THE USE OF AUGMENTED REALITY IN E-COMMERCE: A BIBLIOMETRIC STUDY

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ABSTRACT

Online shopping is increasingly being used by many people because of the easy and fast accessibility factor. In this modern era, the technology applied to e-commerce innovations is increasingly diverse, one of which is using the AR or Augmented Reality feature. This study aims at analyzing bibliometric studies using VOSViewer systematically for the Augmented Reality in E-commerce topic. This paper provides data analysis regarding augmented reality in e-commerce throughout ten years (2010–2021) by utilizing mapping tools in VOSViewer. From the search results, 962 relevant published journals were found, from 2010–2021. The results show that the number of publications on this topic continues to increase from 2010 to 2021 and most of the publications are from Elsevier and Emerald. In 2019, the number of publications related to augmented reality in e-commerce increased significantly compared to previous years, and continued to grow until it peaked in 2021 to reach 308 journals. From the result from VOSviewer tools, the research of augmented reality in e-commerce is divided into 7 clusters. Each cluster explained the network connection among keywords. This means that augmented reality in e-commerce is a topic that can be combined with other topics to research and study. Furthermore, this research is expected to be a resource for researchers who conduct research on related topics.

Keywords: *Bibliometric, Augmented reality, E-commerce, VOSviewer*

1. INTRODUCTION

In a highly dynamic and interactive business environment in this modern era, the role of customer engagement in creating a customer experience gets the attention of e-commerce players. With the increasing dependence on technology, consumers are encouraged to use technology in their daily lives, including in the buying process [1].

Augmented reality has become a rapidly growing technology trend over the last ten years [2]. While increasing improvements to AR technology have led to different uses in many industries such as gaming, for example, Pokemon Go [3], education [4], and online retail for example clothing (e.g. J.C. Penney, Uniqlo, ASOS), footwear (e.g. Converse), accessories (e.g. Speedo goggles, Specsavers glasses) and cosmetics (e.g. Sephora, L'Oreal), as good as showing what items look like in customers' homes (e.g. IKEA, Dulux). Tech giants like Apple, Microsoft, and Google have recently invested hugely in AR technology [5]. As per [6], "Augmented Reality is amongst the emerging technologies that will shape the retail's future."

AR interactive elements create new immersive shopping experiences, and can provide customers with new ways to interact virtually with objects [7]. Augmented reality (AR) bridges the perceived gap between shopping in physical stores and online shopping experiences [8]. Augmented reality is an interactive technology that can enhance the retail process by offering a better shopping experience and affecting consumers' preference toward the retailers [9]. Based on a consumer AR survey by Google found that 66% of people are interested in using augmented reality technology to view products in real-time while shopping online. Jennifer Liu, Director of Product Management at Google, stated that augmented reality technology is very important to be applied in e-commerce. Augmented reality helps to bring e-commerce products to life with detailed information, enabling

customers to make confident purchase decisions. As augmented reality technology offers an immersive experience with 3D visualizations, virtual try-on, and product demos, AR provides consumers with the unique opportunity to try before they buy. As a result, augmented reality technology helps to combat high return rates as customers can make an informed purchase, which will ultimately lead to a reduction in return rates [10]. So, the use of augmented reality in e-commerce offers consumers an immersive experience, allowing them to interact in real-time with products while remaining in their environment. Moreover, AR enables businesses to inform and connect with customers as well as continue to engage consumers after they've made a purchase [11].

A bibliometric analysis is used to assess the knowledge structure and the research development by the analysis of related publications, which includes analysis by quantitative indicators such as the number of citations, most ranked authors, prime publication, and so on [12]. This is a most useful strategy to monitor the growth and productivity of any field within any period or place. Similarly, this paper aims to explore the trend of using augmented reality in e-commerce based on journal publications.

2. MATERIALS AND METHODS

The approach in this paper is Bibliometric analysis. Bibliometrics is the research area of library and information sciences that studies bibliographic material such as research publications, authors, countries' contributions, among others, by using a quantitative approach [13]. In recent years, the development of bibliographic studies has increased exponentially because of the availability of computers and fast internet. This type of study is very useful to classify and provide a general overview of a set of bibliometric documents.

2.1 Database Selection

For this paper, the database that has been considered is – google scholar" for the period 2010-2021. Also, for the study, only the good quality articles were contemplated so selected only the ones which fall under the Database Journal Collection. The criteria of the journal are that every

journal data must be indexed by Google Scholar and be in compliance with the search for the themes needed in this study, which is augmented reality in e-commerce.

The research area is Augmented Reality in E-commerce. The keyword used is also "Augmented Reality in E-commerce.

2.2 Research Method

For this study, VOSviewer is used for mapping analysis. VOS viewer is a software tool for creating maps based on bibliographic data and for visualizing and exploring the maps [14]. VOS means the visualization of similarities. It is a Java program and can be downloaded and used freely. In this study, this software was used for analyzing and visualizing the co-citation of references and co-occurrence of keywords.

3. RESULTS AND DISCUSSION

3.1 Document Distribution

Based on data obtained from a search using the Publish and Perish software, 996 journals on the topic of augmented reality in e-commerce published in journals between 2010 and 2021 were discovered. After cleaning the data according to predetermined criteria, the final result was 962 journals with total citations of 31995 and 2666 citations per year.

The record comprised 962 documents from 2010 to 2021. The distribution of the publications is shown in Figure 1. From figure 1 it can be seen that the trend of journal publications related to augmented reality in e-commerce from 2010 to 2021 continues to increase. this means that topics related to augmented reality in e-commerce are getting more and more popular. The increase in the number of published articles in peer-reviewed journals also indicates that this research topic has been recently studied under a more scientific approach. At the beginning of 2010, the rise in the published articles was slow-moving, and also in between these years, the annual average published volume does not vary much. The most significant number of publications on this topic starts in 2019, and maintains steady growth until reaching its peak in 2021 up to 308 journals.
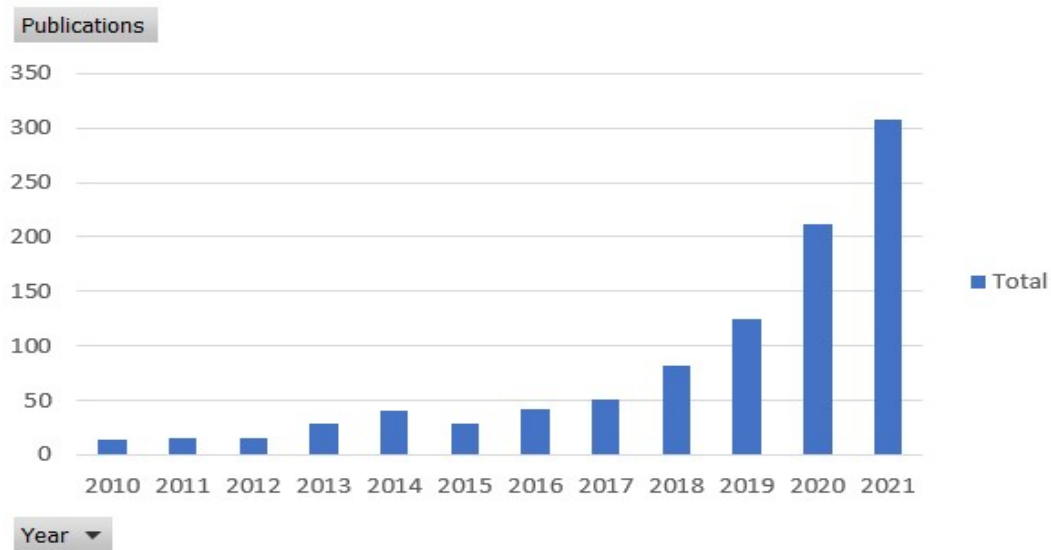
Figure 1: Articles published in 2010-2021

Table 1 shows the 10 most cited documents related to the topics Augmented Reality in E-commerce. By analyzing the data, it can be seen that the "Mobile edge computing: A survey" paper has the highest total citations, and "Effects of COVID-19 on business and research" has the highest total citations per year. The article from [15] "Mobile edge computing: A survey" describes the application areas that implement mobile edge computing, one of which is applications that use augmented reality. An example of the case raised in the article is a smart healthcare infrastructure called U-fall. U-fall senses motion detection with the help of smart device sensors, such as gyroscopes and accelerometers. U-fall intelligently maintains integrity between the smartphone and the cloud server to ensure real-time detection. MEC enables smartphones to collect patient physiological information, e.g., pulse rate, body temperature, etc., from smart sensors and send it to the cloud server for storage, data sync, and sharing. Health advisers having access to the cloud server can immediately diagnose patients and assist them accordingly.

Table 2 shows the 10 major journals, that are publishing on topics related to Augmented reality in e-commerce. The 10 journals with the largest number of publications on the subject are: Elsevier with 150 total publications followed by emerald.com, Taylor & Francis, koreascience.or.kr, researchgate.net, Springer, inderscienceonline.com, iopscience.iop.org, mdpi.com, and journals.sagepub.com.

Table 1: Most Cited Documents

No	Paper	Total Citations	TC per Year
1	Mobile edge computing: A survey	1316	263.20
2	Augmented reality: An overview and five directions for AR in education	988	89.82
3	5G Internet of Things: A survey	981	245.25
4	Effects of COVID-19 on business and research	903	451.50
5	Uses and grats 2.0: New gratifications for new media	880	97.78
6	Introduction to the special issue information technology in retail: Toward omnichannel retailing	836	104.50
7	Mobile recommender systems in tourism	523	65.38
8	Trust considerations on attitudes towards online purchasing: The moderating effect of privacy and security concerns	512	42.67
9	Digital twin-driven product design framework	497	165.67

| 10 | Fashion shopping in multichannel retail: The role of technology in enhancing the customer experience | 477 | 59.63 |

Table 2. Top 10 Publishers

No	Publisher	Number of Publications	Number of Citations
1	Elsevier	150	11742
2	emerald.com	109	3511
3	Taylor & Francis	88	5540
4	koreascience.or.kr	41	320
5	researchgate.net	37	445
6	Springer	31	1601
7	inderscienceonline.com	22	212
8	iopscience.iop.org	20	235
9	mdpi.com	18	236
10	journals.sagepub.com	17	626

3.2 Mapping

Term co-occurrence word analysis provides overview of the trends in research, as it reflects the topics covered. The analysis was performed using VOSviewer software. The VOSviewer results established 107 items and organized them into 7 clusters with 1695 links. Each cluster has a different color. The seven clusters were as follows:

- Cluster 1 has 25 items. The 25 items are area, attention, augmented reality application, challenge, concept, customer experience, digital economy, digital transformation, digitalization, e-commerce environment, education, field, game, ICT, Indonesia, information technology, insight, literature review, location, number, opportunity, problem, real-world, term, and tourism.
- Cluster 2 has 20 items. The 20 items are author, behavior, brand, china, covid, determinant, e-commerce company, e-commerce site, e-commerce website, effect, evolution, form, importance, intention, online shopping, pandemic, social commerce, social presence, theory, and trust.
- Cluster 3 has 19 items. The 19 items are a benefit, combination, digital technology, entertainment, fashion, hand, instance, integration, IoT, mobile augmented reality, mobile device, need, online, order, perception, recent year, survey, TAM, and user experience.
- Cluster 4 has 18 items. The 18 items are ability, article, case, case study, consumer experience, difference, e-commerce business, e-commerce system, effectiveness, image, implementation, interest, mixed reality, mobile application, place, trend, virtual, and work.
- Cluster 5 has 10 items. The 10 items are advertising, attitude, computer, digital marketing, India, purchase intention, relationship, rise, smartphone, and year.
- Cluster 6 has 9 items. The 9 items are artificial intelligence, big data, blockchain, e-commerce platform, era, internet, IoT, machine learning, and thing.
- Cluster 7 has 6 items. The 6 items are AR technology, augmented reality technology, chu, effective tool, interactivity, and reality technology.

The link between the terms is depicted in Figure 2. In the network visualization, relationships are represented by a network or line that connects one term to another. Network visualization is a mapping on the co-occurrence of keywords related to augmented reality in e-commerce. The 107 points with different colors represent the 107 keywords. The size of a point represents the frequency of the keywords. The line between the two points represents that both keywords occurred in one article. The thickness of the line is directly related to the proximity of connections between two keywords, the thicker the line between two words is, the closer is the relationship.

Figure 3 depicts the trend in augmented reality in e-commerce research from year to year. Augmented reality in e-commerce research based on Figure 3 took place between 2018 and 2020. The mapping is called overlay visualization. Overlay visualization is the time when a keyword appeared. Keywords in yellow appeared later than that in blue.

The density visualization in Figure 4 shows that the darker the yellow color and the larger the width of the circle, the denser the keywords, indicating that research on this topic was becoming more common. The number of studies was reduced if the color faded and mixed into the green background.
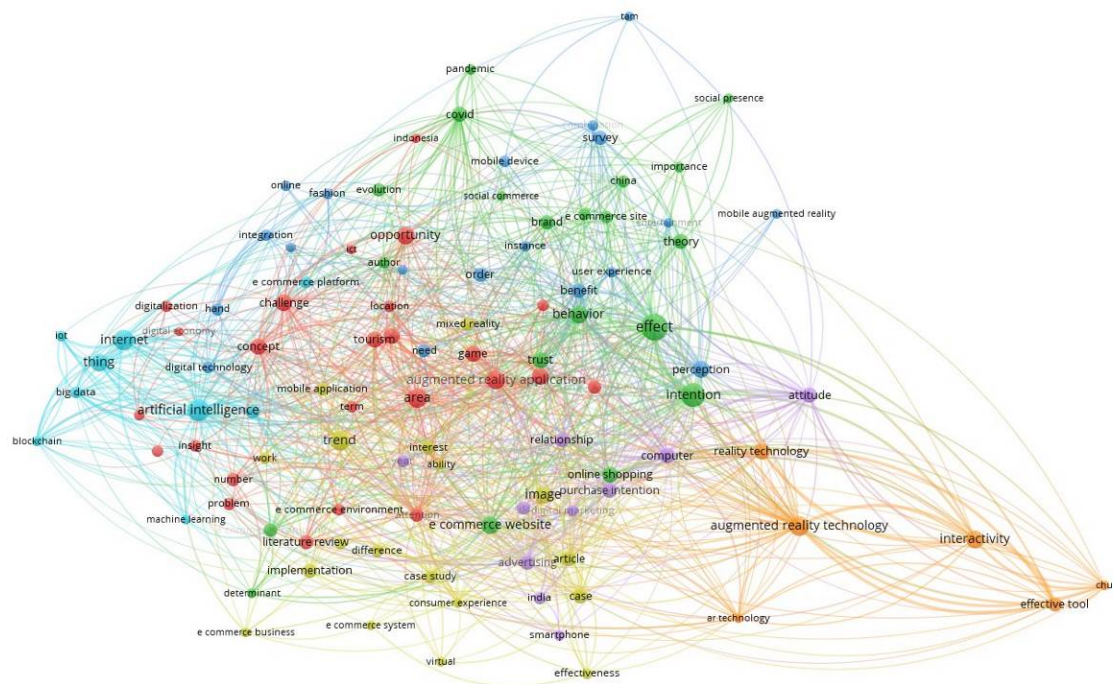
Figure 2. Network Visualization
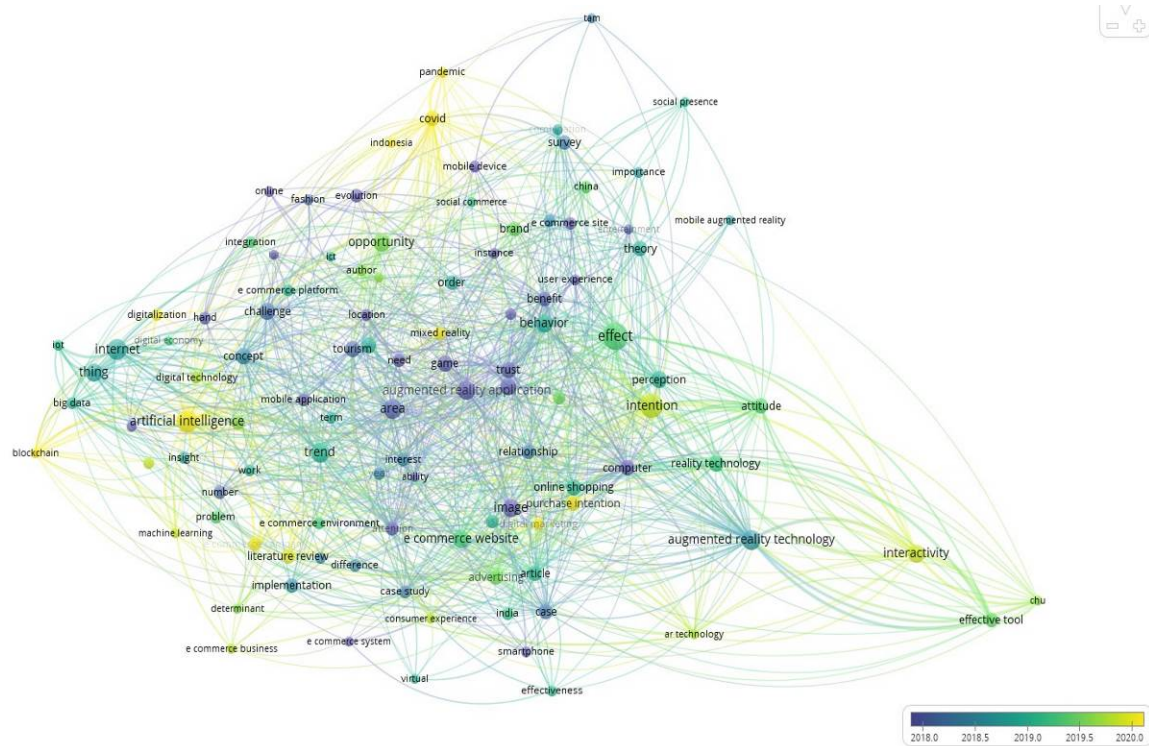
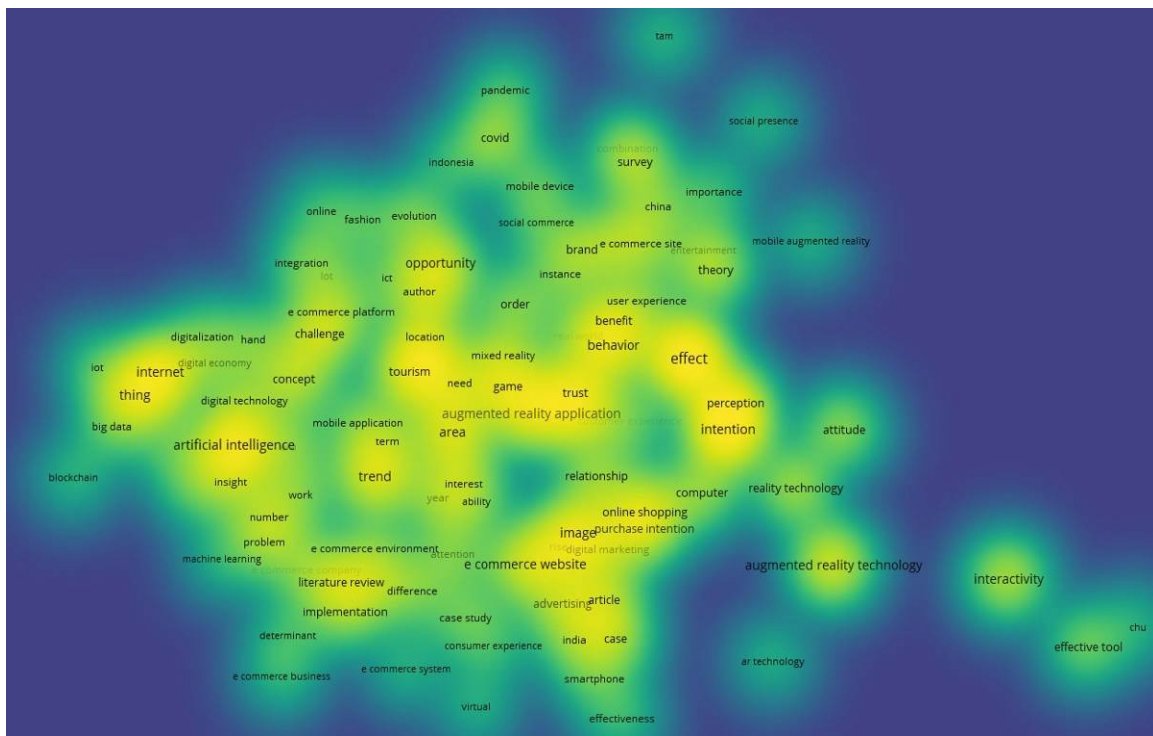*Figure 3.   Overlay Visualization*

Figure 4. Density Visualization

Each Cluster contained a relationship between two terms. Area was the most commonly used term in Cluster 1 as a research topic for augmented reality in e-commerce. According to Figure 5, area are linked to 46 other terms. Mobile device, opportunity, China, theory, entertainment, survey, combination, real-world, computer, online shopping, trust, augmented reality application, education, image, article, case, smartphone, AR technology, mobile augmented reality, attitude, mixed reality, game, attention, interest, e-commerce environment, literature review, e-commerce business, trend, integration, location, tourism, challenge, internet, IoT, big data, thing, digital technology, artificial intelligence, insight, term, year, era is all terms related to area keywords.

Effect was the most widely discussed term in the augmented reality in e-commerce in Cluster 2. effect was linked to 70 other terms in Figure 6. TAM, social presence, importance, survey, China, theory, Covid, brand, instance, user experience, benefit, behavior, trust, customer experience, relationship, computer, perception, intention, attitude, reality technology, augmented reality technology, AR technology, interactivity, effective tool, online shopping, purchase intention, effectiveness, article, image, advertising, e-commerce website, case study, consumer experience, e-commerce business, literature review, attention, term, year, interest, ability, artificial intelligence, internet, big data, concept, online, and

evolution were all terms related to the effect keyword.

In Cluster 3, perception was at the center of the term that was most commonly used as a research topic for augmented reality in e-commerce and had numerous connections with other terms. According to the graph, perception was linked to 41 other terms (Figure 7). Mobile augmented reality, attitude, reality technology, augmented reality technology, AR technology, computer, case, article, e-commerce website, attention, interest, game, augmented reality application, artificial intelligence, digital technology, challenge, author, Covid, combination, benefit, behavior, effect, and intention were all perception keywords.

Meanwhile, in Cluster 4, trend became the main center of the term that was most frequently raised as a topic of research on augmented reality in e-commerce and had numerous connections with other terms. Figure 8 depicts the relationship between trend and other words. Figure 8 shows how trends were linked to 53 other concepts. Brand, intention, attitude, augmented reality technology, Chu, area, rise, ability, digital marketing, advertising, article, case, virtual, case study, e-commerce business, blockchain, big data, thing, internet, artificial intelligence, concept, challenge, integration, evolution, Covid, pandemic, author, mobile application, field, term, and information technology.
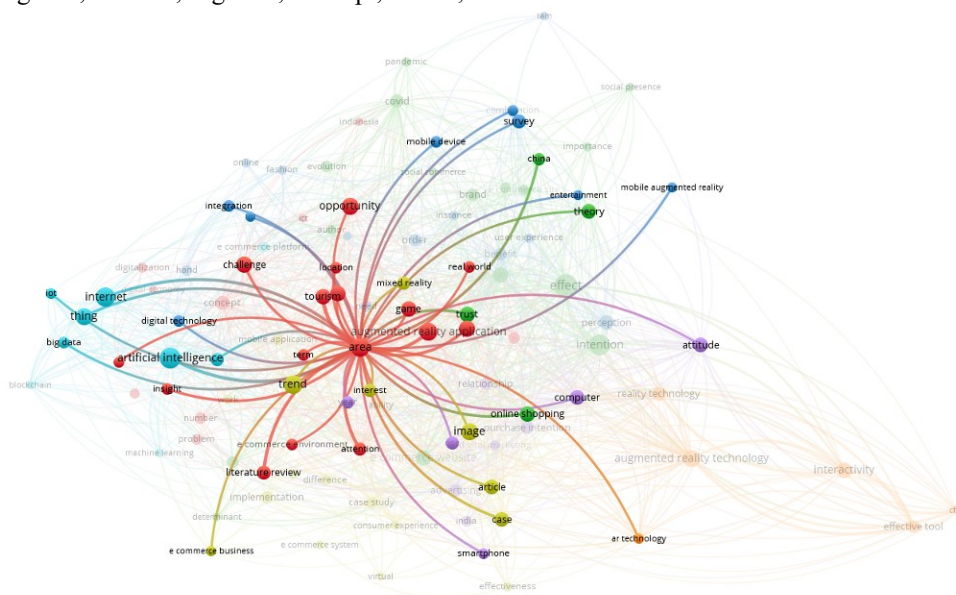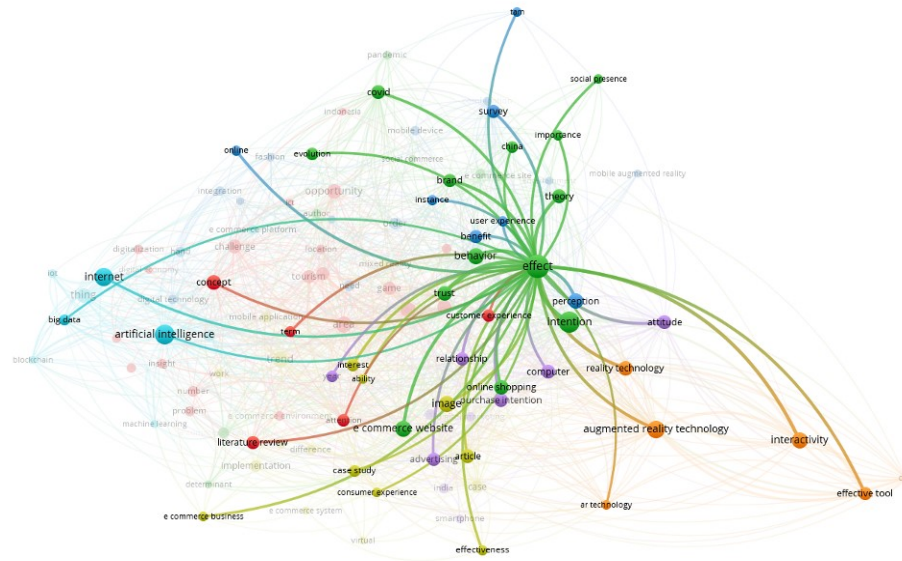

Figure 5. Network Visualization of Cluster 1

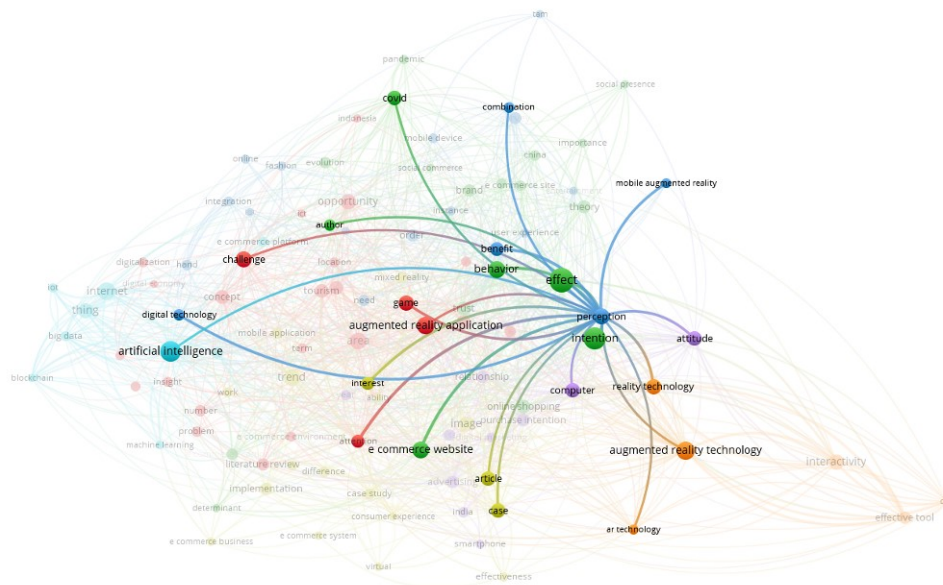*Figure 6. Network Visualization of Cluster 2*

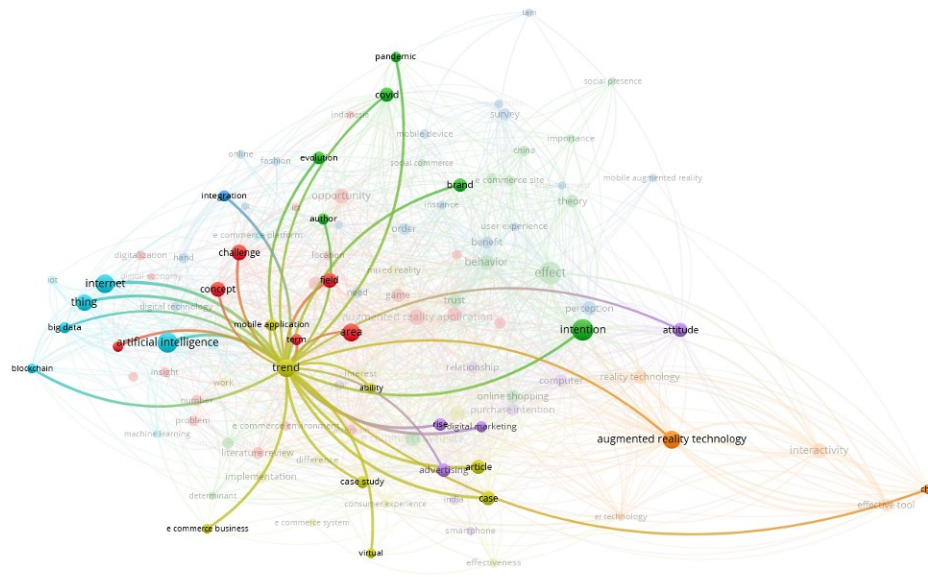*Figure 7. Network Visualization of Cluster 3*

Figure 8. Network Visualization of Cluster 4

In Cluster 5, attitude was the center point of the term that was most widely used as a research topic for augmented reality in e-commerce and had numerous connections to other terms. According to Figure 9, attitude was linked to 41 other terms. AR technology, augmented reality technology, interactivity, Chu, effective tool, reality technology, effectiveness, case, article, India, advertising, consumer experience, image, relationship, computer, online shopping, purchase intention, e-commerce company, year, trend, area, tourism, need, game, internet, concept, behavior, instance, mobile device, survey, combination, TAM, China, entertainment, user experience, mobile augmented reality, effect, perception, intention, rise, and customer experience were all terms related to attitude keywords.

In cluster 6, artificial intelligence was the center point of the term that was most frequently used as a research topic for augmented reality in e-commerce and had numerous connections to other terms. According to Figure 10, artificial intelligence was linked to 58 other terms. Covid, TAM, importance, China, theory, brand, user experience, behavior, effect, perception, intention, relationship, purchase intention, digital marketing, augmented reality technology, e-commerce system, implementation, AR technology, e-commerce business, determinant, machine learning, insight, work, e-commerce environment, literature review, attention, advertising, trend, interest, area, mixed

reality, instance, opportunity, author, evolution, online, fashion, location, tourism, mobile application, concept, challenge, integration, e-commerce platform, hand, digitalization, internet, IoT, thing, big data, blockchain, information technology, field, place, e-commerce company and digital transformation were all terms related to artificial intelligence.

Meanwhile, in Cluster 7, augmented reality technology becomes the focal point of the term that was most widely used as a research topic on augmented reality in e-commerce and had many connections to other terms. Figure 11 depicts the relationship between augmented reality technology and 55 other concepts, including AR technology, interactivity, effective tool, Chu, attitude, reality technology, perception, intention, effect, theory, computer, online shopping, purchase intention, relationship, image, advertising, article, case, smartphone, effectiveness, virtual, consumer experience, case study, e-commerce website, determinant, implementation, e-commerce company, year, trend, term, e-commerce environment, artificial intelligence, blockchain, digital economy, concept, challenge, e-commerce platform, location, evolution, opportunity, author, covid, mobile device, order, combination, survey, importance, form, user experience, benefit, augmented reality application, behavior, era, and education.
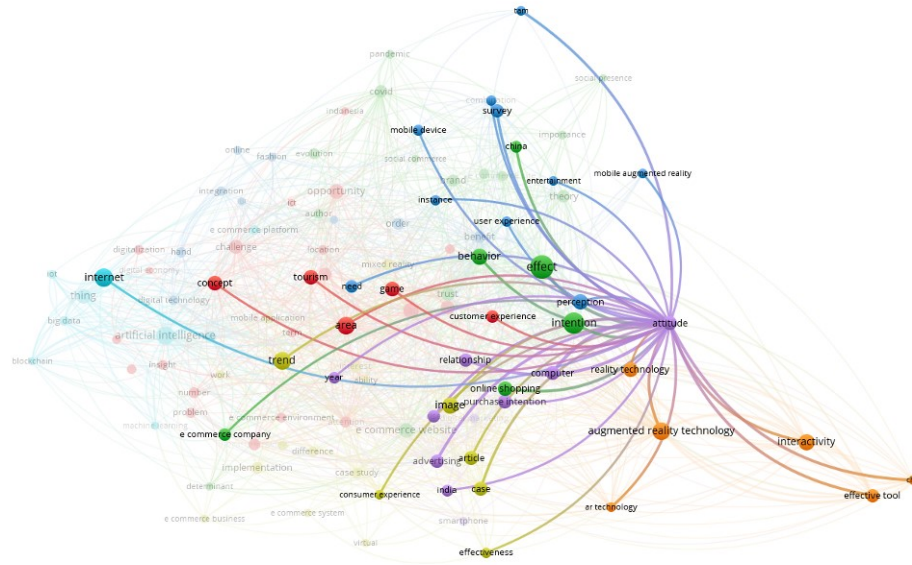
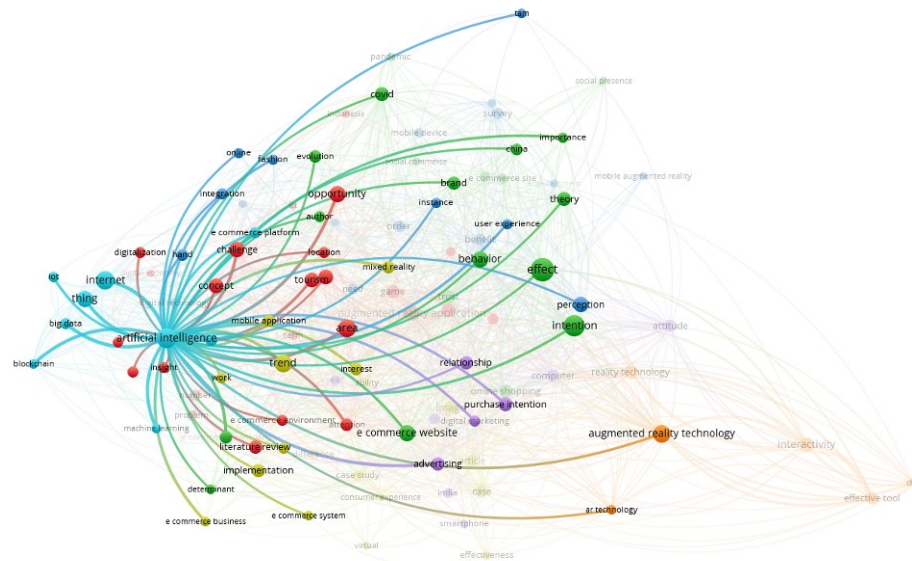*Figure 9. Network Visualization of Cluster 5*

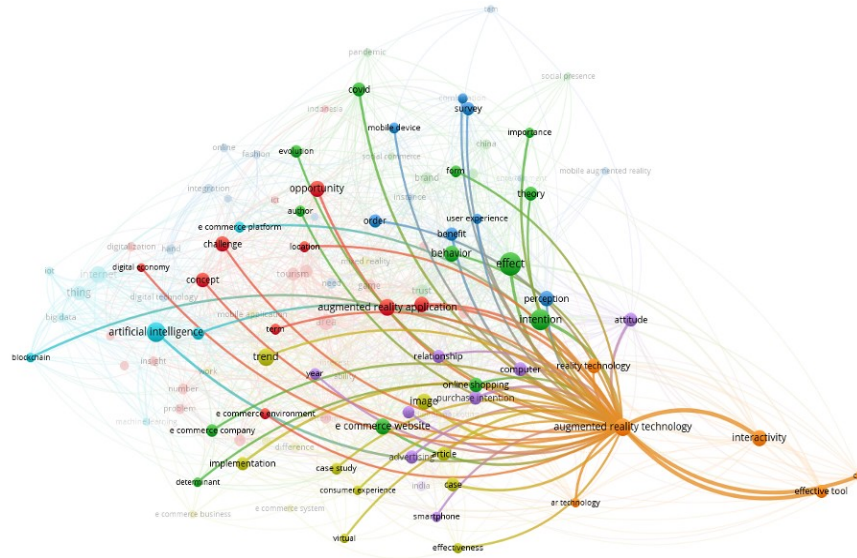*Figure 10. Network Visualization of Cluster 6*

Figure 11. Network Visualization of Cluster 7

3.3 Discussion

Not many bibliometric studies have raised the topic of using Augmented Reality in e-commerce. Two examples of previous research that are relevant to the topic of this research are Bardhan. A [16] and Aggarwal, I., & Gochhait, S. [17]

Bardhan. A [16] conducted a study entitled "Augmented Reality and Virtual Reality In Retail - A Bibliometric Analysis". The study uses the Web of Science database from 1993-2020. The increase in publication of papers in the last 27 years began after 2010. The study covered 38 countries. Based on the volume of research, the top five countries are China, the United States, the United Kingdom, Germany, and South Korea. Virtual Reality, Retail, Interactivity are one of the trending buzzwords in this field in recent years. The main research themes in AR/VR in retail are primarily focused on research directions such as technology adoption, impact on consumer behavior, and performance and control of user information.

Aggarwal, I., & Gochhait, S. [17] conducted a study entitled "Role of Augmented Reality to Enhance Consumer Experience: A Bibliometric Study". The paper aims to review and discuss research studies on the role of Augmented Reality in various industries to improve customer experience at a global level published in the Journal of Peer Review and indexed for the period 1999-2019 in the Web of Science. There is positive growth in the literature. The number of papers is less in the early years but keeps increasing year by year. The United States and the United Kingdom have the highest publications. Most cited articles mostly after 2007. Core research areas are Computer Science and Engineering. English has become the primary language for more than 92% of publications.

However, these studies differ in terms of results. This research uses the Google Scholar database and takes a period from 2010 to 2021. The result is that the number of publications continues to increase and reaches its peak in 2021. Most publications come from Elsevier and Emerald. Another difference is that this study explains in detail the results of mapping per cluster so that we can find out the topics that are most widely used and discussed in research on Augmented Reality in e-commerce.

This study will be useful for Augmented Reality practitioners to create customized solutions for customers. This study takes a detailed evaluation of current trends in Augmented Reality and future potential areas for a smarter consumer experience.

Based on existing studies, it can be concluded that the study of Augmented Reality in e-commerce, even if started early, is still in a developing phase. In the future, further research needs to be done in this regard which will include more documents to focus on the growing trends in e-commerce and changing consumer preferences due to the adoption of Augmented Reality technology. Because there are still much e-commerce that has not taken advantage of technologies that have developed rapidly at this time, even though these technologies can make it easier for consumers to shop and can improve the quality of e-commerce itself.

4. CONCLUSION

The literature review in this study only focuses on the Google Scholar database and does not include other databases such as Scopus, Crosserf, Web of Science, PubMed, Microsoft Academic, and others. The data sources were taken using Publish or Perish software.

In conclusion, this bibliometric study showed that there is a growing trend in published articles related to augmented reality in e-commerce and relative research interest in the last 10 years. This paper studied the global trend of 962 research publications journals regarding the use of augmented reality in e-commerce The results have shown that the publication rate on this topic has increasingly grown from 2010 to 2021 and most publications were from Elsevier and Emerald. Although the trend of publications increased with the growth of ICTs in the e-commerce sector, this trend seemed to highly increase from the beginning of 2019, correlating with the popularity and increased development of ICTs in the e-commerce environment. This means that the trend of using augmented reality is increasingly popular in e-commerce and is predicted to continue to increase in the following years along with the development of increasingly sophisticated technology

The mapping procedure was then completed using VOSviewer. The VOSviewer results established 107 items with 1695 links. Also from the result from VOSviewer tools, the research of augmented reality in e-commerce is divided into 7 clusters. Each cluster explained the network connection among keywords. This is important for understanding how the results have a relation for practitioners to do more research. Indeed, this can be used for further developments.

This study presented the bibliometric information related to journals of augmented reality in e-commerce from the Google Scholar database. Although relatively objective and comprehensive, this study has some limitations. First, some of the non-English good articles are not included in the Google Scholar database, so they are not analyzed in this study. Second, bibliometric data are changing over time, there may have a different conclusions as time passes by. So this study should be updated in the future. Third, the bibliometric analysis may not represent the real situation. For example, some newly published outstanding articles are not cited many times, but the sum number of times cited will increase in the future. On this condition, the bibliometric analysis may not reflect the truth.

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