of these databases used the same keyword in specifying the literature, but there are a little different keyword specifications in ScienceDirect's database. The Science Direct database has different limitations in conducting the Boolean search, so we divided the keywords into several parts in defining the commerce. The keyword use is ("mobile commerce" OR "m-commerce" OR "electronic commerce" OR "e-commerce" OR "electronic marketplace" OR "e-marketplace" OR "online shopping" OR "internet shopping" OR "social commerce") AND ("customiz*" OR "personaliz*" OR "config*") AND ("AR" OR "augmented reality").

C. Inclusion and Exclusion Criteria

In order to find the most relevant literature, some inclusion and exclusion criteria were managed. We limited the papers specifically according to the year and the type of publication. The inclusion and exclusion criteria are listed in Table 2.

TABLE II. INCLUSION AND EXCLUSION CRITERIA

Step	Inclusion Criteria	Exclusion Criteria
Initiation	Between 2012-2021	Less than 2012
Step 2 (Title, Abstract, and Keyword Selection)	• The paper is written in English • The paper must mention AR in e-commerce • The paper is about 3D application in customization e-commerce	• Non-scientific publication • Duplicate paper • Non-article paper (editorials, prefaces, article summaries) • Paper not related to AR in e-commerce
Step 3 (Full-Text Selection)	AR in e-commerce	• Duplicate paper • Paper about literature review • Discussion paper • Posters • Short paper, less than four pages • Paper not related to AR customization in e-commerce

D. Quality Assessment

Some checklist questions for quality assessment were applied to get a clear explanation of AR implementation. This assessment was taken after the full-text selection. The questions for quality assessment were:

1. Does the article describe the research purpose clearly?
2. Does the article describe the research results clearly?
3. Does the article provide conclusions that are relevant to the research objective/problem?

E. Data Extraction and Data Synthesis

Data extraction and data synthesis were the last step before writing the report. In synthesizing the paper, we compare, contrast, criticize, synthesize, and summarize to get the most relevant articles to answer the research questions.

IV. RESULTS AND DISCUSSION

A. Literature Review Results

In this systematic literature review paper, 32 articles were selected as the final results, after initiation, abstract, keyword, title selection, full-text selection, and quality assessment. The explanation about the number of articles in each step was described in Table 3.

TABLE III. NUMBER OF PAPERS OF EACH STAGE

Database	Step 1 Initiation	Step 2 Title, Abstract, Keyword Exclusion	Step 3 Full-Text Exclusion	Step 4 Quality Assessment
ACM Digital Library	7	0	0	0
Emerald Insight	380	35	9	9
IEEE Xplore	7	5	0	0
Science Direct	579	70	16	16
Scopus	1004	92	7	7
Total	**1.974**	**202**	**32**	**32**

From one decade Boolean search, 2012 to 2021, it can be seen that there are no articles in 2014, 2015, and 2021. Moreover, the most popular for this topic happens in 2019. The diagram explanation is given in Figure 1.
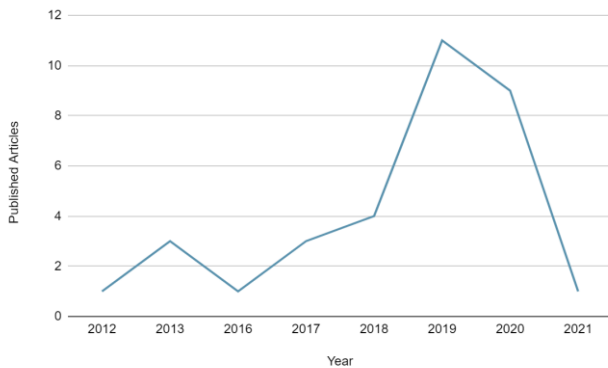

Fig. 1. Number of Published Article per Year

B. Implementation of AR in E-Commerce

The implications of Augmented Reality in e-commerce are diverse. To easily understand the AR usage, we divided this explanation into two main criteria: the AR application in serving a better performance, and the second is the AR implementation to have a better relationship with customers. Most of the AR implementations are interaction technology that is a virtual try-on product. The applications of the studies are varied, and the details of these are listed in Table 5. From 32 literature, two articles are included in the first criteria, and the rest are joined in the second criteria. We will expound on the better performing AR in e-commerce first.

Both articles in advancing AR performance are products try on virtual using footwear for executing. The author develops a cloud service framework to evaluate footwear design using a video of feet motion uploaded to the cloud. The authors found a problem in the design process of footwear, as the users. This framework uses users' feet motion as the input and will receive virtual try in a clip at the end-users [16]. The second article is about footwear customization that uses FingARTips, which uses visual tracking to detect a set of simple gestures based on the artificial vision library. This implementation also uses CAD/CAM software that can have a high computational with low-cost equipment [17].

The AR relationship with customers in e-commerce has many objectives. The objectives of using AR in e-commerce are diverse. Moreover, this categorization aims to make it easier for researchers to see literature that is in accordance with user needs, because understanding user desires is something that is not easy [9]. However, some of the literatures have the same goal direction, which are (1) customer experience that consists of flow experience, brand experience, and experiential value, (2) customer behavior response that consist of interactivity, cognitive, and behavioral response, (3) customer purchase intention that consists of attitude toward the product, purchase intention, customer decision process, and customer satisfaction, (4) customer acceptance that consists of customer acceptance, intention to adopt, and user evaluation, (5) customer brand love that consists of customer usage intention, brand love, and loyalty, and (6) customer attitude toward risk.

This paper explains the paper's theory, research object, and the implementation of AR e-commerce based on research' objective grouped before. Table 4 describes the theory used, and Table 5 describes the research object used in the previous papers.

TABLE IV. RESEARCH THEORY

Research Objectives	Theory or Model Used
Customer Experience	Flow Theory [18] [19] , Virtual Liminoid Theory [18], Cue Utilization Theory [19], Self-Determination Theory [4], The Concept of Self-Evaluation [4], Cognitive Theory [20], Narrative Theory [21], Media Richness Theory [21]

Research Objectives	Theory or Model Used
Behavioral Response	Technology Acceptance Model [22] [23] [24] [25], Stimulus-Organism-Response Model [26], Uses and Gratification Theory [27], Feeling as Responsible Theory [27], Theory of Reasoned Action [24], Cognitive Consistency Theory [24]
Purchase Intention	Stimulus-Organism-Response model [6], Self-reference Theory [28], Cognitive Fit Theory [29] [20], Psychological Ownership Theory [30], Equity Theory [31]
Adoption and Acceptance	Technology Acceptance Model [32]
Brand Love	Prospect Theory [33], The Value-Attitude-Behavior Hierarchy Consumer Decision Model [33], Self-Referencing Theory [34], Delone and Mclean Information Success Model [29]
Attitude toward Risk	-

TABLE V. RESEARCH OBJECT

Application	Articles
Garments	[33], [18], [4], [6], [21], [22], [35], [25], [36], [34], [37], [28]
Footwear	[38], [16], [17]
Accessories	[18], [4], [34]
Watch	[30]
Glasses	[39], [31], [40], [23], [32], [38]
Mekeup	[26], [24], [41], [42], [20], [43]
Furniture	[31], [27], [32], [41], [44], [28], [29]
Others (Car, Laptop, Restaurant, Toys, Wine Shop, and Space Journey)	[32], [20], [45], [19], [31]

The objective of having customer experience in using AR e-commerce leads to having some different implementation in papers. These implementations are:

1. Using EE and SP [20], having endless interactions with virtual information [40], enhancing audiovisual modality and synchronizing body control [4], using haptic imagery and sense of self-location [18], and having narrative experience for user [21].
2. Matter consumers' intrinsic motivation variables [4].

The use of AR is slightly different for the papers whose objective is response towards product. Some papers believe that AR can create brand value by simplifying decision making [22], purchase intention [26], support buying decision [23], and increase attitude toward product [21]. Nevertheless, there are different results in the relation between AR and customer response toward the product that some papers reveal that AR is not related to making better e-commerce.

AR characteristics like interactivity can affect reuse intention and purchase intention. However, the other characteristics, like system quality and product informativeness, are better in the usual web products. Besides, AR reality congruence is also equal to web product [27]. Furthermore, in another papers AR is less effective than pictures of human models in the m-commerce setting because of the limitation of eco tools and poor AR.

AR articles with the objective of purchase intention are the most published articles, with most of the objectives are attitudes toward product and purchase intention. For this, some AR implementation is:

1. Using spatial presence and personalization [41], personalized motion [37], ability to control access to personal information [31], more 3D product information [40], and applying environmental embedding and simulated physical control [30] [20], also performing quality and test believe [28].
2. Some variables used for this goal are perceived ease of use [36], perceived enjoyment [36] [35] [42], new store perception [36], perceived usefulness [35], privacy risk [35], real time interactivity [18], entertainment [18], and informativeness [42].

However, there are also some different results among papers. In paper [42], informativeness can influence behavioral responses that lead to purchase intention and willingness to buy. Nevertheless, in [29], informativeness does not influence purchase intention. Moreover, in [6], AR has less to make a decision, while physical try-on has higher attitude and purchase intention, good visual information, and higher telepresence level than AR in e-commerce [6].

The implementation of AR with the objective of acceptance, adoption, and user evaluation are:

1. Using body image [39]. Body image can form consumer evaluation that influences their media usefulness and enjoyment.
2. Apply hedonic variable (for enjoyment and pleasure) and utilitarian variable (for information) [32], and this is supported by using TAM and using different semantic pairs for analyzing specific strength and weakness of AR application [32].

Another research' objective is to get the brand value. Some AR implementation applies different variables in conducting this goal, that is (1) convenience, emotional, and social value [33], (2) information quality and visual quality [29], and (3) self-reference (rehearsability and high-level ownership control) and vivid product utilization [34].

Moreover, to have less risk on using AR and get a long-term benefit AR, the things that can be done are making customers feel familiar with the condition of choosing the product online. AR's need is a more complex, more realistic, and maybe less fun but more efficient application in design [38].

C. Research Directions for Future Works

Most articles provide research limitations and recommendations for future work. Based on the published research, some of the recommendations have been implemented. However, most authors mentioned the demographic is the limitation, especially for different countries, ages, populations. Other papers also mentioned using another object to measure the AR. This section will

discuss AR's use in future e-commerce research based on the research's objective: user experience, user behavior, attitude toward product and purchase intention, acceptance and adoption, brand love, and reducing risk, the same as a grouping in the previous section.

For user experience, the suggestions for future research are to implement sensory smell and taste [18] and apply actual shopping behavior such as economic data, item purchased, and frequency [21]. In the e-commerce experience, many studies also recommend exploring the psychological factors in using AR [21] [4] and the effect after using AR [20] and also the relationship of customer characteristics and AR flow experience [18]. Furthermore, the need to study the customer response [20] [4] toward AR application based on age, cognitive style [20], and product categories (in modality, synchronous sense, and re-processability) [4]. Last, a study also mentioned the need to find the AR benefit in brand positioning and extension [4] and how the narrative experience is shaped by AR [21].

The future directions for user behavior study are considering adding some variables, such as task-oriented value [26], perceived control in content navigation [23], and personalization during decision making [23]. Moreover, advancing AR tools need to be considered [23], like developing virtual try-on tools with zoom, rotate, have 360° view, or have a video [25].

For attitude toward product and purchase intention, the future directions for subsequent research are to advance AR function with body wrap [6], motion capture [37], personalization with human-like expression [37], AR dan VR combination [37], and generate complete and precise virtual avatar [37]. Most of the future directions for this objective is to understand the effect after using AR, from customer value [6], customer attitude [28], the psychological effect [20] [30], customer purchase decision [34], and willingness to pay form unknown brand [30], impact to a different type of customers [20], customer experience in visual imagery [6], and possible customer change in attitude toward using VTO and intention to purchase [35], also the need to consider individual characteristics in learning or using AR [41]. Moreover, the previous study also mentioned adding healthcare variables in conducting AR.

For acceptance and adoption of augmented reality in e-commerce, the future direction for research is adding variables in a model built, that is, hedonic and functional utility [32].

Future directions for brand love objectives are to study perceived difficulty in mobile shopping and remove difficulties [43], exploring IT identity [34], exploring the role of consumer characteristics [34], and understanding the cause of the difference between the sense of ownership control and self-referencing by first-person perspective [34]. Furthermore, the study was also mentioned to be ecologically valid in measuring the research [34].

There are no limitations and future research for perceived risk topics.

Besides, several things that can be considered to be used in addition to the characteristics of the respondent when conducting the survey are income [4] [21], social status [4], lifestyle [4] [36], consumer-level of familiarity [24], media used [39], before and after purchase reaction [34] [27], and also the need to consider potential interdependencies in the case of participants taking part in several experiments [32].

CONCLUSION

This study discusses the implementation and future works for AR in e-commerce. From 5 databases and a decade range for Boolean search, the final result consists of 32 journal articles. The implementation and future work are divided into two areas for AR's advanced performance and customers' relation. In understanding the relationship with customers, explaining the theories, research objects, and some variables used in the papers are delivered. Last, for future works, the report is divided into six objective areas of papers.

ACKNOWLEDGMENT

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