



# Impact of Mobile Applications on Customer Service for the Tourism Sector: A Systematic Review and Neutrosophic Dematel

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## Abstract

This study aims to systematically review mobile applications and their impact on customer service in the tourism sector from 2017 to 2021. For this, the use of the DEMATEL method in its neutrosophic variant is proposed. The search strategy identified 257,399 articles from digital libraries such as Scopus, IEEE Xplore, ACM Digital Library, Springer Link, Google Scholar, Microsoft Academic, EBSCOhost, ProQuest, ScienceDirect, and ARDI. Likewise, only 70 articles based on exclusion criteria were considered using the PRISMA Flowchart. The results of the systematic review have focused on recent studies of mobile applications and their impact on customer service in tourism and also provide a mapping of the extracted studies, metrics, trends, and validation methods to compare relevance to their settings and situations. The applicability and importance of multiple decision-making methods for solving complex problems were demonstrated. In addition, the effectiveness of using neutrosophy to reach valid conclusions when faced with real-life problems was manifested.

**Keywords:** Mobile applications; customer service; tourism; Neutrosophic Dematel

## 1. Introduction

The new era of information and communication technologies (ICT) has opened many new tools for the tourism industry, such as mobile applications. Since the tourism industry is one of the most suitable areas where mobile applications are widely used from operational and business perspectives, it is not surprising that the idea of smart tourist destinations, gamification methods, user experience or behavior, and content generated by the user for a better experience, has developed quite quickly in this industry[1].

Studies have reported that smart tourism refers to using a set of technologies to collect large amounts of data and provide real-time support to all stakeholders in the destination by improving their experiences[2]. Likewise, smart tourism not only maximizes the use of tourism resources but it also manages tourism destinations, protects tourist attractions, and improves the interaction between tourists and residents. Furthermore, the growing importance of tourism for national and local economies and its cultural and sociological effects allowed it to develop as a discipline and led researchers from different disciplines to become interested in the field. Therefore, tourism improvement over the years is evident through its multidisciplinary structure based on the metrics used, approaches, methods, models, etc., which require further quantitative and qualitative analysis[3, 4].

This study aims to identify state of the art on Mobile Applications and their impact on Customer Service in the Tourism sector. To carry out a systematic review regarding the field of study, the knowledge of experts in the field is also used, as well as the contributions made to the field by neutrosophy through the application of methods for the resolution of multiple problems. Neutrosophy is a discipline that combines aspects of logic,

philosophy, and technology to analyze the origin, nature, and scope of neutralities. This discipline also focuses on the study of uncertainty in decision-making and indeterminacies to consider these aspects in analyzing real-world situations[5, 6].

## 2. Related Work

The developments and changes in the technological environment are quite uncertain, and to sustain itself in the highly competitive era, it is essential for the tourism industry to keep an eye on these aspects. Therefore, it requires elaborate illustrations of the contribution of the different studies in the e-Tourism research area[7]. Smart tourism is defined as tourism supported by integrated efforts in a destination to collect and aggregate data from physical infrastructure, social connections, governments, businesses, other organizations, and humans, and transform this data with analytical tools advanced in meaningful experiences and commercial value propositions with a clear focus on efficiency, sustainability, and experience enrichment. Furthermore, the advent of smartphones not only brought the benefits of the Internet into the traveler's hands, but also enabled more personalized, location-based recommendations and on-demand services, such as transportation apps[8].

ICTs have a double reinforcing effect: firstly, using websites, applications, and other electronic services allows the collection and analysis of user data[9]. This allows for more accurate and holistic knowledge of a destination that can be leveraged to deliver new or more efficient services. Secondly, many electronic services exist, allowing companies to promote their products and services created with the above data to more people than was possible before ICT became a household product.

The tourism industry has begun to increase its commitment to sustainability, mainly by developing a more sustainable range of products. These tourism products are endowed with different sustainability attributes to guarantee high standards of economic equity, positive socio-cultural impacts, and respect for the environment. Likewise, sustainability communication aims to raise consumer awareness about the availability of sustainable travel products, inform consumers how these offers meet their needs and meet sustainability criteria, and ultimately stimulate personal purchases. Sustainable[10].

Many visitors do not explore tourist attractions as a whole because of their breadth, and visitors do not understand them in general. In addition, tour guide facilities provide paid tourist attractions, so most visitors are reluctant to use them. Therefore, many users are less interested in adventure and receive less information and history that this tourist attraction contains[10].

With the development of mobile applications, they can be used to help deliver information on cultural history in heritage tourism and, through the application of gamification solutions, can be solved for the exploration of heritage sites, providing utility and satisfaction. To address gap in the literature, this article provides the first review of the literature on Mobile Applications and their impact on Customer Service in the Tourism Sector with research questions (RQs) on some types of NERs (named entity recognition)[11], such as: people, organizations, places, expressions of time, and quantities that appear more frequently in the abstracts of the investigations, as well as articles whose abstracts, conclusions and discussions are characterized by their high objectivity and low polarity organized by year. In this systematic review, information was collected on the impact of mobile applications on customer service in the tourism sector.

## 3. Methodology

The research was carried out by adopting the recommendations of a systematic literature review (RSL). The literature is collected and analyzed. According to the guidelines, the study consists of three main phases: planning, conducting, and documenting the review. The phases are shown below in Figure 1.

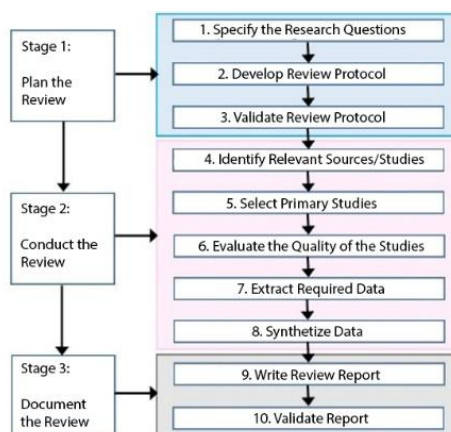


Figure 1: Phases of the SRL [9].

### 3.1 Problems and Research Motivation

When carrying out systematic literature research, the research questions play an essential role in the strategy of the search, extraction, and analysis of data. Initially, ten research questions were proposed for analysis; however, for reasons of effectiveness and efficiency in conducting the study, applied the DEMATEL method in its neutrosophic variant, as proposed by [10], for the selection of those elements with the greatest preference by a group of 4 experts

**Definition 1** ([12]) Let  $X$  be a space of points (objects) with generic elements in  $X$  denoted by  $x$ . A single-valued neutrosophic set (SVNS)  $A$  in  $X$  is characterized by the truth-membership function  $TA(x)$ , indeterminacy-membership function  $IA(x)$ , and falsehood membership function  $FA(x)$ . Then, an SVNS  $A$  can be denoted by  $A = \{x, TA(x), IA(x), FA(x) \mid x \in X\}$ , where  $TA(x), IA(x), FA(x) \in [0, 1]$  for each point  $x$  in  $X$ . Therefore, the sum of  $TA(x), IA(x)$  and  $FA(x)$  satisfies the condition  $0 \leq TA(x) + IA(x) + FA(x) \leq 3$  [18].

**Definition 2** ([13]) Let  $E_k = (T_k, I_k, F_k)$  be a neutrosophic number defined for the rating of  $k$ -th decision-maker. Then, the weight of the  $k$ -th decision-maker can be written as:

$$\psi_k = \frac{1 - \sqrt{[(1 - T_k(x))^2 + (I_k(x))^2 + (F_k(x))^2]/3}}{\sum_{k=1}^p \sqrt{[(1 - T_k(x))^2 + (I_k(x))^2 + (F_k(x))^2]/3}} \tag{1}$$

Moreover, it is crucial to involve group decision-making in any decision-making process to attain a satisfactory outcome. Hence, it is necessary to combine all the evaluations made by individual decision-makers into a unified neutrosophic decision matrix during the group decision-making process. One method to achieve this is utilizing the SVNWA aggregation operator introduced by Ye, a weighted averaging method for single-valued neutrosophic numbers[14].

**Definition 3** ([15]) Let  $D^{(k)} = (d_{ij}^{(k)})_{m \times n}$  be the single-valued neutrosophic decision matrix of the  $k$ -th decision-maker and be the weight vector of decision-maker such that each  $\psi = (\psi_1, \psi_2, \dots, \psi_p)^T, \psi_k \in [0, 1], D = (d_{ij})_{m \times n}$  where

$$d_{ij} = \langle 1 - \prod_{k=1}^p (1 - T_{ij}^{(p)})^{\psi_k}, \prod_{k=1}^p (I_{ij}^{(p)})^{\psi_k}, \prod_{k=1}^p (F_{ij}^{(p)})^{\psi_k} \rangle \tag{2}$$

**Definition 4** ([16]) Deneutrosophication of SVNS  $\tilde{N}$  can be defined as a process of mapping  $\tilde{N}$  into a single crisp output for  $x: \tilde{N} \rightarrow \psi^* \in X$ . If  $\tilde{N}$  is discrete set then the vector of tetrads  $\tilde{N} = \{(x \mid T\tilde{N}(x), I\tilde{N}(x), F\tilde{N}(x)) \mid x \in X\}$  is reduced to a single scalar quantity  $\psi^* \in X$  by deneutrosophication. The obtained scalar quantity  $\psi^* \in X$  best represents the aggregate distribution of three membership degrees of neutrosophic element  $T\tilde{N}(x), I\tilde{N}(x), F\tilde{N}(x)$ . The the deneutrosophication can be obtained as follows.

$$\psi^* = 1 - \sqrt{[(1 - T_k(x))^2 + (I_k(x))^2 + (F(x))^2]/3} \tag{3}$$

In general, decision-making entails the utilization of human language, which is often denoted as linguistic variables. Linguistic variables are essentially words or terms that are utilized in human language. This approach of using linguistic variables benefits decision-makers since it gives them a convenient way to express their evaluations. For instance, ratings of criteria can be articulated through the use of linguistic variables like "very influential (VI)," "influential (I)," "low influential (LI)," "no influence (NI)," and so forth. It is possible to convert linguistic variables into SVNSs, as depicted in Table 1.

Table 1: Linguistic variable and Single Valued Neutrosophic Numbers (SVNNs)[17].

Integer	Linguistic variable	SVNNs
0	No influence / Not important	(0.1,0.8,0.9)
1	Low influence / important	(0.35,0.6,0.7)
2	Medium influence / important	(0.5,0.4,0.45)
3	High influence / important	(0.8,0.2,0.15)
4	Very high influence / important	(0.9,0.1,0.1)

To determine which are the most research questions, the use of the DEMATEL method in its neutrosophic variant is proposed through the steps below[18].

1. *Identify research questions* A series of research questions are established by conducting semi-structured interviews with a particular group of people and engaging in brainstorming sessions. Following this, experts are requested to assess the relationship between different factors by means of paired comparisons, utilizing the scoring system presented in the table..
2. *Determine the experts' relative importance: The expert group's significance* is determined by their expertise and familiarity with the decision problem, resulting in varying weights assigned to each decision-maker. These weights are expressed through linguistic variables and processed in SVNN before being recognized using equation (1)..
3. *Converting the language assessments given by the SVNN experts:* Table 1 provides guidance on how to construct the individual neutrosophic matrices of decision-makers using the integer matrices obtained from their evaluations.
4. *Get the initial direct relationship matrix:* Equations (2) and (3) are utilized to aggregate the individual decision-makers' neutrosophic matrices and transform them into a crisp number initial direct relationship matrix.
5. *Identify cause-effect relationships between factors using the DEMATEL method:* Using equations (4-6), the total relationship matrix T can be calculated with ease based on the aggregate direct relationship matrix A obtained in step 4.

$$D = A * S \tag{4}$$

Where

$$S = \frac{1}{\max_{1 \leq i \leq n} \sum_{j=1}^n a_{ij}} \tag{5}$$

$$T = D * (I - D)^{-1} \tag{6}$$

where I is the identity matrix.

From this, the cause-effect relationship diagram  $(r_i + c_i, r_i - c_i)$

6. *Analyze the cause-effect relationship diagram.* The  $(r_i - c_i)$  indicates importance of each factor while  $(r_i + c_i)$  is the net cause or effect group. The term "Prominence" refers to the  $(r_i + c_i)$  and serves as a measure of the level of central influence held by a factor or criterion in the system. . While  $(r_i - c_i)$  is called "Ratio" and It denotes the impact created by a factor or criterion in the system.. If  $(r_i + c_i) > 0$  the factor or criterion is located in the group of causes, 2. If  $(r_i - c_i) < 0$  the factor or criterion is located in the group of effects. The pairs  $(r_i - c_i)$  and  $(r_i + c_i)$  It is possible to illustrate this visually in a graphical format, which provides decision-makers with a visual representation of the system..

Table 1 shows the single value neutrosophic numbers obtained from the evaluations carried out by expert 1. In order to abbreviate, the representation of all the evaluations obtained is suppressed, and the general results of the analysis are shown in Table 2.

Table 2: The neutrosophic evaluation performed by expert 1 to select the research questions.

F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.35, 0.6, 0.7)	(0.1, 0.8, 0.9)	(0.5, 0.4, 0.45)	(0.9, 0.1, 0.1)	(0.35, 0.6, 0.7)	(0.35, 0.6, 0.7)	(0.5, 0.4, 0.45)	(0.1, 0.8, 0.9)
(0.35, 0.6, 0.7)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.5, 0.4, 0.45)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.35, 0.6, 0.7)
(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.5, 0.4, 0.45)	(0.1, 0.8, 0.9)	(0.35, 0.6, 0.7)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.9, 0.1, 0.1)	(0.1, 0.8, 0.9)
(0.35, 0.6, 0.7)	(0.5, 0.4, 0.45)	(0.5, 0.4, 0.45)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.35, 0.6, 0.7)	(0.1, 0.8, 0.9)
(0.9, 0.1, 0.1)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.35, 0.6, 0.7)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.35, 0.6, 0.7)	(0.1, 0.8, 0.9)

(0.9, 0.1, 0.1)	(0.5, 0.4, 0.45)	(0.35, 0.6, 0.7)	(0.1, 0.8, 0.9)	(0.5, 0.4, 0.45)	(0.1, 0.8, 0.9)	(0.35, 0.6, 0.7)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)
(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.9, 0.1, 0.1)
(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.9, 0.1, 0.1)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.8, 0.2, 0.15)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.8, 0.2, 0.15)	(0.35, 0.6, 0.7)
(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.9, 0.1, 0.1)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)
(0.1, 0.8, 0.9)	(0.35, 0.6, 0.7)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)	(0.35, 0.6, 0.7)	(0.5, 0.4, 0.45)	(0.9, 0.1, 0.1)	(0.1, 0.8, 0.9)	(0.1, 0.8, 0.9)

Table 3: Result of the application of the DEMATEL method.

No.	Research questions considered	Ri	Ci	Ri+C <sub>i</sub>	Ri-C <sub>i</sub>
<b>F1</b>	What are the most used types of research to evaluate the effect of a Mobile Application and its influence on Customer Service in the Tourism Sector?	4,52 2	3,92	8,442	0.602
<b>F2</b>	What are the types of research that most incur gaps or gaps in terms of existing knowledge on the subject?	4,08 8	3,87 9	7,967	0.209
<b>F3</b>	What types of research offer patterns or trends on the effects of mobile applications on customer service in the Tourism Sector?	3,73 6	4,35 1	8,087	- 0.615
<b>F4</b>	Which are the most relevant publications on the use of mobile applications in the Tourism Sector according to your peers and scientific opinion in general?	3,43 3	4,85 4	8,287	- 1,421
<b>F5</b>	What are the most used Development Environments for the creation of Mobile Applications?	4,64 9	3,12 1	7,77	1,528
<b>F6</b>	Which are the Publication Media (Magazines or Congresses) that report more publications per Year about Mobile Applications and their influence on Customer Service in the Tourism Sector?	4,33 6	3,99 7	8,333	0.339
<b>F7</b>	What are the sustainable development objectives most benefited from the publication of research on the creation of mobile applications in the Tourism sector?	3,39	3,90 6	7,296	- 0.516
<b>F8</b>	What are the named entities (NER): people, organizations, places, expressions of time and quantities that are presented in the Summaries of research on Mobile Applications and their influence on Customer Service in the Tourism Sector?	4,86 8	3,18 5	8,053	1,683
<b>F9</b>	Which are the countries or regions worldwide that report more publications per Year about Mobile Applications and their influence on Customer Service in the Tourism Sector?	3,30 2	6,19 9	9,501	- 2,897
<b>F10</b>	Which are the articles whose Summaries, Conclusions and Discussions are characterized by their high Objectivity and low Polarity, by year, number of citations and by source in research on Mobile Applications and their influence on Customer Service in the Tourism Sector?	4,17 9	3,09 1	7,27	1,088

By identifying the questions, the motivations were also identified, which are detailed in Table 3.

Table 4: Research Questions and Motivation. Source: own elaboration.

Research Question	Main Motivation
RQ1: What are the most used types of research to evaluate the effect of a Mobile Application and its influence on Customer Service in the Tourism Sector?	Identify the most used types of research to evaluate the effect of a Mobile Application and its influence on Customer Service in the Tourism Sector.

RQ2: What are the most used Development Environments for the creation of Mobile Applications?	Specify the development environments most used for the creation of Mobile Applications.
RQ3: Which are the Publication Media (Magazines or Congresses) that report more publications per Year about Mobile Applications and their influence on Customer Service in the Tourism Sector?	Identify the Publication Media (Magazines or Congresses) that report more publications per Year about Mobile Applications and their influence on Customer Service in the Tourism Sector.
RQ4: What are the named entities (NER): people, organizations, places, expressions of time and quantities that are presented in the Summaries of research on Mobile Applications and their influence on Customer Service in the Tourism Sector?	Specify which named entities (NER): people, organizations, places, expressions of time and amounts that are presented in the Summaries of research on Mobile Applications and their influence on Customer Service in the Tourism Sector.
RQ5: Which are the articles whose Summaries, Conclusions and Discussions are characterized by their high Objectivity and low Polarity, by year, number of citations and by source in research on Mobile Applications and their influence on Customer Service in the Tourism Sector? ?	Determine the articles whose Summaries, Conclusions and Discussions are characterized by their high objectivity and low polarity, by year, number of citations and by source in research on Mobile Applications and their influence on Customer Service in the Tourism Sector.

The SRL was motivated by the need to strengthen the use of mobile applications in customer service in the tourism sector through knowledge of state of the art and its impact on organizations.

### 3.2 Sources of Information and Search Strategies

The libraries used to search for research papers were Scopus, IEEE Xplore, ACM Digital Library, Springer Link, Google Scholar, Microsoft Academic, EBSCOhost, ProQuest, ScienceDirect, and ARDI. The search strategy includes searches for keywords relevant to the study (See Table 4).

Table 5: Search Descriptors and their Synonyms

Descriptor		Variable
Spanish	English	Independent Variable (A) Dependent Variable (B)
Aplicaciones móviles	Mobile apps/ apps	
Atención al cliente para el turismo/ Atención al cliente/ turismo	customer service for tourism/ customer service/ tourism	

The search procedure was carried out using search equations for the study, as shown in Table 5.

Table 6: Information Sources and Search Queries

Source	Search Query
Google Scholar	("mobile apps" OR apps) AND ("customer service for tourism" OR "customer service" OR tourism)
Scopus	(ALL ( ( "mobile apps" OR "apps" ) ) AND ALL ( ( "customer service for tourism" OR "customer service" OR tourism ) ) )
ACM Digital Library	[[All: "mobile apps"] OR [All: "apps"]] AND [[All: "customer service for tourism"] OR [All: "customer service"] OR [All: tourism]] AND [[All : "mobile apps"] OR [All: apps]]
IEEE Xplore	("All Metadata": "mobile apps" OR "All Metadata":apps) AND OR "All ("All Metadata": "customer service for tourism" OR "All Metadata": "customer service" OR "All Metadata": tourism)
ebscohost	( ("mobile apps" OR apps) ) AND ( ("customer service for tourism" OR "customer service" OR tourism) )
Springer Link	"mobile apps" OR apps AND "customer service for tourism" OR "customer service" OR tourism'
ProQuest	("mobile apps" OR apps) AND (methodology OR model OR method) AND ("customer service for tourism" OR "customer service" OR tourism)

Microsoft Academic ScienceDirect	("mobile apps" OR apps) AND ("customer service for tourism" OR "customer service" OR tourism)
ARDI	((("mobile apps" OR apps)) AND (("customer service for tourism" OR "customer service" OR tourism\)))

### 3.3 Identified Studies

At the end of the search, the number of articles shown in Figure 2 was obtained.

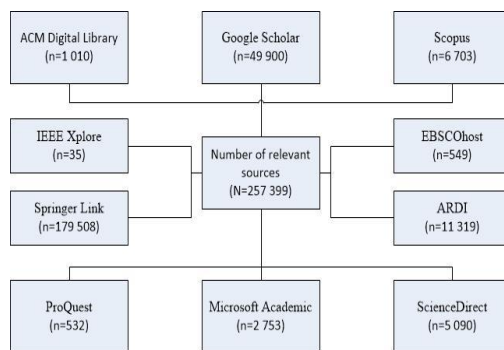


Figure 2: Number of Articles by Source.

### 3.4 Exclusion Criteria

According to the consensus among the experts, a series of exclusion criteria (CE) were defined to assess the quality of the literature accurately analyzed. Articles were reviewed for the following criteria:

- EC1: The articles are older than 5 years.
- EC2: The articles are not written in English.
- EC3: Articles were not published in peer-reviewed Conferences or Journals.
- EC4: The titles and articles' keywords are not very suitable, and the complete text is not available.
- EC5: The proposed solution does not apply to mobile applications or tourism.
- EC6: The articles do not mention a methodology or model or method.
- EC7: Articles are not unique.
- EC8: The abstract of the articles is not very relevant.

### 3.5 Selection of Studies

Originally, 257399 articles were obtained based on the search performed using search criteria relevant to the study. The selection and filtration steps that were used are listed below:

- Step 1: Apply exclusion criteria to ensure that only relevant articles are included in this review.
  - Step 2: Apply the quality assessment to include papers that best answer the research questions posed.
- The result of this stage comprises 70 articles, as shown in Figure 3.

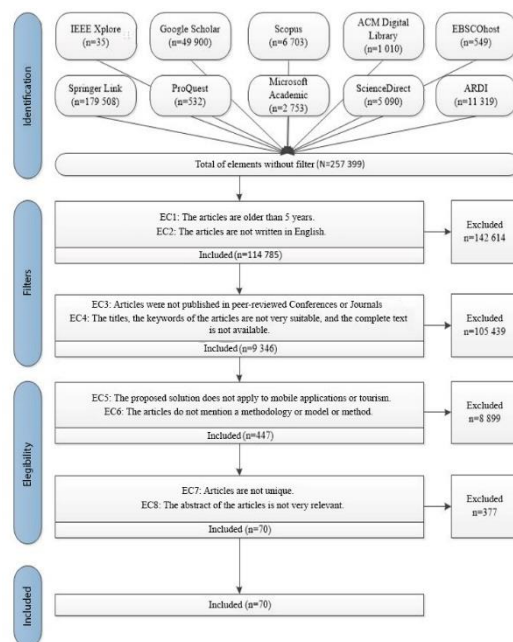


Figure 3: PRISMA Flow Chart.

### 3.6 Quality Assessment

A series of quality assessment (QA) criteria were formulated and applied to identify the final list of articles included in this investigation. Six QAs were identified, which are detailed below:

QA1: Is the document well organized?

QA2: Are the research objectives clearly identified in the document?

QA3: Is the research methodology clearly explained?

QA4: Is the data set used clearly identified?

QA5: Are the results of the experiment visibly identified and reported?

QA6: Is the document considered appropriate?

For this research, the QAs were applied one by one and as a result it was obtained that all the studies met said criteria.

Therefore, the research described in each article (70) is understandable and the results can be trusted.

### 3.7 Data Extraction Strategies

In this stage, the list of articles was used to extract the information necessary to respond to the set of RQs. The information extracted in each article included the following: article ID, article title, URL, source, year, country, number of pages, language, publication type, publication name, authors, affiliation, number of citations, abstract, keywords and sample size. Again, Mendeley was used to perform data extraction.

## 4. Results and discussion

The study selection process ended with 70 research articles that were rigorously reviewed and analyzed to obtain the relevant data for the study. The articles were selected considering the last five years, that is, articles from 2017 to 2022. The analysis carried out allowed us to determine that, in 2019, the number of studies on mobile applications in customer service for tourism was superior with respect to the other years; It should be noted that the years 2020 and 2021 continued the investigations during the pandemic. The year 2019 is when more articles related to mobile applications in customer service for the tourism sector were published. In year 2017 registered 20 articles. The main objectives of scientific production in the area were Magazines with 78.6% of the total articles published, being considerably higher than the second place occupied by Conferences with 21.4% of the total. Something important to highlight, shown in Table 6, is that most articles have been published in Magazines (55) and that no articles published in Conferences have more than or equal to 15 citations.

Table 7: Publication Media by Citation Rank

Publication Type	<5	≥5 and <15	≥15	Total
Journal	35	12	8	55
Conference	11	4	0	15
Total	46	16	8	70

Magazines are the main means of publication aimed at research in the area. Journals are the main means of publication in producing research in the area.

#### Answers to Research Questions

After conducting an exhaustive selection, filtering, review and analysis of the different publications, the results for the literature review were finally obtained.

**RQ1:** *What are the most used types of research to evaluate the effect of a Mobile Application and its influence on Customer Service in the Tourism Sector?*

The study answers the question related to the types of research used in the reviewed articles. Table 7 clearly shows that most of the published articles are of the Non-Experimental type, followed by the Experimental type.

Table 8: Most used types of research

Citation Range	<5		≥5 and <15		≥15		Total	
	Tot. Art	No. Citations	Tot. Art	No. Citations	To.t Art	No. Citations	Tot. Art	No. Citations
Investigation methodology	15	13	9	71	3	203	27	287
Experimental not experimental	31	15	7	45	5	248	43	308
Total	46	28	16	116	8	451	70	595

Likewise, it is shown that the Experimental type articles have more articles published within the citation range greater than or equal to 5 and less than 15. Experimental research contains 8 articles, which differs from the result presented in Table 7, which presents a total of 27 articles.

**RQ2:** *What are the most used Development Environments for the creation of Mobile Applications?*

According to the literature review results, four development environments are most used to create mobile applications. Table 8 shows the most used development environments.

Table 9: Most used development environments

Development Environments	Qty (%)
Android Studio/Java	18 (26%)
Apache Cordova	2 (3%)
Ionic	1 (1%)
iOS/Swift	3 (4%)
No specify	46 (66%)

The use of Android Studio as a development environment to create mobile applications continues to be the most used environment for IOS. Likewise, according to the investigation results, many articles do not specify the environment.

Android Studio is the most widely used development environment for mobile applications.

**RQ3:** Which are the Publication Media (Magazines or Congresses) that report more publications per Year about Mobile Applications and their influence on Customer Service in the Tourism Sector?

The response to this RQ reports the number of articles published in journals or conferences per year. Table 9 shows the production of journals and conferences per year.

Table 10: Number of Articles by Publication Medium and Year

Publication Name	2017	2018	2019	2020	2021	2022	Total
IOP Conference Series: Materials Science and Engineering			1	2	1		4
Sustainability	2			1	1		4
Journal of Hospitality and Tourism Technology		1	2				3
E3S Web of Conferences				1	1		2
International Journal of Innovative Technology and Exploring Eng...			1	1			2
IOP Conference Series: Earth and Environmental Science					2		2
Journal of Tourism Futures			1	1			2
2018 IEEE 20th International Conference on High Performance...		1					1
2020 International Conference on Culture-oriented Science & Tech...				1			1
AIP Conference Proceedings	1						1
Advances in Intelligent Systems and Computing		1					1
Annals of Tourism Research Empirical Insights					1		1
CBU International Conference Proceedings		1					1
Computers in Human Behavior						1	1
Environment and Planning B: Urban Analytics and City Science					1		1
European Research on Management and Business Economics					1		1
...							...
Total	10	12	17	15	15	1	70

The "IOP Conference Series: Materials Science and Engineering" Congress and the "Sustainability" Magazine are the ones that produce the most, with a total of 4 publications each between the years 2017, 2019, 2020, and 2021. The journal that produces the most in the research area is "Journal of Sustainable Tourism," which is related to the result of Table 8.

**RQ4:** What are the named entities (NER): PERSONS, ORGANIZATIONS, PLACES, EXPRESSIONS OF TIME AND QUANTITIES that are presented in the Summaries of research on Mobile Applications and their influence on Customer Service in the Tourism Sector?

The study answers the related question about entities named NER in the abstracts of the articles reviewed and analyzed. According to Figure 4, the NERS of the PLACES and ORGANIZATION type have 36.76% equally, which means that these types are frequently used in the Abstracts of the reviewed articles.

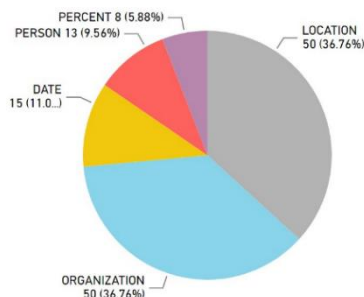


Figure 4: Number of NERs in the Abstracts

No systematic reviews have been located that have carried out this type of analysis, therefore, a comparison of these results with other articles cannot be made.

**RQ5:** Which are the articles whose Summaries, Conclusions and Discussions are characterized by their high Objectivity and low Polarity by year, number of citations and by source in research on Mobile Applications and their influence on Customer Service in the Tourism Sector?

To answer this question in detail, Figure 5 shows; ordered by the number of citations, the objectivity, the polarity of the abstracts and, in addition, the year and the source where they were published. It can be noted that the most cited article is objective and has a neutral polarity. The most cited articles belong to the scientific sources Microsoft Academic, ARDI, Google Scholar, and Scopus.

Paper Title	No Quotes	Objetivity	Polarity	Year	Source
[6] What determines tourist adop	101	1.00	0.00	2018	Microsoft Academic
[17] Technology in tourism-from	90	0.18	-0.29	2019	Google Scholar
[49] A comprehensive review of m	66	0.66	0.09	2018	Google Scholar
[27] Mobile applications in tour	64	0.31	-0.31	2017	Scopus
[50] eTourism: ICT and its role	44	0.92	-0.06	2019	ARDI
[2] GeoGuides, Urban Geotourism	38	0.68	-0.06	2018	Scopus
[12] Factors affecting the adopt	32	0.48	0.11	2017	Scopus
[16] Design and development of a	16	0.68	0.12	2019	Scopus
[24] Time, money, or convenience	14	1.00	0.00	2019	Microsoft Academic
[32] Implementing smartphone ena	11	0.66	-0.09	2017	Science Direct
[36] IT and tourism: still a hot	10	0.61	0.05	2018	Google Scholar
[33] Lift-share using mobile app	9	0.71	0.08	2017	Scopus
[35] Explaining tourist behavior	9	1.00	0.00	2019	Microsoft Academic

Figure 5: Articles most cited due to the Objectivity and Polarity of their Abstracts

Likewise, the Figure6 shows; ordered by the number of citations, objectivity, the polarity of the discussions and conclusions, and the year and source where they were published. It is noted that for the most cited article its discussions, and conclusions are objective, and it has a neutral polarity. The most cited articles belong to the scientific sources Microsoft Academic, Google Scholar, and Scopus.

Paper Title	No Quotes	Objetivity	Polarity	Year	Source
[6] <u>What determines tourist adop</u>	101	0.78	0.16	2018	Microsoft Academic
[17] <u>Technology in tourism-from</u>	90	0.36	0.21	2019	Google Scholar
[49] <u>A comprehensive review of m</u>	66	0.66	0.09	2018	Google Scholar
[27] <u>Mobile applications in tour</u>	64	0.55	0.06	2017	Scopus
[50] <u>eTourism: ICT and its role</u>	44	0.57	0.03	2019	ARDI
[2] <u>GeoGuides, Urban Geotourism</u>	38	0.67	0.08	2018	Scopus
[12] <u>Factors affecting the adopt</u>	32	0.50	0.02	2017	Scopus
[16] <u>Design and development of a</u>	16	0.61	0.05	2019	Scopus
[24] <u>Time, money, or convenience</u>	14	0.66	0.12	2019	Microsoft Academic
[32] <u>Implementing smartphone ena</u>	11	0.64	0.06	2017	Science Direct
[36] <u>IT and tourism: still a hot</u>	10	0.69	0.01	2018	Google Scholar
[33] <u>Lift-share using mobile app</u>	9	0.59	0.00	2017	Scopus
[35] <u>Explaining tourist behavior</u>	9	0.76	0.04	2019	Microsoft Academic

Figure 6: Objectivity and Polarity of the Discussions and Conclusions for the most cited Articles

In this case, no research has been found that reports a response to this type of RQ, therefore, a comparison with other articles cannot be made.

## 5. Conclusion

This study has identified, reviewed, and exhaustively analyzed the components, methods and frameworks used in mobile applications for customer service in tourism based on research questions through an RSL between the years 2017 and 2021 in various databases. of magazines and conferences. The DEMATEL method was applied, in its neutrosophic variant, to determine the research questions of greatest interest and relevance to the interests of the study.

Through the research questions posed, it was possible to obtain answers reported by the publication media that most support production in this area are magazines, in this case, the "IOP Conference Series: Materials Science and Engineering" Congress and the "Sustainability" magazine." are the ones that produce the most with a total of 4 publications each between the years 2017, 2019, 2020 and 2021. Likewise, it is shown that the types of research most used to evaluate the effect of a mobile application in the tourism sector respond to Not experimental. On the other hand, it is evident in the present investigation that the development environment most used to develop mobile applications continues to be Android Studio. Similarly, it was possible to show that the named entities (NER) most frequently in the abstracts of the reviewed articles are the types of PLACES and ORGANIZATION, each with 36.76%. Also, the most cited articles that provide high objectivity and low polarity in their Summary, Discussions, and Conclusions by year and source were identified. In this case, it was the article "What determines tourist adoption of smartphone apps? An analysis based on the UTAUT-2 framework", from 2018 and from the Microsoft Academic source.

Likewise, research has shown the usefulness of multiple decision-making methods in solving complex problems, and the effectiveness of the application of neutrosophy in obtaining valid conclusions in real-life situations has been demonstrated.

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