

Review Article

# Augmented Reality as an Option to Enhance the Tourism Experience - A Review

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**Abstract** - Due to the Covid-19 situation, the tourism sector has faced several challenges to be able to gradually continue with its different activities related to the tourism experience. Therefore, the sector has had to reinvent itself to return to the tourism activity; from this context arises the need to explore various technologies and, within this, the different types of augmented reality (AR). This paper is a systematic review of the literature. The following databases were considered: IEEE Xplore, Springer Link, Scopus, and Science Direct. The PRISMA methodology was used to collect and synthesize information. As a result, the different contributions of AR were systematized, and the most used type of AR and the main factors that influence the improvement of the tourism experience with the support of an AR-oriented application have been rescued. Finally, a proposed model for establishing AR-related systems to provide a better tourism experience is presented.

**Keywords** - Augmented reality, Tourist experience, Systematic review.

## 1. Introduction

AR has had a great impact in recent years thanks to technological advances, changing people's daily lives by offering an immersive experience [1]. AR technology can see synthetic images superimposed on the real world using digital cameras, where layers of virtual content such as text, images, or video can be displayed [2][3]. The technology is very popular among users, so companies use AR as a marketing tool to improve their campaigns and increase their sales, as well as strengthen the emotional bond between the place and tourist, so it benefits different tourist sites being thus disseminated and generating greater audience [4].

In addition, this technology has focused on the tourism sector, attracting consumers to perform tourist activities where presence is a very important factor, so AR is a good complement for this sector [5][6]. AR is also considered in the tourism field as a technology that benefits and helps tourism vendors and visitors, especially by providing a high experiential value to users and providing a positive and satisfactory effect when used. It also considers that visitors tend to get excited, so they manifest positive and satisfactory attitudes through the experience with AR [7,8]. Therefore, RA in the tourism sector is a technology aimed at maintaining and preserving a destination, providing enhanced, satisfying experiences and experiential authenticity of the destination.

A trip related to a cultural heritage site produces and generates cultural awareness by physically visiting and visualizing the place. However, this experience has been truncated and limited by the current situation that still exists due to covid-19 [56], so that visits to certain heritage and tourist sites have been banned, little by little, it was allowed to be present in these places, but still, severe restrictions apply, since the virus can re-infect many people. Despite the restrictions and precautions, many visitors still fear visiting certain tourist sites. This generates economic, commercial, and labor conflicts. Thus, the tourism sector was affected by this conflict at the international and national levels.

Despite the usefulness of these studies, none of the studies highlighted in this section conducted a systematic study mapping the potential experience improvement of the software, in this case, RA. The selection process for the studies in most of the articles is infrequent. Therefore, there is no demand for studies in tourism experience enhancement. Therefore, this research aims to fill the gaps in the field regarding the influence of RA on tourists' behavior and the increase in tourists' interest in RA.

Therefore, the research is justified to recognize and identify the improvement of user experience related to AR oriented to the tourism sector. It is considered important since it helps obtain quality improvement oriented to the travel experience and finding correct directions; also, the RA



is used to make excursions and study tourist and cultural objects [4], so it collaborates with the tourism sector.

The article is organized as follows. Section 2 presents the related work. Section 3 describes the research methodology, including the research questions. The results are presented in section 4, and the research findings are discussed. In section 5, the proposed model is presented, and finally, in section 6, the conclusions are presented.

## 2. Related Tasks

There are some works related to the topic of study. In [9], they reviewed a meta-analytical framework of immersive technologies in the tourism sector, identifying AR as a good factor that adopts presence as one of its main features. These results contribute a lot to tourism. On the other hand, in [10,43], the author identified AR techniques that can favor tourism and improve its tourism experience, identifying other technologies that can complement AR to improve tourism in the future further.

Likewise, in [11][12][13], they identified which technologies are better options to improve the tourism experience against the COVID-19 pandemic and, in the future, concluded that AR is one of the promising options for digital tourism, hospitality, and marketing. Also, in [14], they analyzed which technologies lead to a better tourism experience, clarifying key concepts to provide a better definition of those technologies and how it would be applied in the tourism sector. Likewise, in [15], they identified approaches and the basic concepts most used in the smart tourism sector, concluding that many aspects can improve the tourism experience, such as AR

## 3. Methodology

In this systematic review, the PRISMA methodology was used to systematize and analyze the research articles. Next, bibliometric analysis was used to analyse better the clusters formed according to the common words, identifying in tables the factors that influence the improvement of the tourism experience with RA. Finally, an exhaustive analysis of the articles was carried out to extract the most important and most used techniques to improve the tourism experience with RA.

SLR's work presents an estimate of the scientific and academic community's contributions to improving the tourism experience with RA through rigorous and auditable guidelines based on the PRISMA guide.

The PRISMA statement consists of four steps:

- Identification of articles relevant to the topic.
- Exclusion of full-text screening
- Eligibility analysis
- Inclusion of final articles for detailed analysis

A bibliometric map was also adopted to find the relationships between the common terms of the topic under study. For this purpose, the frequency of words, the number of most frequent words and the number of common words in the final articles were evaluated. According to PRISMA, this section is organized as follows: 1) research questions; 2) article search strategies; 3) bibliometric map; 4) inclusion and exclusion criteria, and 5) final choice of articles.

### 3.1. Research Questions

This paper offers a review of the current state of research on the problems of the tourism experience with RA. To this end, it seeks to introduce the reader to issues related to the research objectives. The paper addresses the following research questions, intending to demonstrate that RA enhances the tourism experience.

RQ1: How does AR increase the interest of tourists?

RQ2: What types of AR are the most efficient for enhancing the tourist experience?

RQ3: How does the use of AR influence tourist behavior?

### 3.2. Research Questions

As for the search strategy to answer the research questions, published articles were searched in the main databases such as Scopus, IEEE Xplore, Science Direct and Springer to determine whether similar work has already been done, which helps to locate potentially relevant studies, the topics covered for this study were multidisciplinary, including tourism experience and RA. The analysis showed that some IEEE Xplore articles were also in Scopus. The search process was then carried out to identify relevant articles using the following search equation (Figure 1).

(Augmented AND reality) AND (tourism)  
AND (experience) OR (tourist)

**Fig. 1 Manuscript search chain to obtain the best studies on the tourism experience**

This search equation was used in four databases to find articles published between 2020 and 2022, identifying 1266 articles.

**Table 1. Inclusion and exclusion criteria**

Inclusion criteria
Articles related to AR and tourism.
Articles published in the last 2 years (2020- 2022).
Open access articles
Exclusion criteria
Articles that are not related to the tourism experience
Non-AR articles
Articles that are not written in English
Exclude articles in the review

A four-step approach was followed: in step 1, articles were discarded based on titles and duplicates, which was

reduced to 1262 articles. In step 2, articles were excluded after reviewing the abstracts, resulting in 1200 articles. In step 3, articles were excluded after eligibility analysis,

resulting in 62 publications. Finally, in step 4, full-text articles were excluded with reasons, resulting in a final figure of 41 articles, as presented in Figure 2.

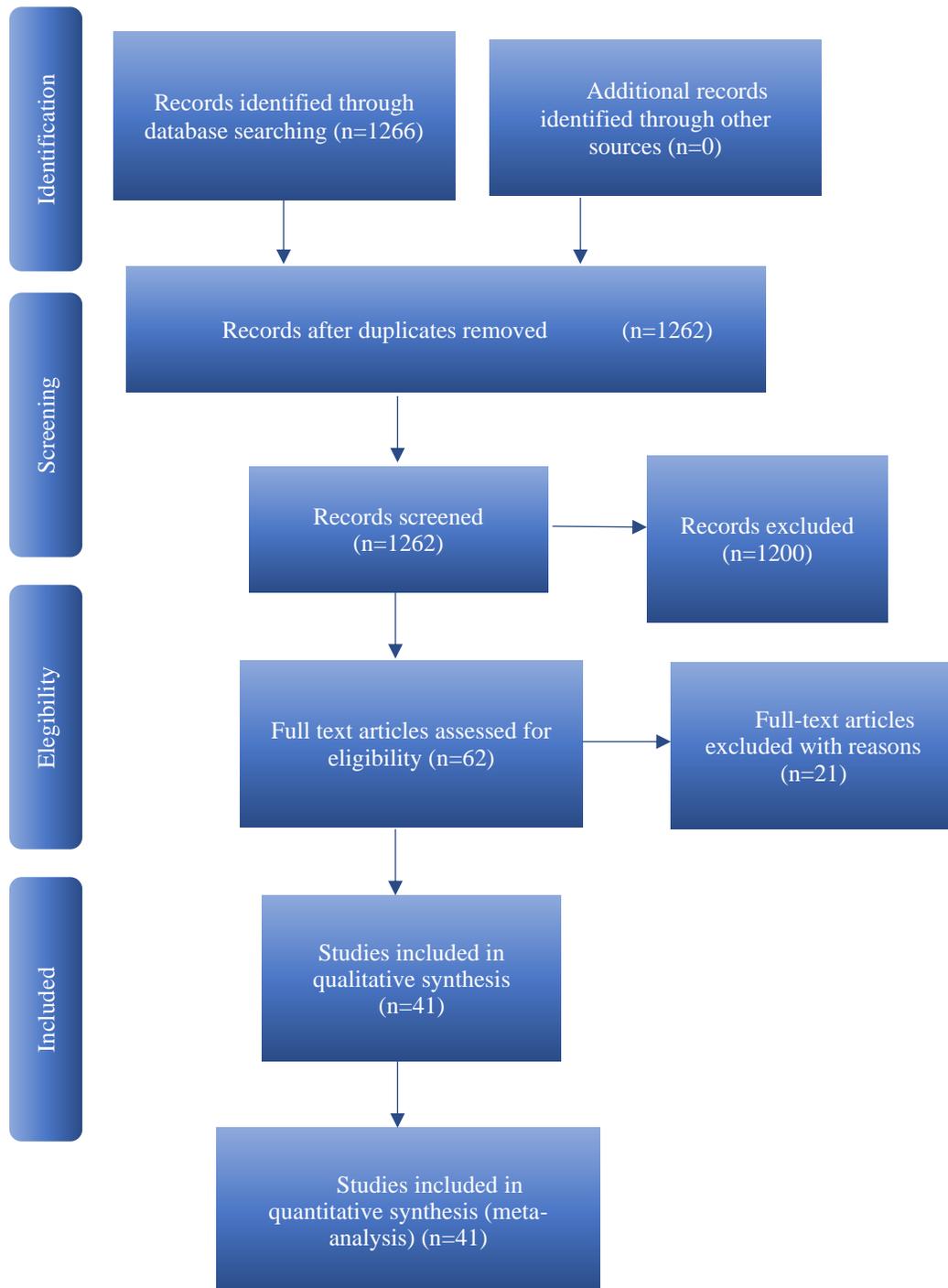


Fig. 2 Steps for the analysis of proposed manuscripts, "Flowchart according to PRISMA"

The 41 manuscripts were divided into three categories, as shown in Tables 2, 3 and 4.

- Studies related to increasing tourism interest in RA.
- Studies related to types of RA to enhance the tourism experience.
- Studies related to the influence of RA use.

**Table 2. Related studies on how RA increases the interest of tourists**

#	Ref.	Application	How RA increases the interest of tourists
1	[16]	Implemented a mixed-reality application with the addition of a rover for an immersive experience.	Showing 3D models that you can visualize on your mobile device to have more information about the tourist site.
2	[17][18]	They used AR to improve the tourist experience in heritage sites.	Display 3D models to interact better with historical artifacts and enhance the tourist experience.
3	[19]	Mentioned how ICT could be applied in the airlines and tourism sector.	Using AR with other technologies to improve tourism.
4	[20]	Implemented an application with AR for the preservation of birds in nature.	Using RA to promote conservation and nature protection attracts many tourists who support this idea.
5	[21]	In this article, we explore the impact of an AR application designed for one of Portugal's cultural heritage landmarks, Quinta da Regaleira.	Using models based on the tourist site's culture produces the effect of intensifying the visit.
6	[22]	This article generates new requirements for AR mobile applications that reflect the needs of the Asian tourism market.	It is observed that users who already had prior knowledge of heritage sites through AR applications tend to improve their experience.
7	[23]	In this article, they designed mobile apps to help travelers and tourists find the heritage and other tourist objects on a map.	They fundamentally transform our relationship with cultural heritage and memory.
8	[24]	They showed that information technologies could offer viable alternatives to mass international tourism and package tours, ensuring both travel safety and a deeper immersion in the experience.	Showing 3D models with information about the tourist site.
9	[25]	They demonstrated that digital skills are the most necessary for tourism.	They specified that RA is considered for digital competencies with respect to the tourism sector.
10	[26]	Implemented AR for a geo-tourist itinerary.	Geotourism itinerary with AR helps increase tourists' interest, as it provides learning and curiosity to use this application.
11	[27]	They developed an application with AR that turns the tourist experience into anchors, opening up multiple personalized encounters through engagement with technology.	Visitors come to have increased cognitive and affective encounters with the art, to increase cognitive and affective encounters with the art.

**Table 3. Studies related to types of RA to improve the tourism experience**

#	Ref.	Application	Types of RA to enhance the tourism experience
1	[3], [28]	Developed an AR tourist guide system to update tourist attraction data automatically.	Location-based AR.
2	[29]	Implemented an AR prototype for tourist sites in Indonesia following the COVID-19 pandemic.	Marker-based AR.
3	[57]	Implemented an AR prototype to drive tourists' curiosity in cultural heritage.	AR-based without markers and environment identification.
4	[31]	Proposed a Mixed Reality prototype for a museum to improve the visitor experience.	Marker-based AR.
5	[32]	Implemented an application with AR for tourist guides with the intention of promoting tourism.	Location-based and marker-based AR.
6	[33]	A recommendation system to generate museum itineraries applying AR techniques and social sensor mining.	AR is based on localization and simultaneous mapping.

7	[34]	Implemented an application with AR to improve the multisensory experience in a museum.	Location-based AR and simultaneous mapping.
8	[35]	Implemented an application with AR to improve the experience of visitors in theme parks.	Location-based AR.
9	[36]	Implemented an application with AR to improve advertising and increase marketing by attracting tourists.	Location-based AR.
10	[58]	Presented an AR prototype to provide solutions for future exhibitions in the tourism industry.	AR is based on three-dimensional tracking and recording.
11	[38]	Implemented mixed reality for tourist guides in cities.	Marker-based AR.
12	[39]	Implemented an AR prototype for the maritime tourist space.	Location-based AR.
13	[40][41]	Provided a mixed reality application for cultural heritage.	Marker-based RA.
14	[42]	Provided an application with AR for ecotourism.	Location-based AR.
15	[59]	Implemented digital technologies for cultural heritage, where AR is one of them.	Location-based AR.
16	[44]	Implemented technologies, including AR, for a museum.	Marker-based AR.
17	[45]	Implemented AR to guide divers and improve their experience.	Marker-based AR.

**Table 4. Studies related to how AR influences the behavior of tourists**

#	Ref.	Application	How the use of AR influences tourist behavior
1	[46]	In this article, they want to identify travelers' experiences with AR applications.	Demonstrated the applicability of sensation seeking to explain AR experiences.
2	[1]	In this article, they want to know what factors influence the acceptance of mixed reality in tourism education.	Demonstrated that users give good acceptance to the applications with AR with respect to tourism education.
3	[7]	In this article, they intend to investigate how the multidimensional components of the experiential value of AR.	The different degrees of interest in cultural heritage sites or concern for the environment.
4	[47]	In this article, they want to demonstrate the use of digital technologies such as AR in the user experience of cultural heritage.	The use of AR, reinforced by immersive storytelling, would limit the physical wear and tear of the site, making its conservation sustainable in the long term.
5	[48]	In this article, they want to assess teachers' perceptions of using AR for heritage teaching.	The use of AR will improve their understanding of the context of the historical moment to which it refers.
6	[60]	In this article, they wish to investigate possible technologies for the future of tourism in the Arctic.	According to the results, Arctic tourism using technologies such as AR and VR enhances the tourism experience.
7	[50]	They implemented AR for tourism experience in cultural heritage.	According to the results, visitors show positivity from AR technology to explore cultural heritage.
8	[51]	They made an application with the mixed reality that offers the possibility to travel to places that no longer exist in their original form, reconstructed only in VR.	They mimic multidimensional and multisensory travel experiences. Transferring visitors to the historical events of the visited zone, where their behavior and decisions could have some influence on the course of events.

#### 4. Results and Discussion

This section presents the bibliometric analysis and the detailed analysis of the analyzed papers. The first part presents the associations between the common words with

respect to RA as an option to improve the tourism experience. The second part seeks to approach the scientific gap of the works presented in this study to develop a new model to improve the tourism experience through RA.

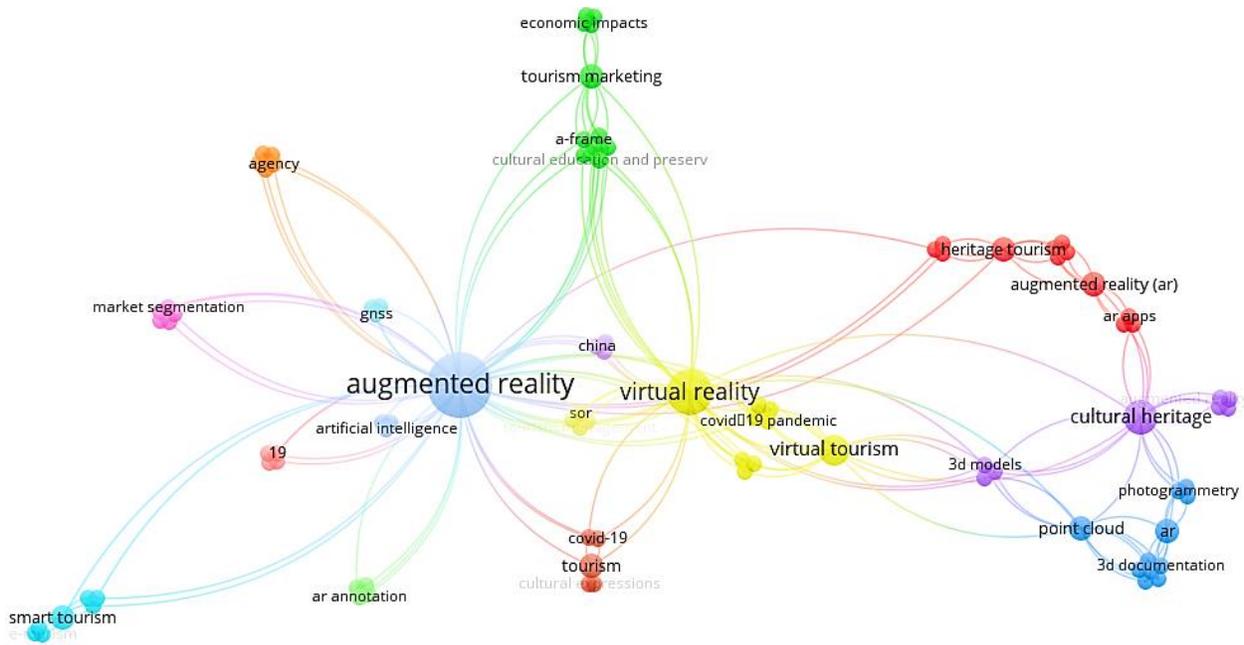


Fig. 3 Associations between common words with the bibliometric map

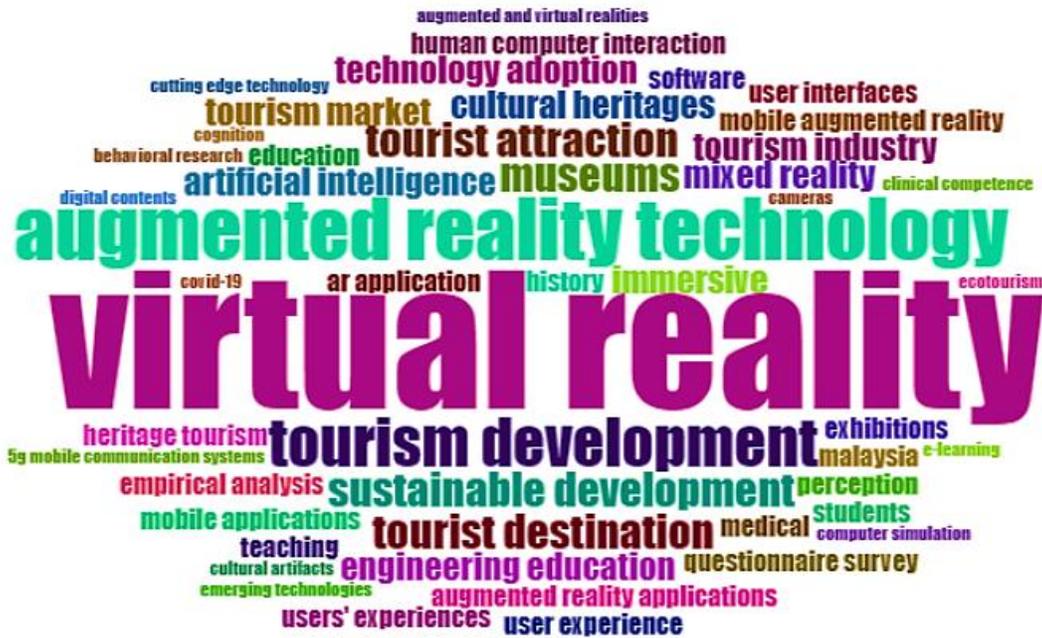


Fig. 4 Word cloud display

#### 4.1. Bibliometric Analysis

VOS viewer [52], a bibliometric visualization network, was used to find common terminology related to AR as an option to improve the tourism experience in the 41 manuscripts analyzed. Vos viewer is a very useful tool for analysing and presenting information in a visual form, allowing us to visualize the associations of keywords associated with AR technology and where the tourism experience has been used with AR and to identify them in clusters.

Figure 3 presents the network map showing the relationships between the most used words and how each of them is linked. The largest node symbolizes the most used words in the manuscripts, and its size is an indicator of the number of times these words appear in the manuscripts. The VOS viewer divides the terminology into clusters according to their relevance to each other.

The analysis was performed in relation to titles and abstracts using a binary calculation technique of 134 keywords examined with a minimum threshold of 1 occurrence, resulting in 134 words, as presented in Figure 3. The most notorious nodes symbolizing each cluster in the network map are determined as the AR cluster (navy blue), virtual reality cluster (yellow), cultural heritage cluster (purple), augmented reality cluster (red), tourism marketing cluster (green), smart tourism cluster (light blue) and, finally, tourism cluster (brown). Similarly, [Figure 4] shows the word cloud.

Looking at the network map in Figure 3, there are 15 clusters that are associated with each other; for example, the term "augmented reality" relates to "artificial intelligence" in the same navy-blue cluster, also in the yellow cluster "., virtual reality" relates to "virtual tourism" and "covid-19 pandemic".[37] Moreover, "covid-19" is also connected with "tourism" in the brown cluster. In addition, "tourism marketing" relates to "economic impacts" and "a-frame" in the dark green cluster. Likewise, "point cloud" relates to "ar", "3d documentation", and "photogrammetry" in the blue cluster. Also, "cultural heritage" is connected with "3d models" in the purple cluster.



Fig. 5 Visualization of the density of documents available in the databases and bibliometric analysis.

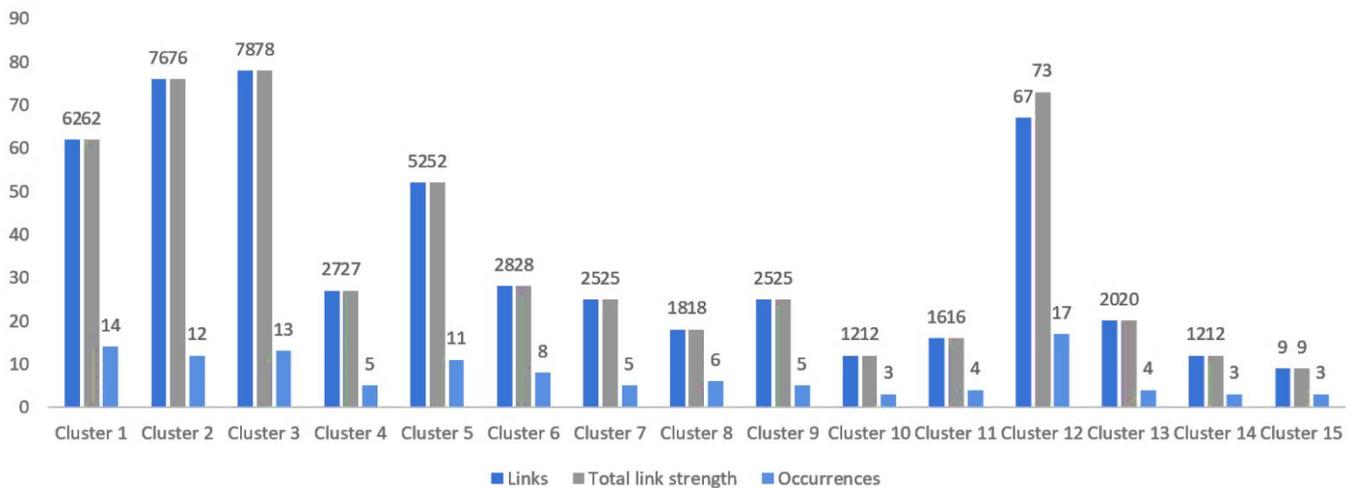


Fig. 6 Items, links, total link strength, occurrence, and year of publication.

**Table 5. Available articles related to AR in the tourism experience**

No.	Database	Initial search	Categorization by year of publication			Final result
			2022	2021	2020	
1	Scopus	166	3	9	8	20
2	Science Direct	428	0	0	1	1
3	IEEE Xplore	510	0	2	14	16
4	Springer Link	162	0	1	3	4
Summary		1266	3	12	26	41

Figure 5 shows visualizations of document density to identify academic performance issues with artificial intelligence available in online databases based on bibliometric analysis.

Finally, looking at the network map in Figure 3 and the visualization of document density in Figure 5, it was possible to identify the most relevant words for each cluster, as shown in Figure 6.

**4.2. Manuscript Analysis**

For the search (4) online databases were used, a total of one thousand two hundred and sixty-six (1266) documents were retrieved. The IEEE Xplore database has the largest number of documents retrieved, five hundred and ten (510) in the year 2021, with the highest number of published articles, as presented in Table 5.

In the review, 4 duplicate papers were found among the 1266 documents retrieved. A total of 166 documents were retrieved in Scopus, of which 146 were discarded based on the exclusion criteria. In Science Direct, 428 documents were retrieved, although 427 were discarded based on the exclusion criteria. IEEE Xplore retrieved 510 documents and discarded 494 based on the exclusion criteria. Springer Link retrieved 162 documents, and applying the exclusion criteria, 158 were discarded.

RQ1 prompted the search for data sources and types of AR techniques to identify the interest obtained in tourists using AR. The review of articles allowed us to extract and analyze the interest obtained in tourists using AR, such as 3D models with destination information, interaction with 3D models, or using AR for environmental conservation.

Table 6 shows the articles that used 3D models with information and interaction with 3D models to increase interest towards tourists in AR. One of them [16] proposed to use RA for the purpose of informing the environment of the tourist place so that tourists know all the culture about the place and increase their interest in the place, as well as, in [17] proposes that having interaction with 3D models provided by RA increases the interest of tourists. Thus, it has been observed that these 2 ways are the most used to increase the interest of tourists.

**Table 6. References of articles associated with increased interest of tourists in RA**

Increasing the interest of tourists with AR	Articles
3D models with information	[16] [22] [24]
Interaction with 3D models	[17][18] [23]
Other	[19] [20] [21] [25] [26]

In addressing RQ2, we examined the types of RA used for the tourism sector. With this objective, we analyzed manuscripts associated with marker-based AR, location-based AR, simultaneous mapping, tracking, and three-dimensional registration, as shown in Table 7. For location-based AR, we found 9 related articles to increase the tourism experience. One of them, in [3], implemented location-based AR for tourist guides to improve their tourism experience when being present at the location.

For marker-based AR, 8 related articles were found to increase the tourist experience; in [29], they implemented an application for tourist guides using markers in order to improve the tourist experience by scanning the objects that will be around the tourist place. Only 2 articles were found where they applied AR based on simultaneous mapping to improve the tourist experience, where these articles are related to localization. Finally, the types of AR found in the "others" section are methods that are not very common or are variations which are not frequently used in the tourism sector.

Table 7 lists the articles analyzed for the types of RA chosen by the author. It should be noted that many of the articles used more than one type of RA.

**Table 7. References of articles associated with types of RA**

Types of RA	Articles
Location	[3] [34] [32] [33] [35] [36] [39] [42] [59]
Markers	[31][29][32] [38] [40][41] [44] [45]
Simultaneous mapping	[34][33]
Other: environment identification, tracking and three-dimensional recording	[53][57][58]

**Table 8. Items associated with how RA influences tourist behavior.**

How RA influences tourist behavior	Articles
Improve the tourist experience by distributing information about tourist attractions.	[46] [48] [54] [60]
Different degrees of interest in cultural heritage sites or concern for the environment.	[7] [50]
Others	[1] [51] [47] [55]

The study also analyzed the metrics of how RA influences tourists' behavior in the scope of our RQ3. The results are presented in Table 8, where we can appreciate the articles that addressed how RA influences tourists' behavior in the analyzed articles.

Answering the question RQ1, we compare with [22]; in this case, they developed an application with AR to show 3D models with information, which allowed to increase the interest of tourists by giving a more general context of the tourist place. Other research, such as in [17] and [18], used AR with interactions with 3D models to increase the interest of tourists by being able to touch these 3D models to enhance their experience in the tourist place. Likewise, [20] used AR to raise awareness of environmental preservation, generating interest from tourists. With what has been said above, we can clarify that the most used AR functions to improve the interest of tourists are 3D models that show information and those that can be interacted with.

Answering the question RQ2, the authors in [29] and [39] implemented similar applications in the field of AR in the tourism sector, e.g. in [29] developed a type of AR that is

based on markers for tourist sites, scanning these images to generate 3D models. On the other hand, [39] developed a type of AR based on location for the tourist space, allowing to have the location with GPS to generate the models depending on the place where it is located. With the above said, we can affirm that AR based on markers is very common with this technology, so the AR based on location is the one that has the highest rate that improves the tourist experience by using the location with GPS to generate the 3D models without the need to be scanning any image, just using the internet.

Answering the question RQ3, [46] used AR to detect how this technology influences tourist behavior, resulting in the distribution of information about tourist attractions. On the other hand, the author [50] has detected that AR positively influences tourist behavior by applying it to cultural heritages or environments. With the above described, we can affirm that the most common behavior by tourists using RA is in a positive way because it not only distributes information about the tourist place, but it increases the degree of interest in cultural heritages, helping to improve their experience with the place.

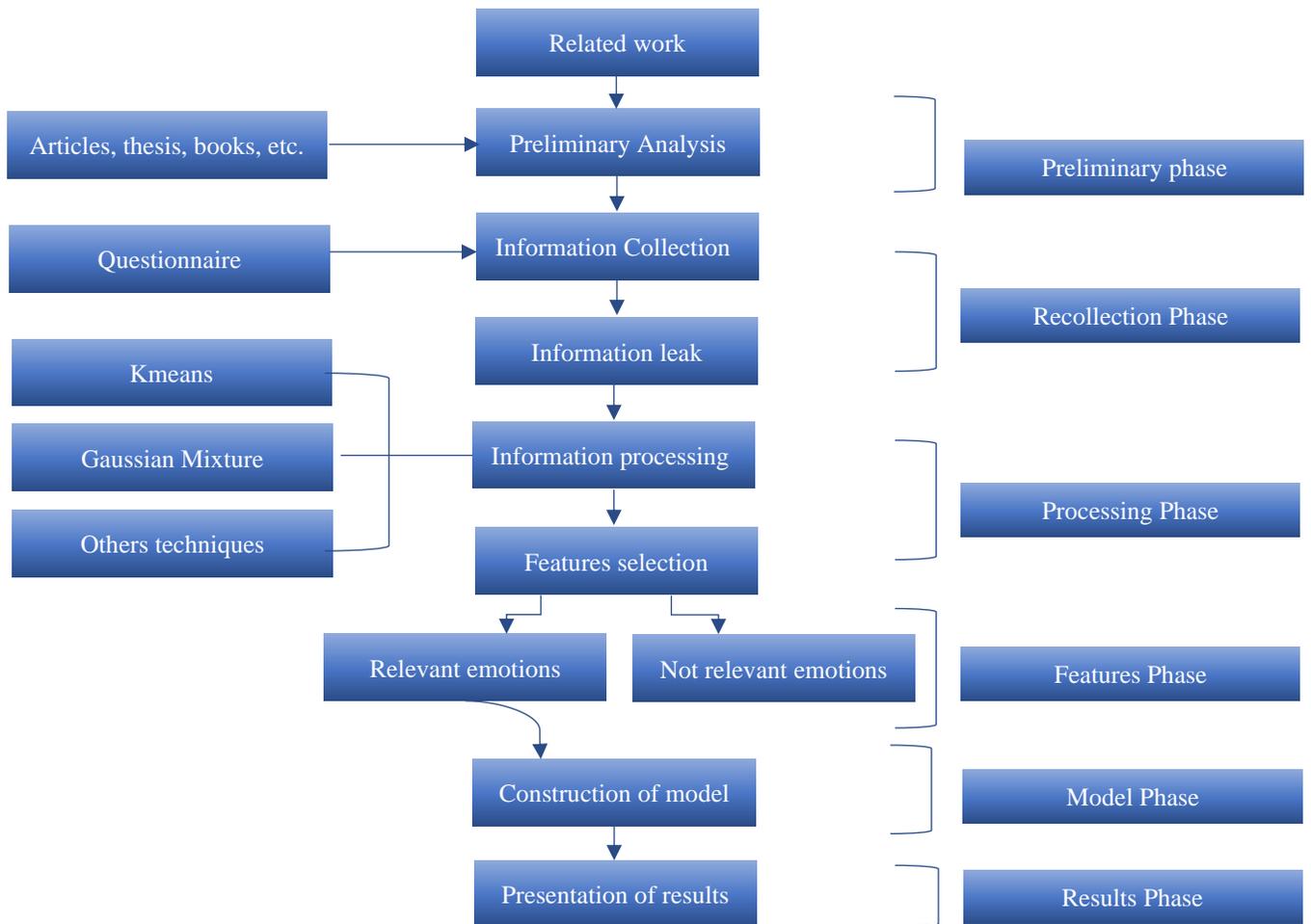


Fig. 7 Proposed model

## 5. Proposed Model

A new model is proposed to fill the gaps about the different RA types that help improve the tourist experience. Since the expectations regarding important and expected issues, such as the influence of RA on tourist behavior and the increase of interest in this technology, have not been met, Figure 7 shows the graphical representation of the proposed model.

The proposed model consists of the following phases: (1) Preliminary analysis, (2) Data collection, (3) Data analysis and preprocessing, (4) Feature selection, (5) Building a model, and (6) Model training and verification.

### 5.1. Preliminary Analysis

In this phase, the literature is reviewed to obtain those data, which serve to analyze, through mathematical approaches, to improve the tourism experience using AR.

### 5.2. Data Collection

In this phase, the data related to usability, satisfaction, and user behaviors of users who have experienced using an AR application is obtained.

### 5.3. Data Analysis and Preprocessing

The data is processed in detail and, if necessary, transformed to expose its informative content better. Different techniques and tools can be used; intermittent values can be eliminated, and the number of parameters can be reduced, among others.

### 5.4. Feature Selection

Metrics are determined, and defects are identified in the study using regression algorithms to predict values. Logistic regression algorithms can also be used to classify and predict. Finally, a corpus is created to define the final list of metrics capable of accurately predicting the factors that contribute to improving the tourism experience through AR.

### 5.5. Build a Model

In this phase, a statistical model capable of predicting the factors that influence the improvement of the tourism experience through types of RA is presented.

## 5.6. Presentation of Results

In this phase, the results obtained by the random forest are presented, where the main factors are visualized with accuracy, measurement, and error rates.

## 6. Conclusion

This study provided 41 articles selected from different databases, countries and years that were reviewed and promoted as references for the study of RA as an option to improve the tourism experience. This work found opportunities for future research with RA to improve the tourism experience based on the review and discussion of existing research through its problems addressed, methodology, data use, timing, etc.

Responding to RQ1: Analysing Table 6, we can see that the AR, where one can visualize information about tourist sites or interact with 3D models, are the one that has most increased the interest of tourists.

Responding to RQ2: We can say, with respect to the analysis in Table 7, that the most used types of RA in the tourism sector are location and markers.

Responding to RQ3: We can define, according to the analysis in Table 8, that RA has a positive influence if it is used for the purpose of distributing information about tourist attractions or for environmental protection.

Compared with related works, it can be analysed that using AR for tourism is a good factor in improving the tourists' experience. It has been seen more often to use interactions with 3D models, where AR is mostly location-based.

Finally, this study's results will help decision-makers fill the gaps in the field regarding the influence of RA on tourist behaviour and the increase of tourists using RA, implying that RA is a good option for the tourism sector.

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