

Augmented Reality for Geospatial in E-Tourism: Current Status, Research Trends, and Future Directions

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ABSTRACT

This study discusses the implementation of augmented reality in e-tourism and examines the current state of research on the topic and presents various inventions or innovations of augmented reality in tourism. These findings will provide insight for further research and experimentation opportunities that are aligned with the development of augmented reality for e-tourism in the future. There are a lot of data, models, and innovations about augmented reality that have been published in different and complex ways. It has explained the overall picture of augmented reality. The purpose of this research is to analyze and identify data sets, research trends, and methods that have been used since 2017. We use a systematic literature review method. We carry out the process of identifying, assessing, and interpreting research evidence and reviewing the literature to answer specific research questions. We conducted the analysis by selecting the main study in the field of augmented reality on e-tourism. We have mapped trends, data sets, and methods on augmented reality implemented in e-tourism. This study concludes that we have successfully identified and analyzed research trends in augmented reality in a measurable and systematic way in the last 5 years.

Keywords: *augmented reality, geospatial, e-tourism, trend research, future direction*

INTRODUCTION

Augmented reality has experienced rapid development in various fields of life. The presence of this technology allows us to be able to integrate virtual objects with the real environment in real-time. Augmented reality itself has been widely applied in various fields including health, education, entertainment to tourism. For a country, the tourism sector has an important role as a source of foreign exchange earnings and can encourage national economic growth. Over time, the tourism sector has transformed digitally by utilizing various technologies. Among the various existing technologies, augmented reality is one of the innovations that can improve the tourism sector if it is maximized properly. The application of AR technology in the tourism industry is usually with the addition of graphics or information that is visible through compatible devices. AR technology can be used on smartphones, tablets, or other devices. Many people rely on their smartphones to complete their travel trips. With AR, users can effectively get an enhanced travel experience through interactive maps. An attractive and easy-to-use navigation feature is useful to help users during their travels.

Many new concepts, ideas, and findings regarding augmented reality (AR) have been generated by developers around the world. However, for its use in the tourism sector, it has not been widely reviewed by researchers, so a comprehensive research trend has not been seen. In various travel and tourism literature, there are no studies that review the current state of AR (Loureiro, Guerreiro, & Ali, 2020). If maximized, AR can offer many opportunities to add value, providing travelers with new ways to explore unfamiliar surroundings. The more massive the development of augmented reality is, we need a review that can produce research trends and directions in the future. With this review, it will be the basis for thinking so that we can see new topics and topics that can be investigated further.

Several studies on AR in the context of tourism have been carried out, including research on exploring the value of AR from the perspective of tourism experts (Cranmer, tom Dieck, & Fountoulaki, 2020). In addition, there are also studies that identify key factors in the use of AR that have an important influence on tourism, which must pay attention to aspects of general requirements, functionality, issues, overlay types, and technology (Keckes & Tomicic, 2017). These studies have provided an overview of how AR can be utilized for tourism. Therefore, it is important to conduct a review to ensure that AR has experienced significant development so that it becomes an option in maximizing tourism potential in the future. It is also important to explain future research trends that will be carried out or an opportunity to conduct in-depth research.

With the existence of various studies on AR that are published regularly and complexly, this research becomes important to do in order to conduct a comprehensive and systematic review. It is very important to get an overview of the current status, research trends, and future directions for the implementation of augmented reality in e-tourism. The purpose of this study is to thoroughly identify the current status, research trends, and future directions on the use of augmented reality in e-tourism through a literature review in the last 5 years.

METHOD

Review Method

The method used in this study is a systematic literature review. Researchers design research questions and collect data related to these questions. Data were obtained from various journals, proceedings, and other supporting literature. The SLR approach is used to review several research trends regarding augmented reality in e-tourism. This approach aims to search, filter and analyze

studies relevant to the topic being discussed. This method has stages, namely planning, conducting, and reporting. To review various existing references, the researcher used the PRISMA model. Using this model, we can use the literature obtained as a basis for reporting reviews and evaluations.

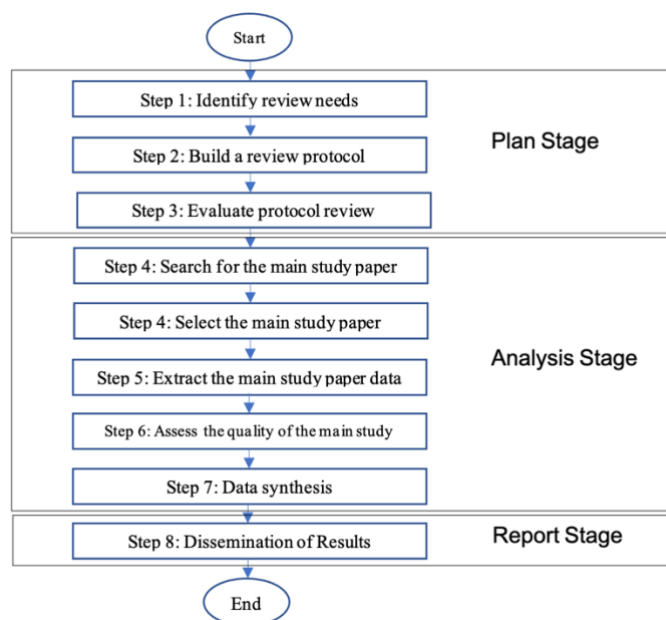


Figure 1. Stages of Systematic Literature Review

Research Questions

This section focuses on creating research questions that are used to conduct a literature review related to the topic under study. Table 1 describes the structure of the research questions that will be the focus to be answered in this study. The formulation of research questions should be based on five elements called PICOC. The five elements can be described in the following table.

Table 1. Summary of Question Structure

Population	Augmented Reality, Geospatial, E-Tourism
Intervention	Augmented Reality Innovation for e-tourism, Augmented Reality Development for E-tourism
Comparison	n/a
Outcome	Augmented reality research trends in e-tourism
Context	Studies on the application of Augmented Reality to E-Tourism

After formulating the question structure, we structured the research questions as shown in table 2.

Table 2. Research question

Id	Research question	Motivation
R1	What journals are significant about augmented reality for e-tourism?	Identify significant journals on AR for e-tourism.
R2	Who are the researchers who are actively conducting research on the use of AR for e-tourism?	Identify researchers who have conducted research on AR for e-tourism.
R3	What are the findings or innovations that researchers have found regarding AR for e-tourism?	Identifying research topics and trends regarding AR for e-tourism.

Figure 2 shows the mind map of the research questions we propose to answer clearly. The mind map makes it easier to explain all of the systematic literature review questions conducted in this study. The main purpose of this research is to answer research trends, active researchers, and future trends regarding augmented reality in its use for e-tourism.



Figure 2. *Mind Map Systematic Literature Review*

Search Strategy

The search is carried out through a series of processes to select articles reliably from databases, libraries, and various other digital sources that have the best level of credibility at the international level. Keywords are determined carefully and thoroughly and ensure the filtering process is carried out correctly. We start by defining keywords precisely so as to increase the probability of articles being found. In addition, with the right keywords, we get articles that are relevant and reliable. We determine the search strategy through an online database that is trusted and has a globally recognized reputation. The list of online article databases that we use is as follows:

- ScienceDirect (sciencedirect.com)
- Springer (springerlink.com)
- Scopus (scopus.com)

Study Selection

The search is carried out based on criteria that have been made previously and have been consistently set. We use research questions that have been formulated previously to limit the search for articles as well as a filter to select various articles that we find in the aforementioned databases.

We use exclusive and inclusive criteria to select various scientific papers in the scientific paper database. The criteria are as follows:

a) Exclusive Criteria

- We only choose papers that are written in English, otherwise, ignore non-English papers
- We only use papers whose methods are closely related to augmented reality in its use for e-tourism
- We ignore papers that lack good and reliable validity or experiments whose results can be trusted with the main topic of augmented reality.

b) Inclusive Criteria

- We do not choose papers that have been published in international conferences or journals if the paper has a conference and journal version, we only use the journal version.
- If the papers have duplicates in the same study, we only use more recent and have a complete review.
- Academic studies or reports and studies that have a level of trust and good reputation such as institutions that have the competence to conduct research on augmented reality for e-tourism can be used in this study.
- The paper selection process is only carried out on studies that specifically address the topic of augmented reality for e-tourism.

All major papers from various digital database sources, we manage in the Mendeley reference management application (<https://www.mendeley.com/>). We have collected 400 papers and conducted a rigorous selection as described previously and obtained 104 papers that met the requirements. The results of the selection of 104 papers are what we review into a systematic literature review. These papers are relevant to the questions we have formulated in this study. The 104 papers that were selected were obtained from various reputable international journals and became references on the research topics raised.

Research trends and topics.

Data Extraction

All the main papers that have been previously selected, we extract data to answer research questions. We have extracted 104 main study papers according to the requirements of the exclusive and inclusive criteria that have been discussed in the study selection section. We arrange the completeness of the properties in order to complete the data extraction that has been done. see table 3.

Table 3. Completeness of data extraction properties

Property	Research Questions
Research journal	RQ1
Active researcher	RQ2

Study Quality Assurance

Quality assurance is very important to ensure the quality of the study. Therefore, we carry out quality assurance to ensure the quality of the data that has been collected. This is done so that it becomes a guideline in interpreting the synthesis that has been carried out. In order to answer the research question, we need a synthesis derived from the various pieces of evidence that have been collected. The evidence is extracted into data in the form of quantitative and qualitative data. We present the data in the form of images, graphs, and tables to facilitate presentation and analysis so that they can be understood properly.

RESULT AND DISCUSSION

Significant Journal Publication

The results of the analysis that have been carried out, get convincing results to answer RQ1 on the research question. The analysis and synthesis that we carried out, obtained the results from the main data in the form of 104 scientific articles with the main topic of augmented reality for e-tourism. The results show that the research trend has increased since 2017. See Figure 3. Figure 3, shows that the distribution of articles that have been collected is published every year starting in 2017. The analysis has been carried out by counting and describing the articles published according to the year the articles were published. Starting at 2017–2021. Our findings find that the discussion of augmented reality related to e-tourism has increased every year. Research trends regarding augmented reality are numerous and varied, however, in relation to e-tourism, researchers have not discussed it in detail. Some of the research that we found, still discusses augmented reality technology in general, but still has relevance to the research topic discussed. Seen a significant increase occurred in the last 2 years 2020-2021. This means that researchers are very intense and serious in continuing to publish their research results. This shows that this topic is very interesting to study in the last 5 years and has become an object of research that is very serious by researchers so that later it can be implemented easily. We claim this result as a finding because we have rigorously selected the collected papers so that we can guarantee their relevance and accuracy. We do not include papers produced from international conferences as papers that must be reviewed, because they have low quality and are only ideas that have not been proven valid and accurate. We only analyze scientific articles that have been published in international journals that have a good international reputation with a minimum SRJ (SCImago Journal Rank) of 0.4 and publish the best quality research results consistently.

Augmented Reality for Geospatial in E-Tourism: Current Status,
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Hiskia Kamang Manggopa, Trudi Komansilan, SONDY KUMAJAS, JOHAN REIMON BATMETAN

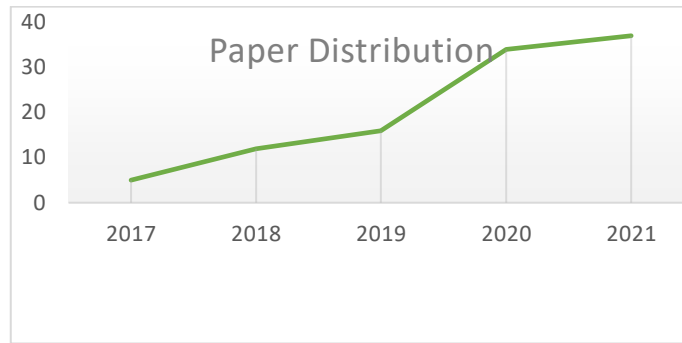


Figure 3. Paper Distribution

We have identified the best international journals in the field of augmented reality and described them in detail to get an overview of which journals were selected to publish the results of augmented reality research for e-tourism. It has consistently been seen that several international journals are very dominant and consistently publish topics regarding augmented reality. See figure 4. It can be seen that the International Journal of Human Computer Studies is a very dominant journal in publishing topics on augmented reality. In addition, it can be seen that the journal Robotics and Computer Integrated Manufacturing also consistently publishes publications on augmented reality. Journal of Business Research and Computers & Graphics are also dominant in publishing articles on augmented reality. Other journals also publish publications regularly and quite contribute to the field of augmented reality.

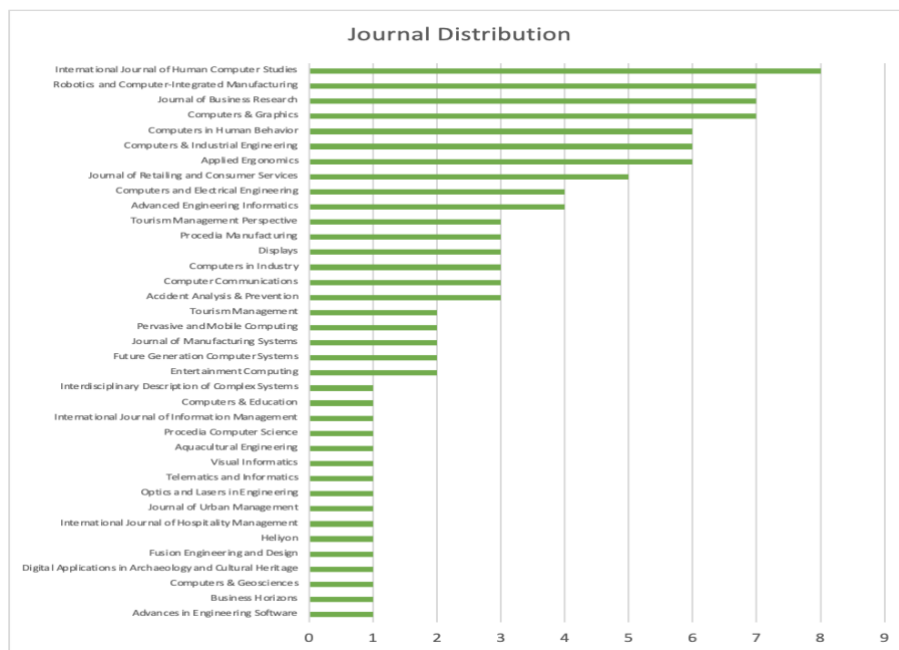


Figure 4. Journal Distribution

We also analyze the number of articles that have been published in various international journals on the topic of augmented reality. The results show that articles with augmented reality are spread in 33 reputable international journals with an SJR minimum of 0.4 starting at 2017–

2021. Of those journals that have been identified, 52% of them are international journals with a high reputation with an impact factor above 0.94. Thus, these journals have a reputation, a level of trust, and a broad impact on the development and trend of augmented reality science. See table 4. In Table 4, you can see a list of reputable journals that we have identified carefully and thoroughly through the online scimagojr database (<https://www.scimagojr.com/journalrank.php>). We have created a list by identifying the journal rank with respect to the grades and Q categories assigned by scimagojr. Thus, we use the ranking value according to the Scimago Journal Rank (SJR) contained in the online database. The SJR value is a value that identifies the impact factor of the journal. While the category Q describes the Journal cluster itself, where the journals with the best performance are in Q1, Q2, Q3, and the lowest order in Q4. For journals that have been indexed in Scopus but have not been given a Q by Scimagojr, we label it No Q, but in the process of selecting journals, we did not find this No Q category. Q this category, we call Scopus Q.

Table 4 Journal Quantity, SJR dan Scopus Q

Journal	Quantity	Scopus Q	SJR
Tourism Management Perspective	2	Q1	1.45
Computers in Human Behavior	6	Q1	2.11
Advances in Engineering Software	1	Q1	1.14
Computers and Electrical Engineering	5	Q1	0.63
Future Generation Computer Systems	2	Q1	1.26
International Journal of Human Computer Studies	9	Q1	0.73
Heliyon	1	Q1	0.46
Tourism Management	2	Q1	3.33
Accident Analysis & Prevention	3	Q1	1.82
Computers & Graphics	6	Q2	0.34
Computers & Industrial Engineering	5	Q1	1.32
Digital Applications in Archaeology and Cultural Heritage	1	Q1	0.55
Robotics and Computer-Integrated Manufacturing	8	Q1	1.56
Telematics and Informatics	1	Q1	1.57
Computers & Geosciences	1	Q1	0.94
Applied Ergonomics	7	Q1	1.09
Journal of Urban Management	1	Q1	0.59
Pervasive and Mobile Computing	2	Q1	0.69
Journal of Business Research	6	Q1	2.05
Entertainment Computing	2	Q2	0.47
Business Horizons	1	Q1	2.17
Computers in Industry	7	Q1	1.43
Journal of Retailing and Consumer Services	5	Q1	1.57
Optics and Lasers in Engineering	1	Q1	1.14
International Journal of Hospitality Management	1	Q1	2.32

Journal of Manufacturing Systems	2	Q1	2.31
Displays	3	Q1	0.59
Computer Communications	3	Q1	0.63
Visual Informatics	1	Q2	0.5
Advanced Engineering Informatics	4	Q1	1.11
Fusion Engineering and Design	1	Q2	0.66
Procedia Manufacturing	1	Q2	0.5
Digital Applications in Archaeology and Cultural Heritage	1	Q1	0.55

Most Active and Influential Researchers

We have done an in-depth analysis and found that the authors who have published articles on the topic of augmented reality are also scattered and have many researchers. We did this to answer the second Research Question (RQ2). The criteria we use to determine that the researcher is an active researcher is if the researcher has at least published 2 scientific articles on the topic of augmented reality and the 2 articles were published in reputable international journals. The researcher can be the first author, the corresponding author, or a co-author who is the team of writers who published the article. The results of the analysis that we are based on primary data show that several researchers are active in conducting research and publications, especially on the topic of augmented reality. The researchers are Flavián, Carlos Ibáñez-Sánchez, Sergio Orús, Carlos who published *The impact of virtual, augmented and mixed reality technologies on the customer experience* (Flavián, Ibáñez-Sánchez, & Orús, 2019), These researchers also publish research related to AR in different journals, namely *Enhancing the customer experience with virtual and augmented reality: The impact of content and device type* (Orús, Ibáñez-Sánchez, & Flavián, 2021). The same thing was also made by Masood, Tariq Egger, Johannes through their research on *Augmented reality in support of Industry 4.0—Implementation challenges and success factors* (Masood & Egger, 2019), and *Adopting augmented reality in the age of industrial digitalization* (Masood & Egger, 2020). Other authors who also published 2 research results in the same year were Qin and Hong with their publications on *A virtual market in your pocket: How does mobile augmented reality (MAR) influence consumer decision making?* (Qin, Peak, & Prybutok, 2021), and *How mobile augmented reality applications affect continuous use and purchase intentions: A cognition-affect-conation perspective* (Qin, Osatuyi, & Xu, 2021).

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Hiskia Kamang Manggopa, Trudi Komansilan, Sondy Kumajas, Johan Reimon Batmetan

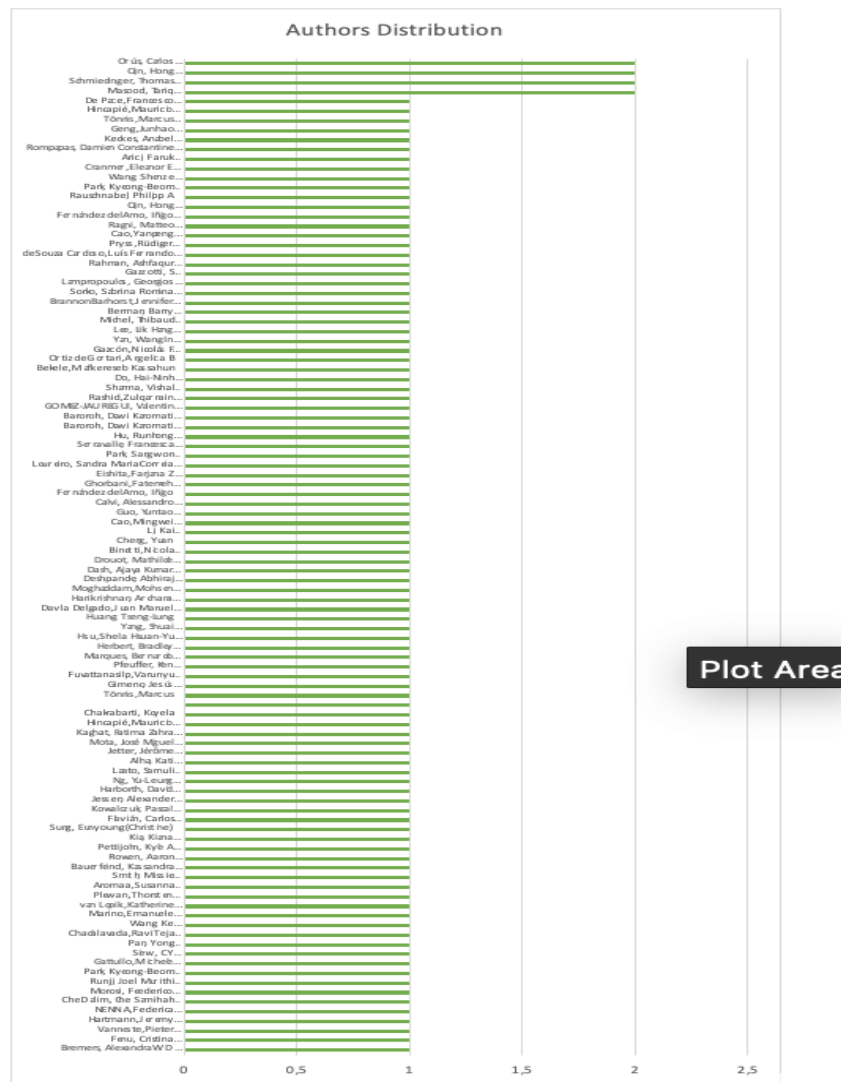


Figure 5. Author Distribution

We have analyzed primary data and found that there are 3 active researchers conducting augmented reality research whose results have been published. See figure 5. The criteria for determining active researchers are researchers who have published 2 articles on the topic of augmented reality in reputable international journals. Meanwhile, other topics are divided among different researchers in various international journals currently available. This number is calculated either as the main author or as a member of the writing team (second author and others).

Trend Research Topic

The results of the topic distribution analysis describe the research trends that have occurred previously through the identification of published topics. We use the criteria, namely, topics that have been published at least 2 times in reputable international journals and these topics must have a strong relationship with the main topic, namely augmented reality. The results of the primary data analysis that we have done show that there are 64 research topics related to augmented reality. See figure 6. The results also show that the dominant topic that appears is the topic of AR implementation and innovation for tourism 8 times. In addition, it can be seen that the topic of AR

Augmented Reality for Geospatial in E-Tourism: Current Status,
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Hiskia Kamang Manggopa, Trudi Komansilan, SONDY KUMAJAS, JOHAN REIMON BATMETAN

for industry and business appeared 7 times. This shows that AR is a technology that has the potential to be applied in various fields and becomes an interesting topic to be discussed in the research. These three topics appear repeatedly in many published articles. Topics regarding AR that are also quite dominant are mobile augmented reality, holographic augmented reality, and deep learning augmented reality. While some other topics are still < 5 but are interesting to be studied further.

Augmented Reality in relation to tourism can be seen in several articles, including the results of research from Loureiro, Sandra Maria Correia Guerreiro, João Ali, Faizan regarding augmented reality in the context of tourism 20 years of research on virtual reality and augmented reality in tourism context: A text-mining approach(Loureiro, Guerreiro, & Ali, 2020) This research will produce an overview of the potential of AR for tourism in the future, including artificial intelligence, physical and sensory simulations, longitudinal virtual experiences of well-being development, BCI, DBS, and EEG. In addition, research from Do, Hai-Ninh Shih, Wurong Ha, Quang-An is also quite interesting. This research discusses the role of Mobile AR applications on impulsive buying behavior in tourism using the SOR framework with the Technology Acceptance Model(Do, Shih, & Ha, 2020). Some of these topics become topics that must be paid special attention to because they have a correlation with the topic of augmented reality in its application to e-tourism.

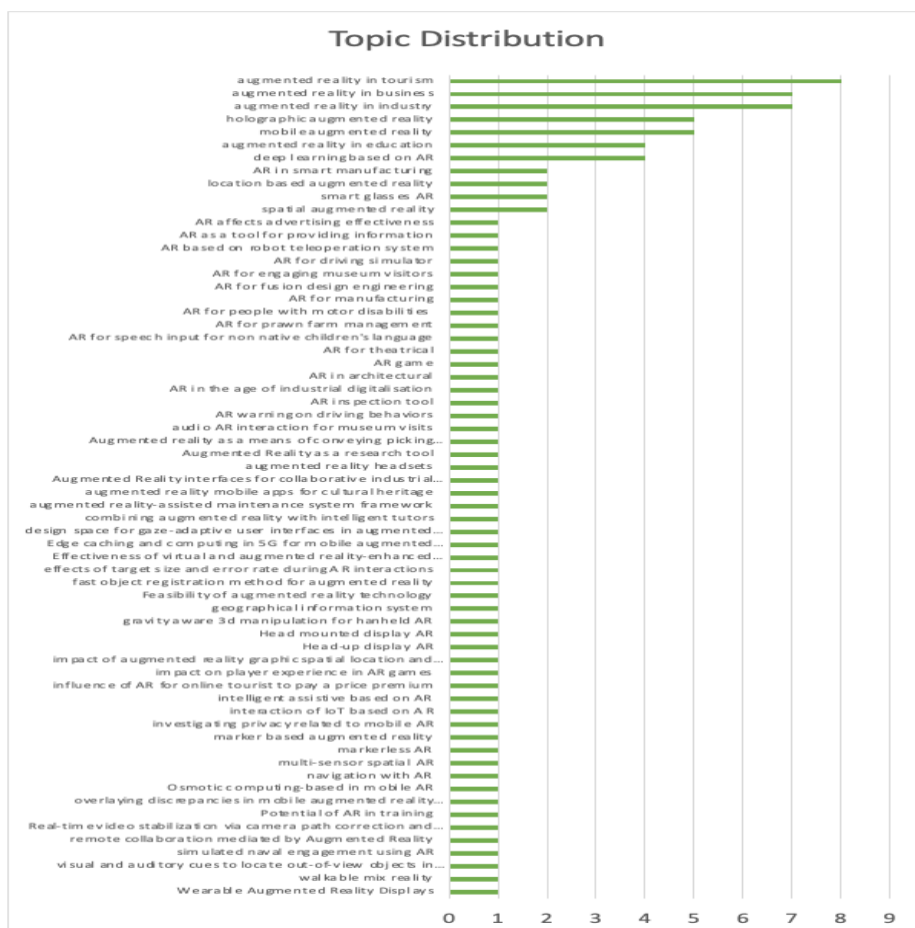


Figure 6. Topic Distribution

and research continue to be carried out and published, it appears that these topics will continue to develop and produce publications in the future.

Some things need to be discussed because they are interesting and require a point of view to see them. We have analyzed the primary data, as many as 104 papers which we selected rigorously through a systematically compiled protocol. The modifications we made to the review model resulted in a more accurate and systematic process with strict selection by ensuring quality assurance of every process carried out. The findings of this research show that we were successful in selecting and obtaining 104 papers that became the basis for the review process. We found that 64 significant research topics were directly related to augmented reality. We use the criteria for making it at least 2 times it has been published in a reputable international journal. Some topics are very significant such as AR for tourism, AR for business and industry.

Another part that needs to be discussed is the findings of journals that significantly affect the publication of augmented reality. We use a reputable international journal database. The findings of this research show that 85% of the journals that publish the topic of augmented reality are reputable international journals in the Q1 Scopus category with a minimum SJR of 0.55. This means that articles that publish the topic of augmented reality have a high level of trust and have a great influence so that they can be used as the main reference on this topic. The Journal of Human Computer Studies has become a very dominant journal and has consistently published various augmented reality research results since 2018. The topic of augmented reality has also experienced a significant increase since 2017 and continues to increase every year.

The third part that is interesting to discuss is the findings of researchers who have conducted research and published their results on the topic of augmented reality since 2018. The results of this research found that Flavián, Carlos Ibáñez-Sánchez, Sergio Orús, Masood, Tariq Egger, Johannes were the researchers who carried out the publication. Research more than once in 2 different journals. Other authors who also published two research results in the same year were Qin and Hong. They consistently research augmented reality technology. In addition, the findings of this research also show an interesting future trend to continue to research. The identified topics are cognitive research, usability, art for marketing, online immersion, camera pose compensation, and manual assembly which are interesting topics to be researched in the future. Overall, we conclude that with systematic steps, a review can be carried out whose quality can be claimed as findings that have good quality and can be trusted. We managed to comprehensively map the research trends on the topic of augmented reality which can be used as research references in the future.

CONCLUSION

This research concludes that in the period 2017 to 2021, we have successfully identified the overall trend of augmented reality research in a systematic and measurable manner. We found that the focus of augmented reality research topics focuses on AR technology in tourism, business, and industry, which includes several trends such as cognitive research, usability, augmented reality for marketing, online immersion, camera pose compensation, and manual assembly which have the potential to become research trends in the future. . The findings of this research also conclude that researchers such as Flavián, Carlos Ibáñez-Sánchez, Sergio Orús, Qin, Hong Masood, Tariq Egger, and Johannes make augmented reality a research topic that is explored and investigated further. Some of the results of this study can be the main reference in augmented reality. Several leading

journals have published research results on augmented reality topics consistently and regularly and these journals have a good and trusted reputation in publishing this topic. The trend of research topics in the future looks very interesting to continue to be studied in depth so that there will be better developed and also contribute to e-tourism in the future.

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Augmented Reality for Geospatial in E-Tourism: Current Status,
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