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CHATBOTS FOR CUSTOMER SERVICE: A COMPREHENSIVE SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Customer service oriented technical support is common, but it has a high demand of users who need to be attended to simultaneously and at any time. This paper presents a systematic literature review showing a broad perspective on chatbots applied to customer service. Searches were conducted in: IEEE Xplore, Taylor & Francis, ETHzurich, Wiley Online Library, Science Direct, ERIC, ERIC, Microsoft Academic, Google Scholar, ACM Digital Library, and ARDI. This review presents discussions on the feasibility of implementing chatbots in customer service. The results of the systematic review conclude that chatbots are constantly improving with respect to the technologies used for their implementation, consequently, there is an improvement in the application of customer service, which has also caused the expansion of the scope of application reaching sectors such as health, transportation, education, among others. This application is booming in all countries of the world; however, the United States is the one that has more research, due to the great demand of customers and the great technological advancement, therefore, this country is the one who is at the forefront when it comes to chatbots.

Keywords: *Chatbots, Customer Service, Virtual Assistant, Bibliometric, Systematic Review*

1. INTRODUCTION

The automation of customer service oriented to technical support is an issue that would greatly benefit an organization since there is a high demand for users who need to be served simultaneously and at any time. Chatbots tend to have great relevance to this problem, however, the scope of application is even broader. Chatbots are computer technologies, which through the use of machine learning and natural language processing techniques are able to simulate a series of reasonable responses in a given context, giving the proximity to a human conversation [73]. Chatbots ensure constant connection with customers with immediate responses [43].

The systematic literature review process has been applied in this work using the Mendeley tool for the management of research documents and bibliographic references, however, this is a process that not many follows with respect to the chatbots topic [43]. The papers related to the mentioned topic focus on countries [73] where they are usually used or which technologies are being used more frequently, in order to improve certain criteria of impact on customer service. The purpose of this research is to determine the state of the art about the impact of Chatbots on Customer Service.

2. RELATED WORKS

Several papers have been reviewed where some applications of chatbots using technologies such as AIML for their conversational service are mentioned, these applications are related to e-learning, e-government, web-based model, dialog

model [70]. There are also papers that focus on the techniques used in chatbots, however, their development was done without the application of SLR [29]. In this case, in addition to showing the areas of application of chatbots, various technologies used for their creation, programming languages, and even the platforms for their deployment are also shown. This whole study was done with the help of the Mendeley tool for managing documents and bibliographic references and efficiently applying SLR.

This shows that there is a research gap where it is evident that studies on chatbots are not always taken in a complete way and aspects such as application areas or technologies used in their development should be taken together and even more in some cases the systematic literature review is not used. In this SLR, the review is extended to investigate how chatbots are used in the customer service process and to have a complete picture regarding this topic.

3. RESEARCH METHODOLOGY

The review method used has been the one formulated by B. Kitchenham [77] for the systematic literature review. This review method has a series of procedures where the research questions, data sources, search procedure, inclusion and exclusion criteria, quality assessment, data extraction and data synthesis are elaborated.

For this systematic literature review, the procedures in Figure 1 were used as a guide.

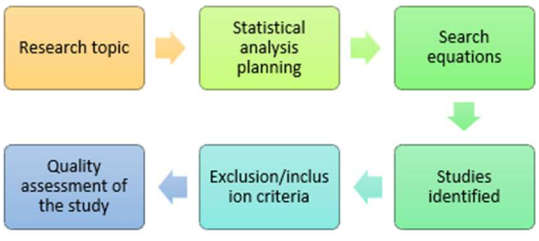

Figure 1. Systematic Literature Review Process.

3.1 Problemas de Investigación

To address the research problem, six research questions (RQ) have been posed and answered with information obtained from research papers from different reliable sources. The questions formulated to develop this research paper are shown in Table 1.

Table 1. Research questions.

N°	Research question
1	What are the most used cloud platforms for deploying chatbots in customer service?
2	Which machine learning techniques are being used for the development of chatbots in customer service?
3	In which areas are chatbot development being applied the most?
4	Which are the countries where the most chatbots papers are being developed?
5	What are the most commonly used programming technologies in the development of chatbots for customer service?
6	What type of database is most frequently used in the development of chatbots for customer service?

3.2 Information Sources and Search Strategies

The search sources are spaces that provide reliable information and guarantee the quality of the research paper. Among the sources used are IEEE Xplore, Taylor & Francis Online, ETHzurich, Wiley Online Library, Science Direct, ERIC, Microsoft Academic, Google Scholar, ACM Digital Library, and ARDI.

However, for the search for information in these papers, two types of variables should be considered to filter the relevant papers, these variables are the dependent and the independent variable, and another one called intervening variable could be included.

The dependent variable in this paper is "customer service process in technical support", the independent variable is "chatbots" and the intervening variable is "Methodology, method, and model".

Once these variables have been identified, a better filter can be performed through the search equations. The equations used in this paper are listed in Table 2.

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Table 2. Search equations.

Source	Generic search equation
Taylor & Francis Online	[All: chatbot] AND [All: customer support] AND [All: Methodology OR Method OR Model]
IEEE Xplore	(("All Metadata":chatbot) AND "All Metadata": customers support AND ("All Metadata": Methodology OR Method OR Model)
Science Direct	(chatbot and customer support and (Methodology OR Method OR Model))
Microsoft Academic	Chatbot AND customer support AND (Methodology OR Method OR Model)
Wiley Online Library	[All: chatbot] AND [All: customer support] AND [All: Methodology OR Method OR Model]
ERIC	chatbot AND (customer support) AND (Methodology OR Method OR Model)
ARDI	(chatbot) AND (customer support) AND (Methodology OR Method OR Model)
ACM Digital Library	[[All: chatbot] AND [All: customer support] AND [All: model OR method OR methodoly]
ETHzurich	All fields contains chatbot AND All fields customer support AND All fields contains (Method OR fields contains Methodology OR All fields contains Model)
Google Scholar	chatbot AND (soporte al cliente OR customer support) AND (Methodology OR Method OR Model)

3.2 Selección Criteria

Given the large number of research papers stored in the database of the search sources, a filter must be made among all this information, for which exclusion criteria are used to filter out information that is not relevant to the development of this paper. The exclusion criteria used are the following:

CE1: Papers older than 5 years.
CE2: The papers are written in a language other than English.
CE3: The papers were not published in conferences or journals.
CE4: The papers do not mention a methodology, model or method.
SC5: The papers are not unique.
CE6: The titles and keywords of the papers are not very appropriate.

3.3 Selección de Estudios

At the beginning 434475 results were obtained, when applying criteria 1 and 2, 301535 papers were excluded. Likewise, when applying criterion 3, the papers were not published in conferences or journals and criterion 4, the papers do not mention a methodology, 129403 papers were excluded. Finally, when applying criterion 5, the papers are not unique (eliminate duplicates) and criterion 6, the titles and keywords of the papers are not very appropriate, 3450 papers were excluded. Resulting in 87 papers as shown in Figure 2.

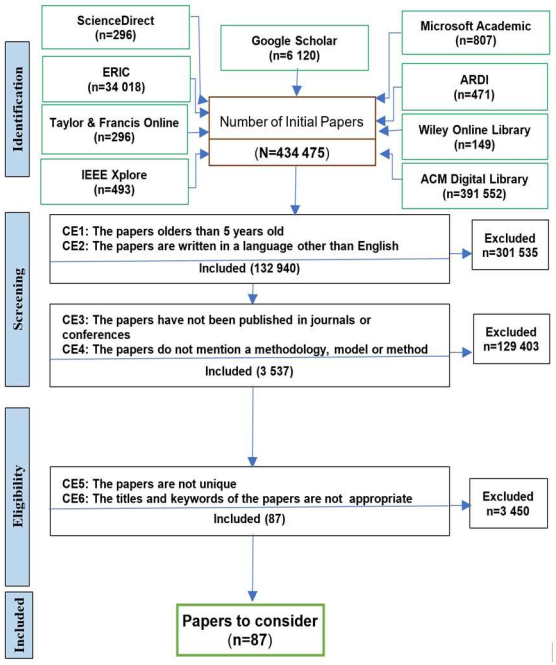

Figure 2. Application of exclusion criteria and filtering of papers.

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3.4 Quality Assessment

Each of the 87 remaining papers were independently evaluated using the following criteria:

QA1: Is the sample size greater than 30?
QA2: Is the purpose of the research explained?
QA3: Does the paper belong to a book, publication, or conference?
QA4: Is the full text of the paper available?
QA5: Is the paper well organized?
QA6: Are the results of the study clearly stated and supported by the findings?

These criteria are intended to evaluate and determine whether the papers could make a valuable contribution to the review. At the conclusion of this evaluation, it was determined that all 98 papers met the quality criteria.

3.5 Data Extraction Strategies

During this stage, data were extracted from each of the 87 papers included in this systematic review according to 16 important properties of the data. The 16 properties considered in the extraction are: Source, Year, Country, Number of Pages, Language, Publication Type, Research Methodology, Authors, Author Affiliation, Number of Citations, Abstract, Keywords, Sample Size, and Responses to Research Problems. The Mendeley tool was used to manage the papers, as shown in Figure 3.

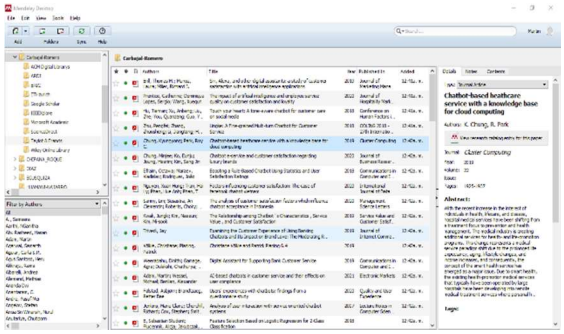

Figure 3. Reporting of papers with Mendeley

3.6 Data synthesis

The data synthesis process includes tabulating the data to answer the research questions. Likewise, the answers to the research questions will be reflected through the use of tables, graphs such as bar charts, pie charts, frequency polygons, and word clouds.

4. RESULTS AND CRITICAL DISCUSSION

4.1 Overview of the Studies

Figure 4 shows the distribution by year of the studies. Note that 11.5% (10/87) of the studies have been published before 2018 and 86.2% (75/87) belong to studies from 2018 to the present. This indicates that, although the study of chatbots has been recognized and researched since 2015, research focused on the development of chatbots applied to customer service is much more recent, with the vast majority of studies developed in the last few years.

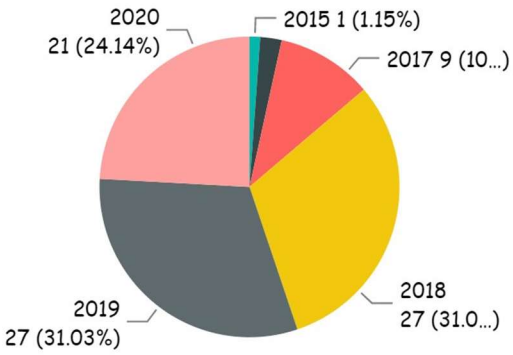

Figure 4. Papers distributed by year.

4.2 Answers to the Research Questions

RQ1: What are the most commonly used cloud platforms for deploying chatbots in customer service?

Cloud platforms to deploy chatbots are essential since the performance for all users depends on them. Among the most used platforms are Google, Amazon, IBM, and Azure. Table 3 shows these platforms for deploying chatbots in customer service.

Table 3. Cloud platforms for the deployment of Chatbots in customer service.

Cloud platform	Papers	Qty. (%)
Google	[1] [2] [3] [4] [7] [9] [11] [12] [13] [15] [18] [19] [20] [21] [26] [30] [31] [33] [34] [37] [39] [40] [42] [47] [48] [58] [59] [60] [61] [64] [65] [66] [69] [76] [78] [79] [85] [86] [89] [90]	41 (42.7)
Amazon	[1] [2] [3][4] [7] [9] [18] [20] [23] [26] [34] [37] [38] [39] [40] [41] [46] [47] [48] [51] [53] [54] [58] [61] [65] [74] [76] [79] [84] [86] [94]	31 (32.3)

IBM	[1] [2] [3][4] [7] [23] [26] [32] [34] [40] [42] [45] [51] [53] [60] [64] [66] [69] [78] [85] [89] [90] [94]	23 (24.0)
Azure	[4]	1 (1.0)

Like [94], the most used platform for chatbot deployment is Google, in this specific study it was found that 42.7% use this type of cloud platform. This is because it provides fast and reliable hosting as it has a very efficient network in terms of performance, bandwidth, and latency. The least used platform in chatbots is Azure with 1.0%, however, its use is considered in other web applications.

RQ2: What machine learning techniques are being used for the development of chatbots in customer service?

There are different machine learning techniques used in the development of chatbots such as Natural Language Processing (NLP), Logistic Regression (LR), Support Vector Machine (SVM), and Naive Bayes (NB) however, the most used methodology in this study is NLP since it is a technique that allows performing tasks such as automatic text abstracts, language translation, relationship extraction, sentiment analysis, speech recognition. Table 4 shows the most used machine learning techniques in chatbots for customer service.

Table 4. Most used machine learning techniques in chatbots.

Machine learning techniques	Papers	Qty. (%)
Natural Language Processing	[1][2][4][5] [7] [12] [19] [20][22] [23] [26] [29][31] [32] [33] [34] [37] [45] [47][48][49] [50] [51][52][56] [58] [60][62][63] [64] [65] [66][67] [68] [80][81] [83] [88] [94]	39 (76.4)
Logistic Regression	[2][3][46][68][74] [94]	6 (11.8)
Support Vector Machine	[13][45][56]	3 (5.9)
Naive Bayes	[13][17][45]	3 (5.9)

Similar to [75], the most commonly used techniques for developing chatbots for customer service are: Natural Language Processing (NLP), Logistic Regression (LR), Support Vector Machine (SVM), and Naive Bayes (NB). The Natural Language Processing methodology seeks to help computers communicate with humans in their language and scale other language-related tasks. Natural language processing includes different techniques for interpreting human language, ranging from statistical and machine-based learning methods to rule-based and algorithmic approaches.

Each technique has its advantages and disadvantages, so several techniques are used in the development of chatbots, consequently, the use of these in development continues to be researched and improved.

RQ3: In which areas are chatbot development being applied the most?

There are several areas that benefit from the implementation of a chatbot such as education, commerce, transportation, and medicine. Table 5 shows the areas of application of chatbots in customer service.

Table 5. Chatbots application areas.

Application area	Papers	Qty. (%)
Education	[3][4][7][9][11][12] [13][14][20][25][26] [30][31][32][33][34] [35][37][42][45][47] [48][52][53][55][56] [58][60][64][65][66] [67][69][78][79][81] [82][84][86][87]	39 (47.5)
Commerce	[1][2][4][6][13][20] [25][28][35][37][38] [42][46][48][50][51] [52][53][54][60][61] [63][64][65][68][69] [70][74][76][78][85] [86][87][88][94]	35 (42.7)
Transport	[4][29][38][64]	4 (4.9)
Medicine	[37][38][89][90]	4 (4.9)

The areas of greatest application of chatbots in customer service is education with 47.5%, due to the fact that what is generally sought in companies is to automate some queries such as

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customer order requests and even make sales through this medium.

The chatbot in commerce leverages data from product descriptions on the page, as well as user-generated content from e-commerce websites, which is more practical and cost-effective in answering repetitive questions, which frees human support staff to answer many higher-value questions [43].

RQ4: Which are the countries where more papers on chatbots are developed?

Customer service oriented chatbots are developed and used in several countries, but the countries that have focused the most on making them useful are shown in Figure 6.

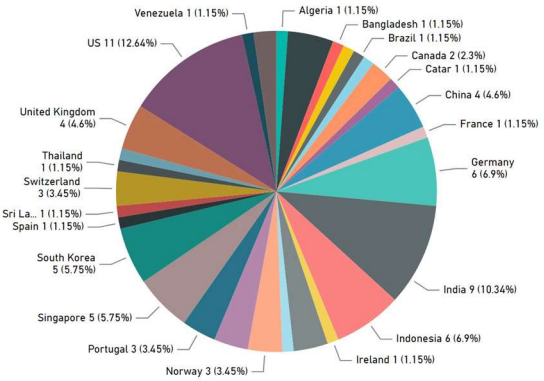

Figure 5. Most productive countries

As shown in Figure 5, the country with the highest amount of research is the United States with 12.64%, due to the fact that there is greater investment in the study and development of these new technologies, as well as the fact that it has many universities focused on research and development. The second country with the second highest amount of research is India with 10.34%. In recent years, the development of chatbots has increased in order to reduce the number of people attending customers due to the Covid-19 pandemic, seeking to automate customer service through chatbots. Then there are the countries of Germany (6.9%), Norway (3.45%), Indonesia (6.9%), China (4.6%), Singapore (5.75%), etc., where the development of chatbots is having positive results.

RQ5: What are the most commonly used programming technologies in the development of chatbots for customer service?

Among the most used programming languages for chatbot development are Python, Java, Javascript, and PHP. Table 6 shows the programming languages most commonly used in the development of chatbots in customer service.

Table 6. Most used programming languages

Programming languages	Papers	Qty. (%)
Python	[2][6][25] [31] [35] [45][46] [52] [54] [59][65] [68] [74]	13 (30.2)
Java	[4][7][10][25] [26] [31][35][45] [46] [52][63][66] [74]	13 (30.2)
JavaScript	[4][7][10][25] [26] [31][35][45] [52] [63][66]	11 (25.6)
PHP	[2][25][31][35][54][76]	6 (14.0)

In agreement with [71], the highest percentage of programming language used is Python in the development of chatbots with 30.2%, basically because it is accessible, easy, and can be used in various environments; and because it is increasingly being used and valued by programmers in the world.

A recent ranking prepared by IEEE Spectrum places Python as the most popular programming language in 2020, followed by Java, JavaScript, and PHP.

RQ6: What type of database is most frequently used in the development of chatbots for customer service?

The chatbots collect various information and metadata, which can then be exploited to improve their responsiveness and language compression. The following databases were used to train the chatbots: Redis, MySQL, Oracle, and MongoDB. Table 7 shows the most used databases in the chatbots.

Table 7. Most used database

Database	Papers	Qty. (%)
Redis	[2][25][26][35] [72]	5 (35.3)
MySQL	[31][46][54][74]	4 (23.5)
Oracle	[1][3][31][34]	4 (23.5)
MongoDB	[2][59][63]	3 (17.7)

The database that is most used in the development of chatbots is Redis (35.3%) because its implementation brought many benefits and generated a great impact on users. Although MySQL and Oracle are better known as commercial databases, their relational characteristic limits their response speed [91]. Non-relational databases such as MongoDB have a great advantage in terms of transaction speed because the data does not depend on other entities and therefore, queries will be much faster.

5. CONCLUSIONS

This research has conducted a comprehensive statistical analysis on the impact of chatbots for customer service by extracting specific information from 98 published papers. This has made it possible to answer each of the research questions, and consequently the purpose stated in the Introduction section has been achieved between the years 2015 and 2020. As for the databases most used in the development of chatbots is Redis, followed by databases such as MySQL, MongoDB and PostgreSQL. The most used programming language in chatbot development was Python, followed by Java, Javascript, and PHP. It is hoped that the results provided in this study will help future researchers identify new and interesting research topics that have not yet been examined, as well as highlight some of the gaps in existing studies. It is surprising to see that most researchers still use relational databases, giving rise to these slower response times compared to non-relational databases.

Therefore, authors are strongly encouraged to use non-relational databases such as MongoDB, and Firestore, among others.

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