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A SYSTEMATIC REVIEW OF USING AUGMENTED REALITY IN TOURISM BETWEEN 2017 AND 2021

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Abstract

Technology has transformed the way individuals perceive and apply information and has become an essential part of today's world. Augmented reality technology may overlay interactive real-world items with a layer of virtual elements, such as pictures, text, video, and sounds, in real-time and 3D. Augmented reality allows for seamless transitions between real and virtual worlds. Because of its capacity to bridge the gap and overcome most tourism experience limits, augmented reality technology has attracted much interest in the tourism industry. Over the last years, the fast spread of Augmented Reality (AR) technologies has provided new possibilities and potential to enhance tourism activities. This study presents the results of a systematic review of the literature on augmented reality in tourism. We systematically reviewed all AR articles, including user studies published between 2017 and 2021. A total of 60 papers were reviewed and classified based on a variety of criteria, including the study's environment, research type, augmented reality type, contributing countries where the study took place, author country, augmented reality display systems, research directions, and the majority of study requirements and recommendations. The review's main contribution is to show how augmented reality has been used in the tourism industry and what characteristics each study has. We also pay attention to the restrictions that researchers encounter and future visions for overcoming these constraints. The methods of the review and the classifications of AR research that have arisen in the field of tourism are described in this poster. In addition, the paper discusses trends.

Keywords: - Augmented reality, Tourism, cultural heritage, historical monuments, archaeology, ruins, systematic literature review.

Introduction

Tourism encompasses various actions, services, and industries, including modes of transportation, lodging and enjoyment, sports centres, restaurants, stores, historical and cultural sites, and so on. The information and communication technology (ICT) revolution has significantly impacted the tourist sector. A new term is being used to describe how tourism locations, their industry, and tourists are increasingly dependent on new types of ICT that enable vast volumes of data to be translated into value propositions[1].this term is (smart tourism. Smart technology assists tourism in enhancing the management efficiency of tourism resources, promoting the full benefits and sustainable development of tourism resources, meeting the needs of both residents and visitors, and an increase in visitors and revenues in general[2]. Augmented reality is one of these technologies that is used for smart tourism[3]. Augmented Reality (AR) refers to a set of technologies that allow for the real-time mixing of computer-generated information and live footage[4]. AR is built on virtual reality (VR) methods. It's a range of experiences that spans the existing reality and virtual reality (VR), which generates and presents immersive, digitally environments. It is critical to distinguish augmented reality from the concept of virtual reality at this point. In comparison, virtual reality utilizes virtual environments (digitally graphics, animations, and other data), and Augmented reality uses actual environments that are supplemented in exact time with virtual elements [5].
In the 1960s, augmented reality (AR) was first explored. In 1994 Paul Milgram introduced the "reality-virtuality continuum"[6], which distinguished technologies between realism and virtuality on a scale ranging Fig.1. AR has been acknowledged as a scientific discipline since that period. Augmented reality, in comparison to mixed reality (MR) and virtual reality (VR), offers more realistic experiences by combining the virtual and real worlds. However, till the mid-2000s, AR growth was still restricted, and it was still in the testing stage. AR has gained traction as a result of the emergence of high-performance devices with cameras, graphics functionalities, and inertial measurement units[7].

Fig.1. Reality-Virtuality Continuum[6]

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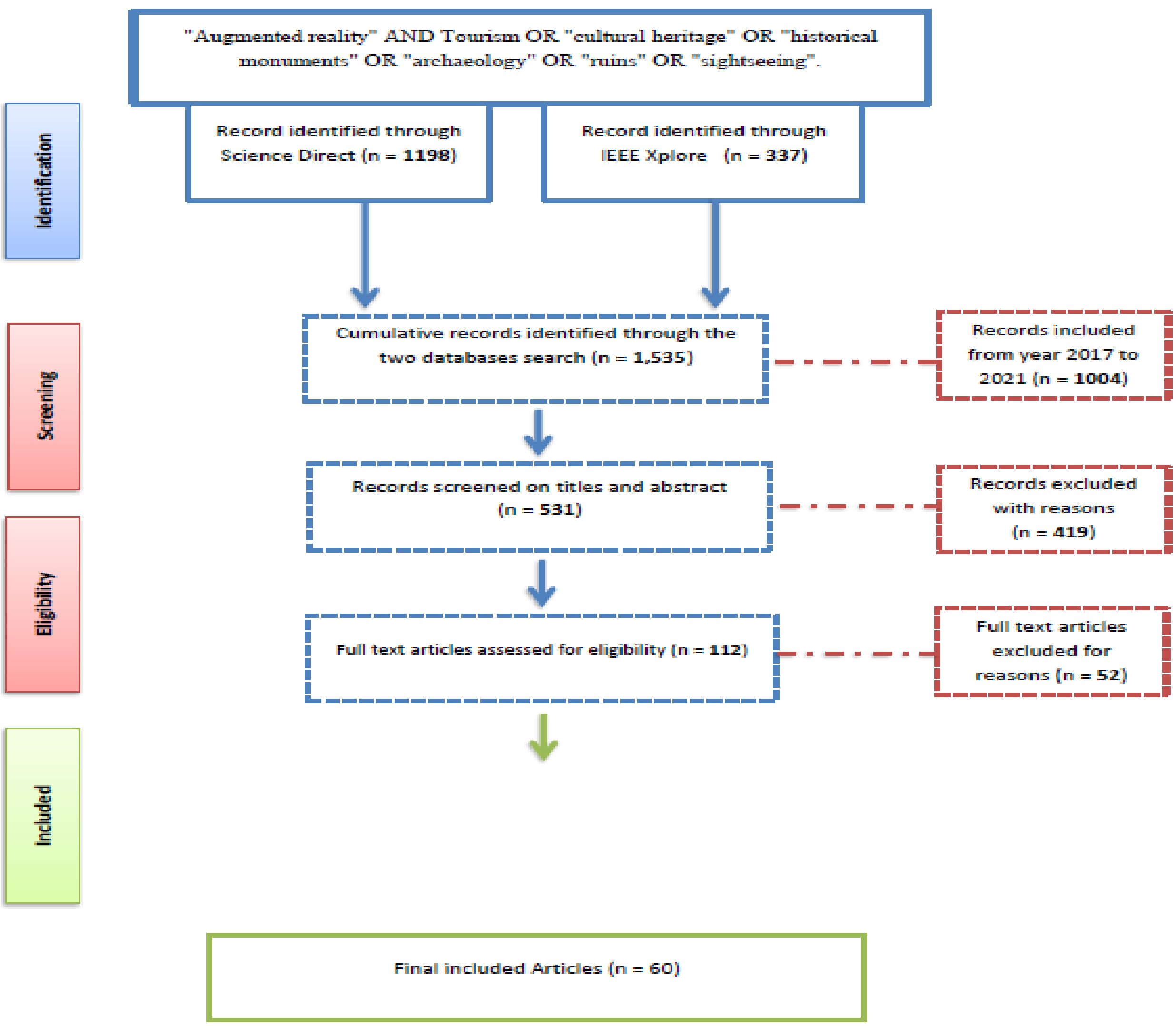
In summary, AR technology has three characteristics,1) It combines the actual and virtual environments,2) Real-time interactivity, and 3) Registered in three dimensions[8].AR has recently been popular in a variety of fields, including education, entertainment, virtual history, tourism, simulations, and gaming. In tourism, augmented reality (AR) is utilized to increase the visitor's overall experience of cultural heritage, historical, or attractive places. Furthermore, with the interactive, realistic, and complicated AR system, users' comprehension of particular events, facts, vital information, and locations can be enhanced, motivated, and stimulated. Tourism is growing in popularity as a result of globalization and the simplicity with which people may move from one location to the other[9]. However, the general population was still unaware of and uninterested in AR applications. Because of the viral success of the augmented reality game "Pokémon Go" in 2016, the public became increasingly interested in using AR applications, prompting researchers to investigate this unique and creative method [10]. As early as 2000, tourism scholars and industry leaders noticed the potential application of AR in tourism, resulting in a growing group of studies. With only a little more than a decade of research on the topic, a systematic evaluation of the literature is both timely and uncommon. While academics such as [11], [12]and[13] were conducting reviews on both virtual reality (VR) and augmented reality (AR) in tourism research, it may be beneficial to separate the review for AR specifically. Because in spite that AR and VR seem similar, they differ in that AR allows users to interact with the real world (which may require users to travel and be physically there), whereas VR relies more on a computer-generated virtual environment. This contrast suggests that AR may be more suited to augmenting rather than replacing the visitor's experience [14]. As a result, if anyone interested in looking for implementation techniques for AR in tourism, an in-depth and focused research of the AR literature would be beneficial.

The goal of this study is to get more information about AR in tourism, as well as to assist the researcher in analyzing existing methodologies in order to fill in the gaps in the tourism domain and present a taxonomy for the literature. Furthermore, the topic's motives and problems are determined. The following is a description of the paper's structure. The first section discusses augmented reality technology. The research process, scope, literature sources, and screening steps are all covered in Section 2. Section 3 shows the results of this paper's final group of articles and offers a taxonomy for relevant literature and statistical data.

Also, studies environments, type of AR, Distribution of studies published by years and types, major contributing countries, countries in which the studies were applied, Products of studies, and research directions. Recommendations taken from the final set of articles from 2017 to 2021 are classified and discussed in Section 4. The conclusion is presented in Section 5.

2 - Method

The systematic literature review (SLR) method was used to assess the state of AR in the tourism and historical and archaeological sites Visiting. SLR's objective is to locate, evaluate, synthesise, and analyse all studies in a particular field. We can use the collected published articles to perform systematic reviews, determine trends, and explore techniques. Utilizing PRISMA diagram, Figure 2 shows our research process.



2.1. Information sources

The database utilized for the SLR:

- IEEE Xplore library of technical literature in engineering and technology.
- ScienceDirect database offering access to scientific, technical, and medical journal articles

2.2 Search Strategy

The extensive research process is one of the most important steps to ensure that the results are more comprehensive. To ensure that the results obtained up-to-date digital development, we have also reviewed published articles dating back to the past decade.

The search began on October 20, 2021, in the IEEE Xplore and ScienceDirect databases, using the 'advanced search' feature. The Searching process is going through each of the databases given in Section 2.1 one by one by using relevant keywords: ("Augmented reality") AND (Tourism OR "cultural heritage" OR "historical monuments" OR "archaeology" OR "ruins" OR "sightseeing"). Table 1 shows the 1535 documents found as a result of this stage of the search. This process was carried out separately for each database.

Table 1 number of documents returned

Database	Fields	Documents founded
Science Direct	Title-Abs-Key	1,198
IEEE	Title-Abs-Key	337

2.4. Eligibility criteria

In order to gather relevant studies that were within the scope of this literature review, inclusion and exclusion criteria were applied during the article selection process. The inclusion criteria have been accurately indicated to ensure a successful selection process. In terms of inclusion criteria, only articels published between 2017 and 2021 were considered. further,The studies that were chosen had to be peer-reviewed articles and were published in English and completely accessible in the databases that were chosen, The exclusion of studies that used augmented reality in tourism-related companies, such as the sale of tourist goods, rather than in actual tourism, is another criterion.Studies that just used virtual reality in tourism were disregarded. Studies that combined virtual reality and augmented reality under the heading of "mixed reality studies" were included. as

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stated in Table 2. Any article that does not match these criteria was not considered for review.

Table 2 Inclusion and Exclusion Criteria

	Inclusion Criteria	Exclusion Criteria
1	Available within the two selected databases	Not available within the two selected databases
2	Articles are written in the English language.	Articles are written in another language.
3	A peer-reviewed journal, conference papers	Unpublished studies, book chapters, theses
4	Augmented & Mixed reality article	Pure VR field
5	Full text is available online	Full text is not available online

2.5 Search Results ,Taxonomy and Statistical information of articles

As shown in Fig. 2, We started with the IEEE database, which yielded 337 results, and then moved on to the science direct database, which yielded 1198 results.

Duplicate articles and items that did not fit within the time frame of 2017 to 2021 were removed, leaving 1,004 articles.

These articles were grouped together under the inclusion criterion based on their language and the area of work they aim to do, resulting in a total of 531 articles.

Then use the other criterion for inclusion, which imposes us to reading the abstract and article title to find the most correct linked articles, resulting in a reduction of 419 articles to 112.

Some criteria were applied to these 112 publications, such as the type of technology used in our field of study, as well as full-text availability and accessibility. Fifty-two articles were eliminated because they did not comply with the requirements listed in Table 2, point A. As a result, 60 items were left in the end, which will handle in our field of research.

These studies are categorized into two groups, each of which is subdivided into levels with distinct characteristics.

Figure 3 shows that the first main group (Augmented Reality), which covers the use of augmented reality, has 51/60 studies, while the second main group (Mixed Reality, which includes the use of both augmented and virtual reality) has 9/60 studies.

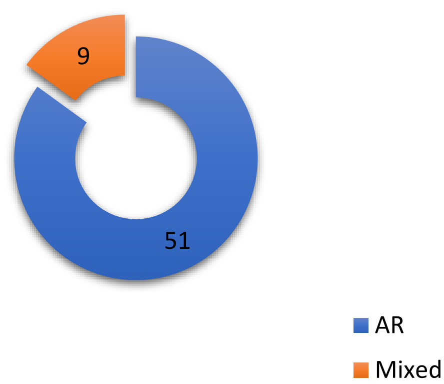

Fig. 3. Query result

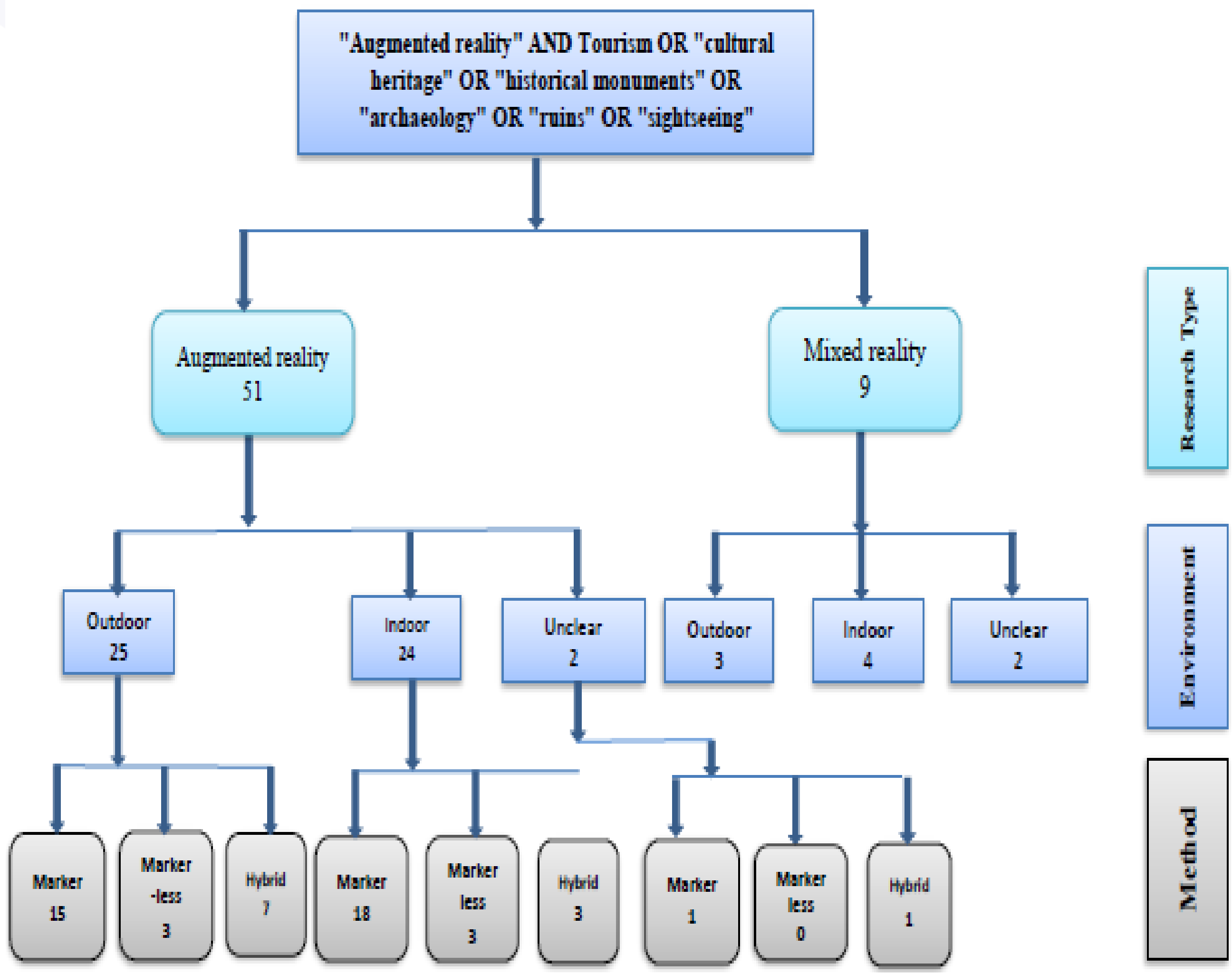

Fig. 4 Taxonomy of research literature

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Within the first level, as shown in fig. 4, the first two groups are divided into three branches, each of which is treated separately. The first level is distinguished by the split of both groups' studies or experimentations according to the environment in which they were executed or applied at the last level. The studies were divided according to the type of augmented reality used in the study. It is worth noting that the last level is concerned with studies that applied the use of augmented reality technology only.

3. Results and Discussion

3.1 Research Environment

The first level of classification for the two main categories is the environment in which the experiment was conducted or the work environment of the proposed application in the articles. The studies were classified according to the environment into indoor, outdoor or Unclear. Fig. 5 and Fig 6 show the number of obtained studies that related to these categories.

3.1.1 Indoor

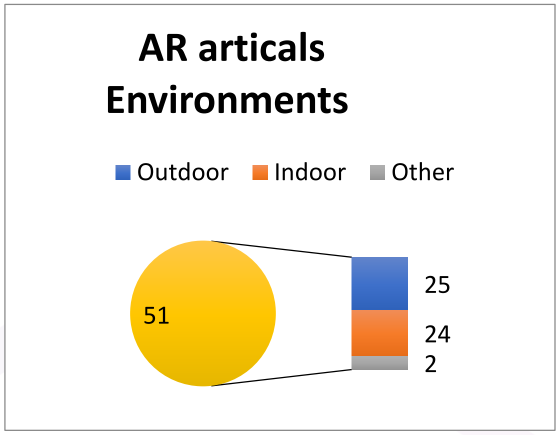
According to our findings, the studies that use AR in an indoor environment like (inside Musem , school , university , lab , room) recorded (21/51 – 41.2%). While in mixed reality, we found (4/9 – 44.4%) studies give its working benefit for indoor environment.

3.1.2 Outdoor

We notice that articles that use augmented reality technology in the outdoor environment are (24/51 – 47.1%). While articles aiming at utilizing the mixed reality in the outdoor environment were documented (3/9 - 33.3%).

3.1.3 Unclear environment

Some of the articles looked at weren't relevant to the environment in which the experiments were carried out or the environment seemed unclear to catogarize. There was (2/51 – 4%) an article for augmented reality that did not specify the environment and (2/9 - 22.2%) an article for mixed reality.



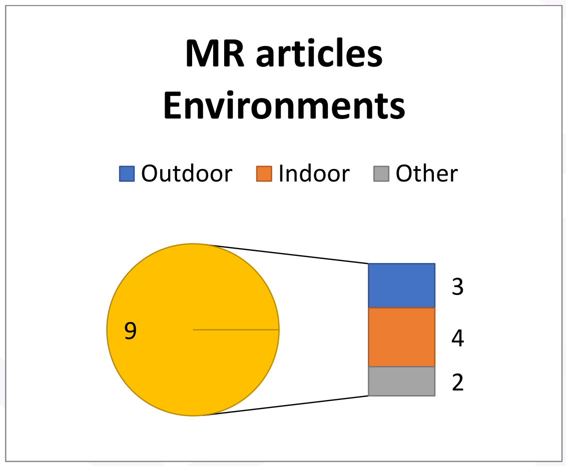


Fig. 6 Mixed reality environment

3.2 AR research types

3.2.1 Marker-based AR

Marker-based augmented reality is a kind of augmented reality that employs real-time recognition. It means reading photos, text, or other actual items to offer extra virtual information to the user. A camera is used, as well as a visual marker such as a QR code or a 2D code. The reader detects the marker first, and after that, the information is presented. This type of AR makes use of a camera to distinguish a marker from every other physical object. Markers can be anything that is both individual and simple (for example, a QR code) and can be detected by the camera. Position and orientation calculations are carried out [15]. According to the studies that were identified in the field of research, Fig. 7 show the articles that included the use of augmented reality based on marker were (34/51 - 67%).

3.2.2 Marker less AR

Marker-less AR differs from marker-based AR in that it does not rely on artificial markers to show notable aspects of the scene. Marker-less AR systems work in real-time to merge virtual objects into a 3D actual environment, enhancing the user's perception and engagement with the real world [16]. Marker-less AR operates by showing elements that are commonly accessible from natural items in the environment, as well as attempting to generate a model or map from the surroundings to reflect the world as seen by the camera. The articles in the study scope we previously explained, which included the use of marker-less augmented reality, were (6/51 – 11%).

3.2.3 Hybrid type

Ten articles used unclear type of augmented reality, in which they were dependent on tow or more types, or it was dependent on the use of marker and markerless types to obtain the research aim and objectives. The term (Hybrid) was coined to describe such articles. It was (11/51– 22%) AR studies, as shown in Fig. 7.

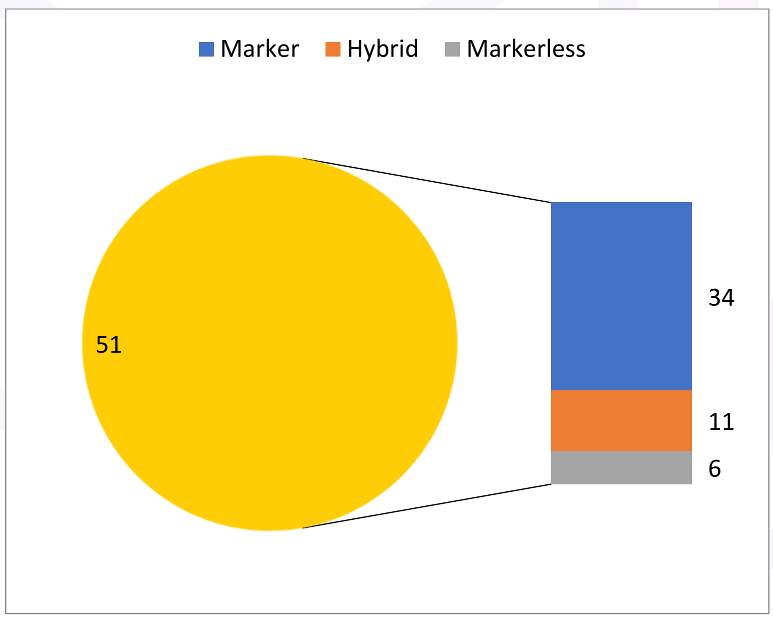


Fig. 7 Augmented reality Types distribution

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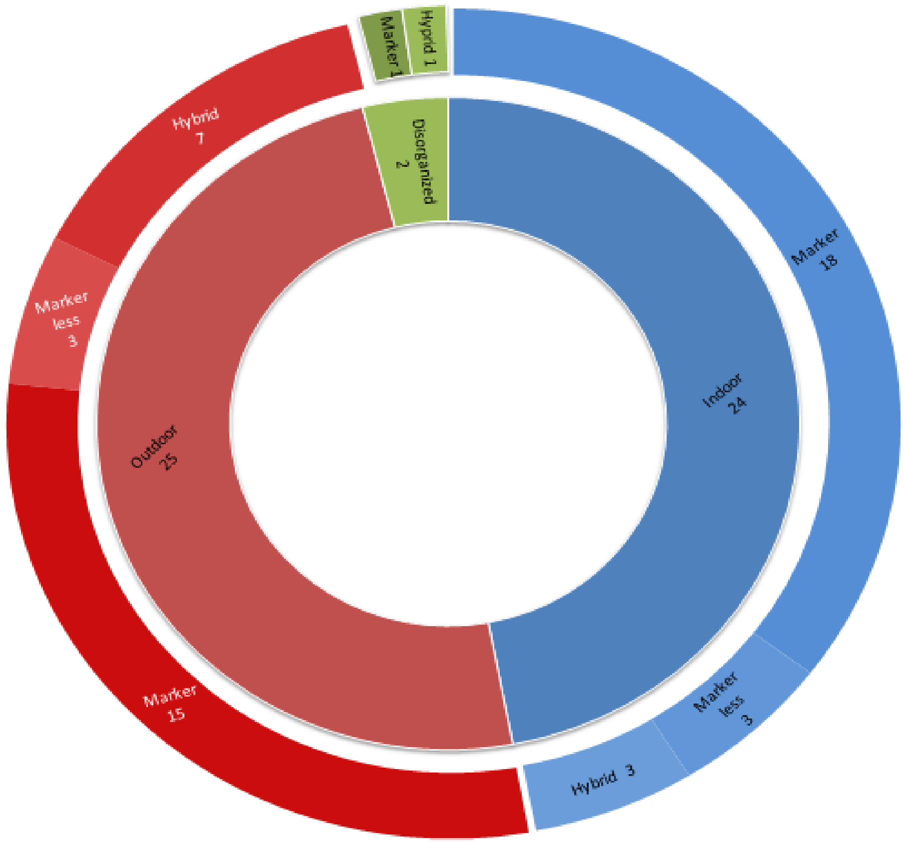

Fig. 8 Augmented reality Articles Distribution

Figure 8 shows the general distribution of studies related to (Augmented reality) and its branches.

Table 3 The 60 articles included after the final synthesis

Ref.	Research type	Environment	AR Type	Display device	Internet usage	Location needed
[17]	Augmented Reality	Indoor	Marker	Hand-Held	Yes	Yes
[18]	Mixed Reality	Indoor	-	Hand-Held	No	No
[19]	Augmented Reality	Outdoor	Marker	Hand-Held	Yes	Yes
[20]	Augmented Reality	Outdoor	Hybrid	Hand-Held	Yes	Yes
[21]	Augmented Reality	Outdoor	Hybrid	Hand-Held	Yes	Yes
[22]	Augmented Reality	Outdoor	Marker	Hand-Held	Yes	Yes
[23]	Augmented Reality	Indoor	Markerless	Hand-Held	No	No
[24]	Augmented Reality	Indoor	Marker	Hand-Held	Yes	Yes
[25]	Augmented Reality	Outdoor	Marker	Hand-Held	Yes	Yes
[26]	Mixed Reality	Disorganized	-	Combination	Yes	Yes
[27]	Augmented Reality	Outdoor	Marker	Hand-Held	No	No
[28]	Augmented Reality	Indoor	Marker	Hand-Held	No	No
[29]	Augmented Reality	Indoor	Marker	Hand-Held	Yes	No
[30]	Augmented Reality	Indoor	Marker	Hand-Held	No	No
[31]	Augmented Reality	Indoor	Hybrid	Combination	Yes	No
[32]	Augmented Reality	Outdoor	Marker	Hand-Held	No	No
[33]	Augmented Reality	Outdoor	Hybrid	Hand-Held	Yes	Yes

[34]	Augmented Reality	Indoor	Marker	Hand-Held	No	No
[35]	Augmented Reality	Outdoor	Marker	Hand-Held	Yes	Yes
[36]	Augmented Reality	Outdoor	Marker	Hand-Held	Yes	Yes
[37]	Augmented Reality	Outdoor	Marker	Hand-Held	No	Yes
[38]	Augmented Reality	Outdoor	Marker	Hand-Held	Yes	Yes
[39]	Augmented Reality	Outdoor	Marker	Hand-Held	Yes	Yes
[40]	Augmented Reality	Outdoor	Marker	Hand-Held	No	No
[41]	Augmented Reality	Outdoor	Marker	Hand-Held	No	Yes
[42]	Augmented Reality	Indoor	Marker	Hand-Held	Yes	No
[43]	Augmented Reality	Indoor	Marker	Hand-Held	Yes	no
[44]	Augmented Reality	Indoor	Marker	Hand-Held	Yes	no
[45]	Augmented Reality	Indoor	Marker	Hand-Held	No	No
[46]	Augmented Reality	Indoor	Marker	Hand-Held	No	No
[47]	Augmented Reality	Indoor	Marker	Hand-Held	No	Yes
[48]	Augmented Reality	Indoor	Marker	Hand-Held	Yes	No
[49]	Augmented Reality	Outdoor	Marker less	Hand-Held	No	No
[50]	Augmented Reality	Outdoor	Marker less	Hand-Held	Yes	Yes
[51]	Augmented Reality	Outdoor	Marker less	Spatial	No	Yes
[52]	Augmented Reality	Outdoor	Hybrid	Hand-Held	Yes	Yes
[53]	Mixed Reality	outdoor	-	Spatial	Yes	Yes
[54]	Mixed Reality	Indoor	Hybrid	Combination	Yes	No
[55]	Augmented Reality	Outdoor	Marker	Hand-Held	Yes	No
[56]	Mixed Reality	Disorganized	Hybrid	Hand-Held	Yes	No
[57]	Augmented Reality	Disorganized	Hybrid	Wearable	No	No
[58]	Mixed Reality	Indoor	-	Wearable	Yes	No
[59]	Augmented Reality	Indoor	Hybrid	Hand-Held	No	No
[60]	Augmented Reality	Indoor	Markerless	Hand-Held	No	Yes
[61]	Augmented Reality	Outdoor	Hybrid	Hand-Held	Yes	Yes
[62]	Mixed Reality	Outdoor	Hybrid	Hand-Held	Yes	Yes
[63]	Augmented Reality	Indoor	Marker	Hand-Held	Yes	No
[64]	Mixed Reality	Outdoor	-	Hand-Held	Yes	No
[65]	Augmented Reality	Outdoor	Marker	Hand-Held	No	Yes
[66]	Mixed Reality	Indoor	-	Hand-Held	No	No
[67]	Augmented Reality	Indoor	Marker	Hand-Held	Yes	-
[68]	Augmented Reality	Indoor	Markerless	Hand-Held	No	No
[69]	Augmented Reality	Disorganized	Marker	Hand-Held	Yes	No
[70]	Augmented Reality	Outdoor	Hybrid	Hand-Held	Yes	Yes
[71]	Augmented Reality	Outdoor	Marker	Hand-Held	Yes	Yes
[72]	Augmented Reality	Outdoor	Hybrid	Hand-Held	Yes	Yes
[73]	Augmented Reality	Indoor	Marker	Hand-Held	Yes	No
[74]	Augmented Reality	Indoor	Marker	Hand-Held	No	No
[75]	Augmented Reality	Indoor	Marker	Hand-Held	No	No
[76]	Augmented Reality	Indoor	Hybrid	Spatial	Yes	No

The 60 studies that were obtained are listed in Table 3. The first column indicates the selected study. The second column indicates whether the study dealt either with augmented reality or both augmented and mixed reality. The third column contains information about the study's work environment, such as whether it was conducted indoors or outdoors or in an undetermined environment. The fourth column describes the type of augmented reality that was employed in the study, whether it was a marker or a marker-less technique, with a focus on studies that relied solely on augmented reality.

The fifth column lists the presentation's devices(display system), which include hand-held, head-mounted, spatial display devices and combination (mixed). The sixth column indicates whether the study requires or does not require the use of the Internet. The seventh column indicates whether or not the study requires the use of GPS technology.

3.3 Distribution by years

We analyzed the years of publication of the 60 studies in our research using the previously mentioned process, which was conducted in October 2021, and after applying the controls for inclusion and exclusion of articles. Fig. 9 shows that the studies increased in recent years and were also active in the years 2018 to 2020. Beginning with 2017, and for goals related to increasing tourist awareness and overcoming the problem of lack of knowledge,[32] presented guides to achieve this goal. Also, in the same year and for the same motives, in addition to reducing the time to explore archaeological and tourist sites and obtaining full benefit from the trip, [33]presented an attractive article. Also, in 2017, the economic motives for bringing tourists were important, as in[34].In the years 2018 to 2020, Travel restrictions due to the Corona pandemic and the urgent need to document archaeological and cultural monuments and preserve them from damage and loss and try to prevent human overcrowding and their presence near archaeological or tourist sites were the highlights of the most of article as in[28], [58]and[52].

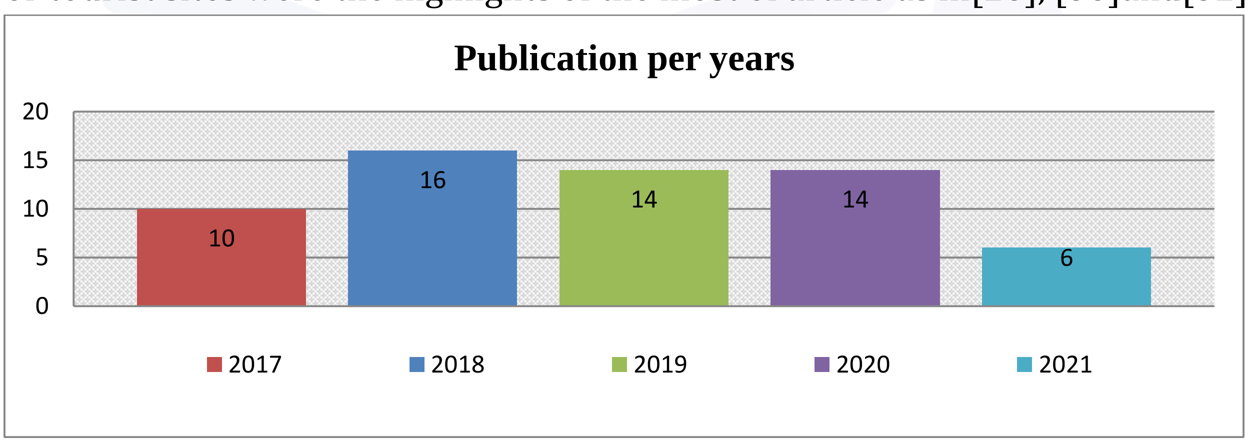

Fig. 9 distribution of publications years

3.4 Research type in this review

In total 60 articles were analyzed from (14) journals and (46) conferences, Journals include Digital Applications in Archaeology and Cultural Heritage(n=5), Journal of Cultural Heritage(n=2), Computers and Electrical Engineering(n=2), International Journal of Human-Computer Studies(n=1), Computers & Graphics(n=1), Ocean Engineering(n=1), IEEE access (n=1) and Procedia Computer Science(n=1). And conference name and location shows in table 4 below.

Table 4 conferences details

Conference name	Location
2017 Fourth International Conference on e-Democracy & e-Government (ICEDEG)	Ecuador
2017 24th Portuguese Meeting of Computer Graphics and Interaction (EPCGI)	Portugal
2017 5th International Conference on Cyber and IT Service Management (CITSM)	Indonesia
2017 IEEE 31st International Conference on Advanced Information Networking and Applications (AINA)	Taiwan
2017 12th Iberian Conference on Information Systems and Technologies (CISTI)	Portugal
2017 IEEE Symposium on Computers and Communications (ISCC)	Greece
2016 International Conference on Advanced Materials for Science and Engineering (ICAMSE)	Taiwan
2017 IEEE International Conference on Consumer Electronics (ICCE)	USA
2018 International Conference on Intelligent Systems and Computer Vision (ISCV)	Fez, Morocco
2018 6th International Istanbul Smart Grids and Cities Congress and Fair (ICSG)	Istanbul, Turkey
2018 2nd International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT)	Ankara, Turkey
2018 International Conference on Information Networking (ICOIN)	Chiang Mai, Thailand
2018 International Conference on Applied Engineering (ICAE)	Indonesia
2017 International Conference on Advanced Mechatronics, Intelligent Manufacture, and Industrial Automation (ICAMIMIA)	Indonesia
2017 3rd International Conference on Science in Information Technology (ICSITech)	Indonesia
2018 20th International Conference on Advanced Communication Technology (ICACT)	Korea (South)
2018 IEEE Games, Entertainment, Media Conference (GEM)	Ireland
2018 International Conference on Information Systems and Computer Science (INCISCOS)	Ecuador
2018 International Congress on Innovation and Trends in Engineering (CONIITI)	Colombia
2017 23rd International Conference on Virtual System & Multimedia (VSMM)	Ireland

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2018 IEEE 3rd International Conference on Image, Vision and Computing (ICIVC)	China
2018 IEEE International Conference on Artificial Intelligence and Virtual Reality (AIVR)	Taiwan
2018 9th International Conference on Information, Intelligence, Systems and Applications (IISA)	Greece
2018 International Conference on Intelligent Systems (IS)	Portugal
2018 3rd Digital Heritage International Congress (Digital Heritage) held jointly with 2018 24th International Conference on Virtual Systems & Multimedia (VSMM 2018)	USA
2019 IEEE 19th International Conference on Advanced Learning Technologies (ICALT)	Brazil
IEEE INFOCOM 2019 - IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS)	France
2019 IEEE 9th International Conference on System Engineering and Technology (ICSET)	Malaysia
2019 IEEE 9th International Conference on System Engineering and Technology (ICSET)	Malaysia
2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR)	japan
2019 IEEE 8th Joint International Information Technology and Artificial Intelligence Conference (ITAIC)	China
2020 International Conference on Intelligent Systems and Computer Vision (ISCV)	Morocco
2020 International Russian Automation Conference (RusAutoCon)	Russia
2020 Fourth World Conference on Smart Trends in Systems, Security and Sustainability (WorldS4)	UK
2019 6th International Conference on Research and Innovation in Information Systems (ICRIIS)	Malaysia
2019 4th Technology Innovation Management and Engineering Science International Conference (TIMES-iCON)	Thailand
2020 IEEE REGION 10 CONFERENCE (TENCON)	japan
2019 International Conference on Advancements in Computing (ICAC)	Sri Lanka
2019 IEEE 9th International Conference on Consumer Electronics (ICCE-Berlin)	Germany
2019 International Conference on Electrical Engineering and Informatics (ICEEI)	Indonesia
2019 IEEE 4th Advanced Information Technology, Electronic and Automation Control Conference (IAEAC)	China
2020 3rd IEEE International Conference on Knowledge Innovation and Invention (ICKII)	Taiwan
2020 3rd International Conference on Intelligent Sustainable Systems (ICISS)	India
2020 3rd IEEE International Conference on Knowledge Innovation and Invention (ICKII)	Taiwan
2020 IEEE Graphics and Multimedia (GAME)	Malaysia
2020 International Conference on Intelligent Computing, Automation and Systems (ICICAS)	China

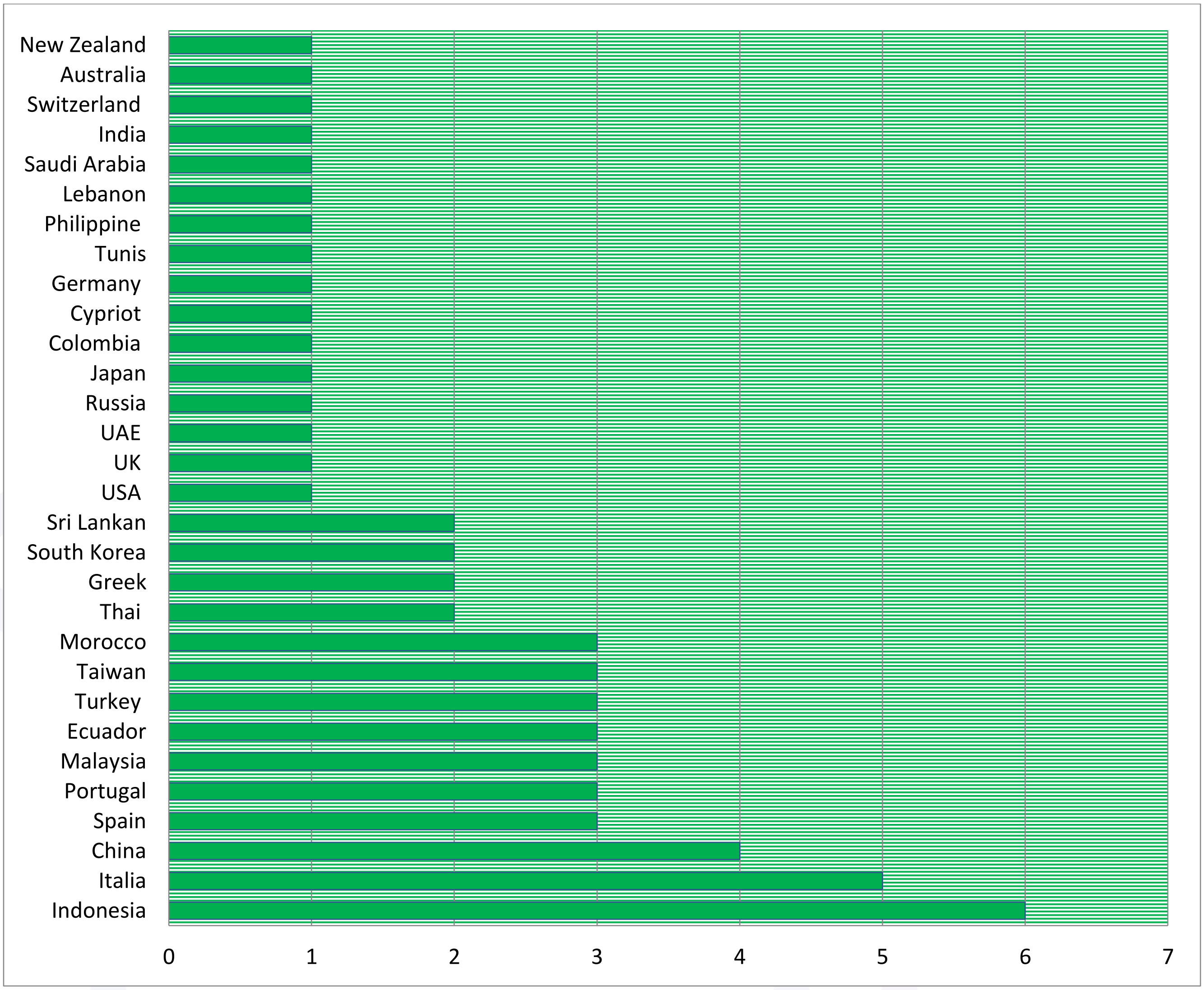

Fig. 10 Contributing Countries in this review

3.5 contributing countries in this review

According to the studies obtained, The Indonesian authors contributed the most publications (n=6)(Fig. 10), followed by the Italian authors (n=5), Chinese authors (n=4), Spanish authors (n=3), The Portuguese authors (n=3), the Malaysian authors (n=3), Ecuadorean authors (n=3), Turkey authors (n=3), Taiwanese authors (n=3), Moroccans authors (n=3), Thai authors (n=2), Greeks authors (n=2), South Koreans authors (n=2), Sri Lankans authors (n=2), While USA authors, Russian, Japanese, Cambodian, Cypriot, Germany, Tunisian, Philippine, Lebanese, Saudi Arabia, Indian, Switzerland, UAE, UK, Australian and New Zealander (n=1) for each one of them.

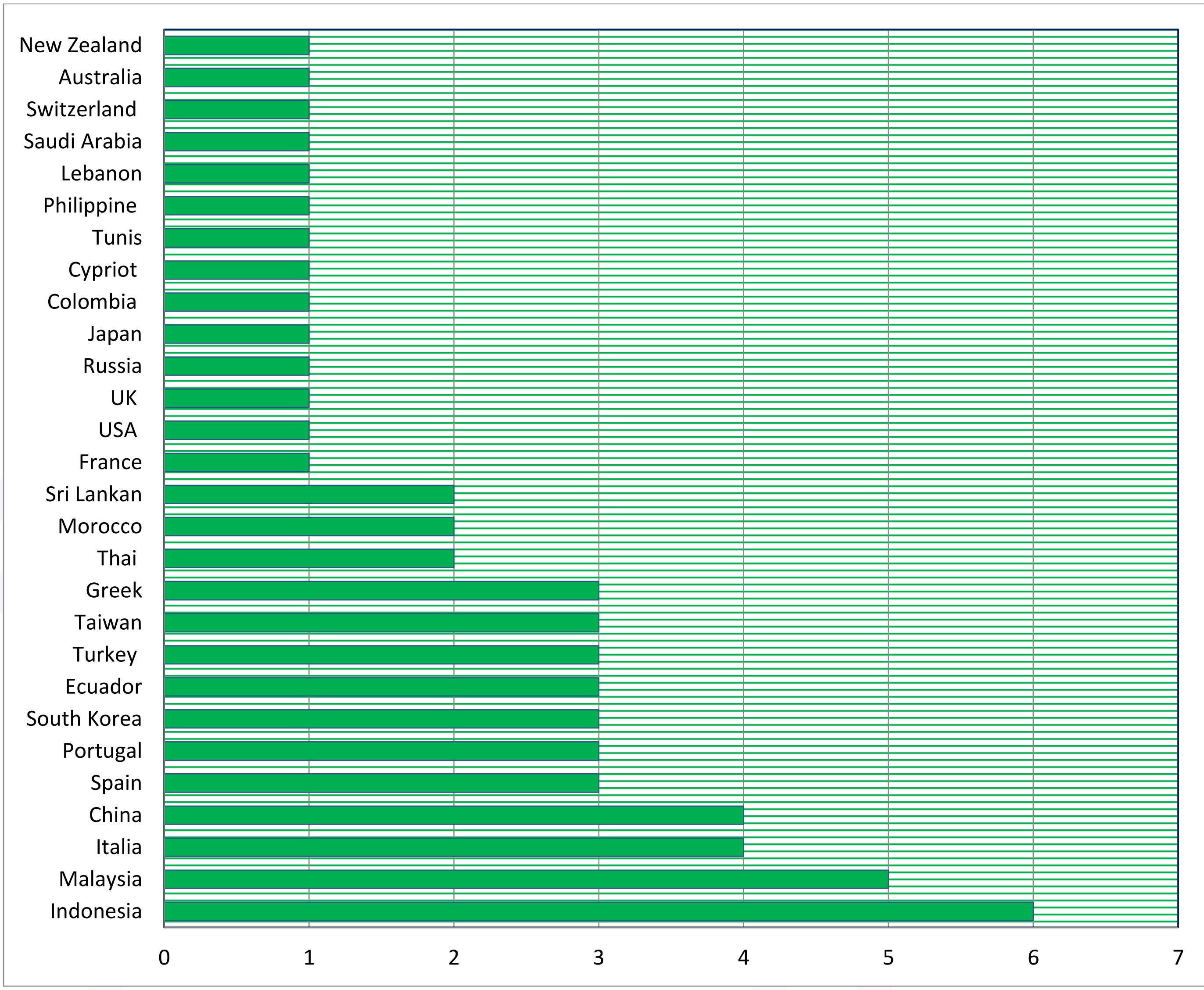

Fig. 11 Countries in which AR research were carried out

3.6 Countries in which AR research was carried out

According to the findings, All the studies we got were investigated and applied in Indonesia (n=6) (Fig. 11).Malaysia(n=5),Italia (n=4), China (n=4), Spain (n=3), The Portugal (n=3), South Korea (n=3), Ecuador (n=3),Turkey (n=3), Taiwan (n=3), Greek (n=3), Thai (n=2), Morocco (n=2), Sri Lankan (n=2), USA (n=1), UK (n=1),Russia (n=1), Japan(n=1), Colombia (n=1), Cyprus (n=1), Tunis(n=1) , Philippine (n=1), Lebanon (n=1), Saudi Arabia (n=1), Switzerland (n=1) , Australia(n=1) and New Zealand (n=1).

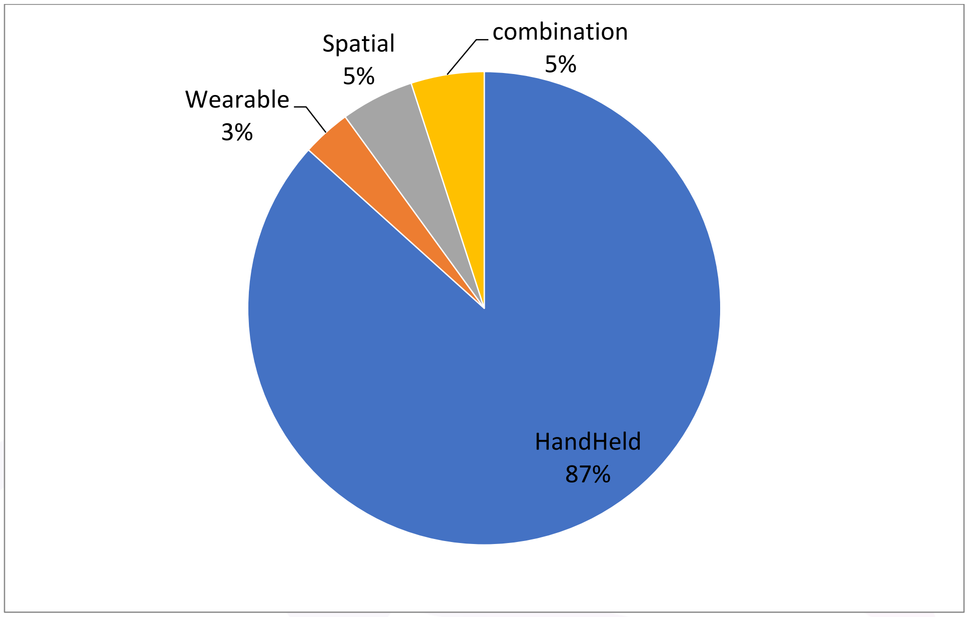

Fig. 12 Display Systems in this review

3.7 Display devices in this review

As previously listed in table 3. There was a display systems column. Display systems integrate virtuality with realism in order for the user to interact and receive augmented reality. The various methods of display systems proposed or indicated that were used in the studies obtained must be mentioned., and according to[77], there are three types of display systems: hand-held, wearable, and spatial.

We discovered that (52 of 60) articles used a mobile phone or tablet (Hand-held) to deliver an augmented or mixed reality experience (Fig. 12). As head-mounted display systems, (2/60) used glasses and an innovative audio system. And (3/60) studies involving the spatial presentation of augmented reality experiences using hologram technology and other devices. In addition, (3/60) studies used a combination of hand-held and head-mounted systems or pc.

3.8 Research products in this review

Each study has analytical, applied and statistical products, according to the findings. We found that 87 % of them include an augmented reality experience (48 systems and four prototypes) that works on a mobile device. While there were only (5%) of the studies presented augmented reality experiences working on computers and the web. Also, (5 %) of the studies include augmented reality experiences works on specific mixed tools such as (smart glasses and pc) or

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(audio systems with hand-held device). And 3% of the studies offered frameworks and applications or systems under trial without officially issuing them for work, testing and publication. Most of the studies included creating applications or systems that needed physical and software resources, as well as location-based services and the Internet.

62 % of the applications and systems used the Internet service, while the rest worked without the need for it. As for the location service, 50 % of the applications needed to work with this service. This shows the necessary need for these two services during the creation of an augmented reality application that serves the field of tourism and exploration. Table 3 shows studies that used these two services.

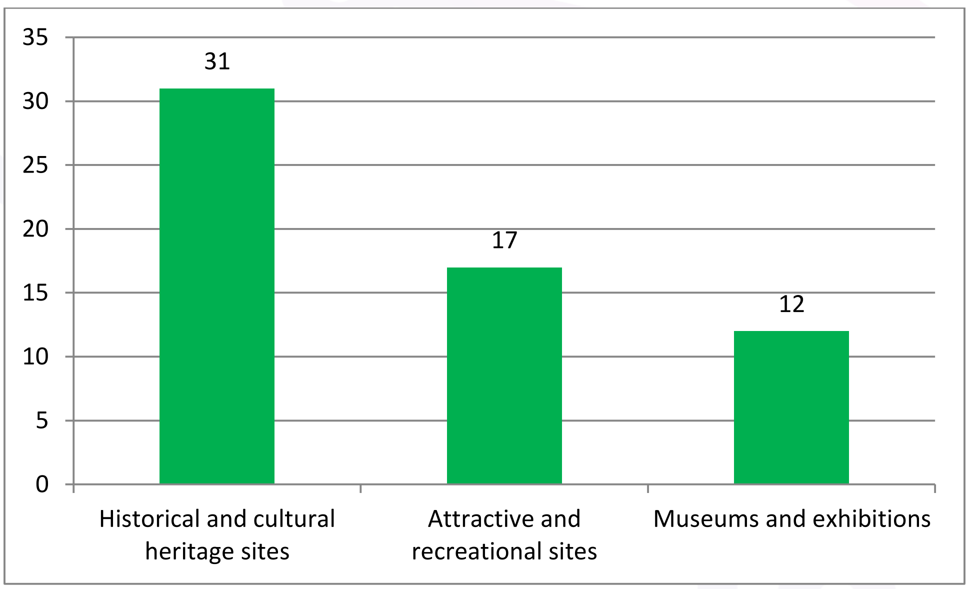

Fig. 13 Research direction in this review

3.9 Research direction in this review

Out of 60 articles that were previously chosen based on the criteria set forth in our analysis. It was discovered that 28% of them work in the field of "promoting tourism in attractive and recreational areas"(Fig. 13), 20% in the field of "promoting tourism in museums and exhibitions," and 52 % in the field of "serving tourism in historical and cultural heritage sites".

3.10 Effectiveness of using AR in this review

The major advantages of AR in these studies reported are enriching tourist experience and motivating tourists to knowledge gain, and helping in safeguarding the value of historical and cultural heritage. As a new technology that develops rapidly and enters all areas of life, the selected studies within the field of tourism showed that augmented reality and its applications contribute to a growing field in the field of promoting tourism and tourist donations and strengthening the economies of countries dependent on tourism, and this was indicated by (27 %) of the articles, while (33 %) of the articles showed that the introduction of augmented reality applications in the field of exploring and teaching cultural and historical heritage has led to positive results because augmented reality applications give interactive and great attraction to the user towards exploration and learning, as they provide virtual content for hard-to-reach places or historically forgotten places.25 % of studies showed that augmented reality technology has a positive and effective role in preserving and documenting cultural and historical heritage and revitalizing it in an acceptable way for tourists or explorers.15% of the studies showed that mixing augmented reality with virtual reality and other technologies made it give better benefits.

4- Limitations and future vision

Some research indicated new trends, and others spoke of important limitations. The limitations were some of the obstacles that the researchers faced in their experiments, such as Space restrictions and environmental problems, including those locations that accept a fixed number of tourists for protection and conservation reasons [44, 72], illumination limitations [32, 37, 38, 47, 55], internet availability[24, 33], Overcoming the problem of Markers availability which is most tourism applications requirement[29, 39, 40, 42, 44, 47, 48, 73, 74]. All of these restrictions need to be addressed. On the other hand, some authors recommend to Solved the problem of insufficient interactivity [23, 68] maybe by Employing game components to enhance the usability and enjoyment of an application [19, 52, 56]and enhancing recognition so that it can be easily recognized under less-than-ideal situations[25, 37]. Based on these studies, we conclude that additional research is required. Regarding the Addressing the necessities of providing Internet and GPS services, increasing interactivity and attraction, and using new ways to make applications without the need for specific marker or objects to recognize, that is, in the end, work must be done to provide simple and low-requirement applications for the tourist so that he can move easily and use them without restrictions and This enables it to achieve the desired goal of tourism in threatened historical sites.

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5-Conclusion

In this article, we systematically reviewed the literature. The technique of performing research utilizing keywords in Science Direct and IEEE databases was described, and the papers were chosen based on the period from January 2017 to October 2021 and inclusion and exclusion criteria. We found that the number of AR studies in tourism has significantly increased since 2018. Authors from Asia contributed to most AR studies in tourism that were conducted from 2017 to 2021. In addition, Asia, and specifically Indonesia, was the most of the countries in which augmented reality experiences were applied as case studies or applied tourism systems. The researchers discovered that the majority of studies developed mobile augmented reality applications based on markers, internet service availability, and GPS. This explains why, in order to complete the activities of their apps, the researchers in the publications acquired are seriously constrained by the necessity for Internet access and GPS. We kept an eye on a few experiments that tended to result in applications that didn't require Internet access. At the same time, they couldn't give up the GPS service. It was also discovered that most of the display systems that were used or recommended to display augmented reality experiences are hand-held devices, whether it is a phone or tablets. This explains that users and tourists tend to use phones largely because they meet all their technical needs and are easy to carry and move. It provides comprehensive functionality. With regard to research trends, we found that most of the theoretical and practical studies and applications focused on the tourism of archaeological and heritage sites and focus on creating augmented reality experiences that serve the re-imaging of those areas and the revival of their heritage value. This explains the global trend to preserve and protect these places from Environmental and external risks and restore them to their former glory. Additionally, we discovered that augmented reality has a significant positive impact on tourism, increasing the number of tourists and bolstering the economies of tourism-dependent countries. We look for Future studies with a focus on developing applications that serve the tourism industry and allow visitors to visit attractive archaeological and cultural sites without the need for markers, Internet, GPS services or any other requirements in order to make these applications simple to use under all conditions.

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