

Received August 14, 2020, accepted September 4, 2020, date of publication September 14, 2020,
date of current version September 24, 2020.

Digital Object Identifier 10.1109/ACCESS.2020.3023546

Working in Virtual Teams: A Systematic Literature Review and a Bibliometric Analysis

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This work was supported in part by the Doctorate in Business Management from the Technological Institute of Costa Rica.

ABSTRACT Modern developments in technology have changed the way we socialize, communicate and work. Globalization, Information and Communication Technologies, digital culture and the increase in the amount of technology available for online communication mean that more organizations are implementing virtual teams. The growth in the use of virtual teams in organizations has incited researchers to investigate the different aspects, factors and challenges of these teams. This article uses a systematic literature review and a bibliometric analysis of virtual teams to identify the most relevant articles on the subject. These articles are then thoroughly reviewed and finally, a summary is made of all the research published over a five-year period. The systematic review of literature proposed by Ramey and Rao [1] and enhanced by Pulsiri and Thesenvitz [2] was used to examine the Scopus and Web of Science databases to identify the theories, research problems, research methodologies and results of 2354 studies on virtual teams published between 2015 and 2019. The main topics of the existing research in the field are reviewed, and the main limitations, problems and existing gaps in research are presented.

INDEX TERMS Systematic literature review, bibliometric analysis, COVID-19, thematic analysis, virtual teams.

I. INTRODUCTION

Crises, wars, disasters and epidemics have triggered or accelerated changes in all types of activities, including the ways we live and work. Currently, the COVID-19 outbreak is a global health challenge. Health authorities suggest that “it is time for businesses, hospitals, schools and citizens to start preparing”. Many companies have chosen to reduce risks by using remote working or working from home to prevent employees from being in close contact and spreading the virus [3].

Globalization, improvements in information and communication technologies (ICTs), the increase in the number of remote workers and the emergence of computer-mediated groups, have led to changes in how workers communicate and collaborate in organizations. With current technological advances, the knowledge economy and digital culture,

new ways of working are appearing in organizations. This study investigates the type known as virtual teams [4].

For this new type of working groups, the physical limits of distance or differences in time-zone are no longer relevant. Other characteristics of teamwork have become more important when working remotely, such as communication, trust, task characteristics, leadership, cohesion and empowerment, all of which have an impact on a team’s performance [5], [6].

However, the number and range of publications available on virtual teams can cause confusion if there is no effective and systematic process for classifying and associating the ideas in them. In addition, advances in information and communication technology means that information is transmitted around the world much faster and this has encouraged academic researchers to produce even more publications and therefore add to the confusion [2].

This excess of information and the confusion caused by it makes a systematic review of the existing literature necessary. The main objective was to find the most important articles

The associate editor coordinating the review of this manuscript and approving it for publication was Jenny Mahoney.

about virtual teams and their performance in the Scopus and Web of Science (WoS) databases. These articles were then reviewed and summarized, by means of a systematic literature review and a bibliometric analysis.

The article is organized in the following way. Firstly, the fundamental concepts which the research uses are defined and some related research papers are quoted. Then, the inherent methodology of a systematic literature review process and bibliometric analysis are discussed. Following this there is an analysis and discussion of the results, and finally conclusions are drawn.

II. CONCEPTUAL BACKGROUND

This section presents the concepts used in this study and gives a brief explanation of each one.

A. VIRTUAL TEAM

A virtual team is a geographically dispersed group of individuals who work together to achieve a common goal. ICTs allow each team member to communicate and coordinate from different locations in different time-zones outside the boundaries of the organization [7], [8]. These working groups have been given different names, such as, virtual teams, distributed teams, remote teams, computer-based teams, online teams and cross-site teams, and are used interchangeably in the literature on the subject [9].

B. CLOUD COMPUTING (CC)

This technology is usually explained in one of the two following ways. The first does not make any difference between the cloud and the Internet and includes them both in the same concept. Therefore, a reference to cloud computing includes any service available on the Internet. The second explanation takes a wider view and uses the term “cloud computing” to refer to a range of technologies that provide a number of advantages for both the customer and the service provider. This type of technology provides “economies of scale” for Internet services by reducing costs and increasing scalability [10]. The cloud is understood to be all the tools used to store, and possibly process, the information of an organization, but they are not physically positioned at the premises and can only be accessed by connecting to the Internet [11].

Cloud technology is a breakthrough, but it should be adopted in a modular way which allows for the constant reconfiguration of resources and services so that the changing needs of the market can be met [12]. The cloud as a new technology and business model represents progress, but it must be adopted in a modular way which provides a wide range of reconfiguration possibilities, so that resources or services can be accumulated in a flexible manner, in order to meet changing market demands [13].

C. BIG DATA (BD)

Big Data (BD) is the result of technological advances that have made the consumer a data source. This means that there

is a large number of high-speed and diverse “data sources” available. This has led to the definition of Big Data as the three “V”s of Volume, Velocity and Variety by [14].

D. BUSINESS INTELLIGENCE (BI)

BI derives from the management of knowledge by companies and is made up of a set of strategies, actions and tools for the creation and administration of knowledge by analyzing the data held by an organization or company [15].

E. COMPUTER MEDIATED COMMUNICATION (CMC)

One of the main changes being seen in organizations, which has been researched on various occasions, is the use of virtual teams in the different departments of an organization [16]. Virtual teams are essential for the success of a knowledge-based organization in a volatile, dynamic and globalized market. In addition, a very important factor is the reliance on collaborative technologies using Computer Mediated Communication (CMC), which provides rapid and effective collaboration and communication channels for team members [17].

Current research is dedicated to finding relationships between the increasing use of virtual teams in organizations, and advances in CMC technologies. These technologies have strongly influenced organizations, not only in the way members of the organization collect, communicate, share, and distribute data, but also in the dynamics of the relationships between team members [18].

Information and Communication Technologies (ICTs) have become an important tool for business globalization when designing the working strategies of any type of organizational structure. Modern design methods use CC tools and systems with access to Big Data and BI [19].

Literature on the matter shows that using virtual teams means more efficient work and this creates value for organizations. Other advantages include increased scope, improved response times and the dynamic adaptation of organizations to new situations [8], [20], [21].

Virtual teams also allow companies to make better use of their resources by hiring staff with the necessary experience, regardless of their geographic location. This can improve the overall performance of the organization [22]. A virtual team also helps improve creativity, facilitates the acquisition and exchange of knowledge, and enables organizations to respond faster to market changes [23], [24].

Another line of research, which is similar to the previous one, investigates the importance of CMC technologies by analyzing the factors that influence the efficiency of teams using these CMC technologies compared with traditional face-to-face teams [25], [26].

CMC technologies allow the interaction of virtual teams in several ways, at the same time and place (e.g., email in an office), at the same time and in different locations (e.g. instant messaging), at the same place at different times (e.g., video conference), and at different times in different locations (e.g., online classrooms) [18].

F. REMOTE WORK

Remote Work (RW) is defined as work done at a location far from the company headquarters or factory, where the worker has no personal contact with other co-workers, but is able to communicate with them using modern technology [27].

G. RELATED WORKS

As shown in Table 1 SLR and bibliometric analysis have been used in “several previous research papers” [28], [29]. Some of the research papers which use SLR to investigate virtual teams and remote work have been relevant and interesting for researchers and this method of literature review has proven useful and, above all, can be reproduced.

TABLE 1. Selected articles about SLR and bibliometric analysis (BA).

Authors	Year	Type	Subject	Field	Contribution	Factors
Clark et al	2019	SLR	VT	Engineering	135 articles studied	Empathy, trust and technology
dos Santos-Rocha et al	2013	SLR	VT	Engineering	Detailed SLR of virtual teams	BPM & PL
Nguyen-Duc et al	2015	SLR	VT	Engineering	SLR of geographical separation	Geographical separation
Yu	2015	SLR	VT	Engineering	SLR of global business	Communication, leadership and trust
Acharya	2019	SLR	VT	Business and administration	Study of virtual teams in three cities in India	Virtual work
Charalampus et al	2018	SLR	TW	Psychology, business and administration	63 quantitative, qualitative and mixed studies	Social isolation
Donnelly and Johns	2020	SLR	RW	Psychology, business and administration	Empirical SLR of virtual teams	Workers location
Vayre	2019	SLR	TW	Psychology, business and administration	Detailed analysis of virtual teams	Different factors, such as motivation and family conflict

Source: Authors

Clark *et al.* [29] analyzed 135 articles about engineering, concluding that the relevant factors were empathy, trust and technology. Santos Rocha and Fantinato [28] investigated virtual teams with SLR in order to show that Business Process Management (BPM) is a potential area for the successful use of lineal software products. Nguyen-Duc *et al.* [30] investigated geographical separation as a relevant factor in the performance of virtual teams, while Yu [31] studied the

relationship of global business with virtual teams, and especially the aspects of communication, leadership and trust.

Acharya [32] studied remote workers in virtual teams in the area of administration and economy in three cities in India. Charalampus *et al.* [33] and Donnelly and Johns [34] researched the areas of psychology, business and administration. The first analyzed 63 quantitative, qualitative and mixed studies, finding social isolation to be a negative factor. The second focused on empirical work and concluded that the location of the remote worker appears to be an important factor. Finally, Vayre [35] used the SLR method in a detailed and complete analysis of virtual teams, identifying motivation as a positive factor and family conflict as a negative factor.

III. RESEARCH METHODOLOGY

The aim of this research was to use a systematic literature review (SLR) and a bibliometric analysis to investigate virtual teams working on programming projects. To achieve this, the following factors were considered in the methodology.

There were no previous articles that used both bibliometric analysis and SLR methods when investigating VT. However, research by Vatananan-Thesenvitz [2] used the CIMO (Context, intervention, mechanism and outcome) model to show the usefulness of literature reviews using BA and SLR. According to these authors, such revisions can be automatic and give an overview of the subject being investigated (bibliometric analysis) and then select the most relevant articles (SLR). Therefore, the benefits of both literature review systems are coupled and the resulting research is more comprehensive. Therefore, this methodology could be used in this research to analyze the factors that affect the performance of VTs, since it analyses a large amount of literature and then selects the most relevant articles with a systematic review. Other research in other areas used a similar methodology, such as Caiado *et al.* [36] who analyzed the literature on eco-efficiency, Pulsiri, Pulsiri and Vatananan-Thesenvitz [2] and Vallaster *et al.* [37] who analyzed articles about entrepreneurship.

A. JUSTIFICATION OF SLR. THE NEED TO STUDY VIRTUAL TEAMS

In recent years, a large amount of research into virtual teams has been published [7], [16], [21], [22], [25], [38]–[49].

However, few articles in the literature provide a comprehensive analysis of cutting-edge research to show where new virtual teams are being used, and where new collaboration and communication technologies have been incorporated into virtual teams. The importance of using the systematic SLR review methodology proposed by Ramey and Rao [1], [31], [50], [51] is based on the following four points:

- 1) It reduces bias and/or subjective judgment when choosing the search items.
- 2) It summarizes the results of existing studies and evaluates any inconsistencies with previous studies.

- 3) It identifies, as far as possible, gaps in knowledge or incongruous or weak findings that can be areas for future research.
- 4) It provides criteria for new research activities and for maintaining periodic updates on the subject.

The prevalence of virtual teams in organizations, the existence of different team structures, the emergence of different CMCs to facilitate communication in virtual teams, and the growing amount of literature investigating a variety of virtual team features requires a careful literature review to understand the current state of research on virtual teams and provide areas for future research.

B. RESEARCH QUESTIONS

The main aim of this research is to analyze the most important articles about Virtual Teams in the existing literature with bibliometric tools. Two large databases, Scopus and WoS (Web of Science), were used to collect the information. These articles were then systematically reviewed and summarized. The result is a systematic framework with categorized search terms that sorts, structures and gives important information about Virtual Teams for researchers, knowledge engineers and professionals working with virtual teams. This study has the following research questions:

- Q1. What are the main areas and topics of current research in virtual teams?
- Q2. What are the main constructs that have been investigated in current research on virtual teams?
- Q3. What are the gaps in existing research and possible areas for future research?

C. SLR PROTOCOL

To answer the questions above, a systematic literature review and a bibliometric analysis were used to find the most important research papers on virtual teams. A systematic review and analysis were carried out which classified and categorized the research papers identified. The dependent, independent and moderator constructs and terms were also analyzed and classified, as shown in table 2.

The SLR methodology used in this research was proposed by Ramey and Rao [1], [50]. This methodology was chosen because it is simple to apply, uses well-structured steps and has also been used in several previous research papers about SLR. This methodology is complemented by the ideas in the research by Pulsiri and Vatananan [2], that incorporates automation and bibliometry and consists of the following stages, planning, realization, analysis and synthesis and finally, reporting. The research methodology used is shown in Figure 1 below:

The SLR in this study was planned with the topic and research questions that were given in the Research Questions section above, Q1-topics and areas, Q2-constructs, and Q3-gaps in research. The published literature on Virtual Teams was reviewed in order to identify the main research topics in this area, prepare the research terms and define a framework of the constructs to be used in the research.

TABLE 2. Main virtual team constructs.

Variable	Input Process Output (IPO Model)	Construct/Type
1.Cultural diversity	Input	Culture (independent)
2.Distribution index	Input	Design (independent)
3.Task characteristics	Task processes	Task-Technology-Structure Adjustments (independent)
4.Interdependence of tasks	Task processes	Moderator
5.Leadership	Task processes	Coordination (independent)
6.Cohesion	Socio-emotional processes	Cohesion (independent)
7.Empowerment	Input	Training (independent)
8.Trust	Socio-emotional processes	Trust (independent)
9.Degree of Virtuality	Socio-emotional processes	Moderator
10.Communication	Task processes	Communication (independent)
11.Performance	Output	Performance (Dependent)

Source: Based on Gilson [52] and Powell [4]

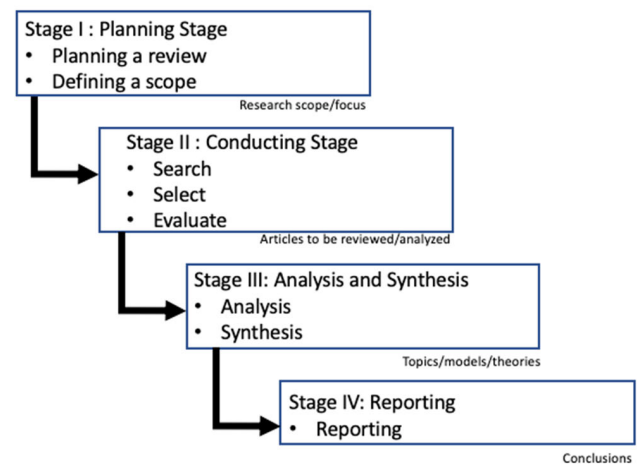


FIGURE 1. Research methodology: systematic literature review SLR process. Source: Based on Ramey and Rao [1], [50] and Pulsiri and Vatananan [2].

In the review stage, a thorough search of the literature was carried out using numerous rules and search parameters to identify the most relevant set of articles for the following study. These rules and parameters included the year of publication, the databases in which the document is included, the search keywords and the inclusion and exclusion terms and criteria.

The process started with setting the time period covered by the study. The main purpose of the study is to show the current state of research on the subject and so only research papers published between 2015 and 2019 were included. Two of the most highly acknowledged databases, WoS and Scopus, were used to find the initial group of research papers. The SCOPUS database provides the largest database of summarized and indexed articles and the largest source of citations and search terms for finding relevant literature [53]–[55].

The next step was to define rules with logical connectors to fine-tune the literature search for the terms and keywords used in the research. The search terms and keywords were initially chosen from the results of an exploratory search which included “virtual team(s)” and “virtual collaboration”. The keywords and terms for the search were selected from the range of keywords included in the literature found in the exploratory search.

During this initial search, the main concept term (i.e. virtual team[s]) was found to have several synonyms. For example, some researchers used the term “online group” and others “computer-mediated team” or “distributed team”. Different databases were also found to have different term selection and algorithmic search behavior and these differences affect the search results.

To ensure that an exhaustive list of documents was retrieved from the different databases, and to ensure that biases were minimized, the search terms and keywords were organized into several search strings that would work with all of the databases (Table 3). Advanced search features were also applied to maintain the consistency of the results from all the databases. Synonyms of all the words were also included in the terms searched for. In addition, an iterative process was used for the search terms and keywords in the databases, as shown in Table 3 below.

The Publish or Perish (PoP) software [56] (www.harzing.com/pop.htm) was used to search for article topics with the keyword “Virtual Team”. This software is produced by Research in International Management, and is used to retrieve and analyze academic research articles on the SCOPUS and Web of Science databases, among others.

The data was collected on January, 2020. The results of an initial search were collected and put into a file with a bibliographic format “.BIB” using the title and summary references. After this process there were an initial set of 2354 relevant published works that were then used for further analysis.

The term “Virtual Team” and its variants were used as the key phrase in the search of the titles, summaries, and keywords of the articles in the databases.

The next step was to formulate the inclusion and exclusion criteria. Researchers held collaborative meetings to prepare the criteria. First, exclusion rules were drawn up and subsequently applied to the articles found in the searches. Four limiting rules were applied to the content of documents and related fields:

- 1) Articles and documents which describe and deal with any aspect of the communication, collaboration and coordination of virtual teams are considered, since the field is multidisciplinary (e.g. technical aspects, behavioral aspects, management, tasks, processes, leadership, knowledge management, etc.).
- 2) Articles and documents should consider a virtual team as a relationship for communication, collaboration, and coordination between its members.

TABLE 3. The database searches used to find relevant articles published between 2015-2019.

Database	Web of Science	Scopus
Search using a complex Query and exclusions	TOPIC: ("virtual team" "virtual teams" "virtual collaboration" "online group" "computer mediated team" "distributed team") Refined by: DOCUMENT TYPES: (ARTICLE) AND PUBLICATION YEARS: (2019 OR 2018 OR 2017 OR 2016 OR 2015) AND LANGUAGES: (ENGLISH) Timespan: 2008-2019. Indexes: SCI-EXPANDED, SSCI, ESCI.	(TITLE-ABS-KEY ("virtual team") OR TITLE-ABS-KEY ("virtual teams") OR TITLE-ABS-KEY ("online group") OR TITLE-ABS-KEY ("virtual collaboration") OR TITLE-ABS-KEY ("online group") OR TITLE-ABS-KEY ("computer mediated team") OR TITLE-ABS-KEY ("distributed team")) AND (LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015)) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English"))

Source: Authors

- 3) Articles and documents must provide a clear link or contribution to the different aspects (e.g. problem, research question, method, results, or findings) of communication, collaboration, and coordination in virtual teams.
- 4) The main objectives and research questions of the articles or documents should be clearly and sufficiently described and explained, and the methodology should propose appropriate steps to address the research problem and answer the research questions.

The following criteria (Figure 2) were obtained after using the above rules:

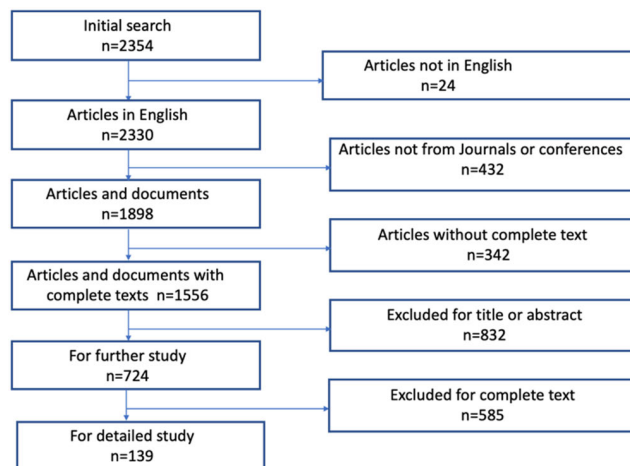


FIGURE 2. Number of articles in each stage after applying the inclusion and exclusion criteria.

- 1) The results of the research should only include studies published in English, as these are currently the most accessible and disseminated publications worldwide. Studies published in languages other than English were excluded, resulting in 2330 remaining articles.
- 2) The results of the research should only include research articles and conference documents. 432 documents were therefore excluded, leaving 1898 remaining for analysis.
- 3) Because the goal was to only consider high-quality publications, only those which had undergone peer review and, for which the complete text was available were included in the results. This criterion was applied to the previous 1898 articles and 342 articles and publications that were not reviewed by peers or for which the full text was not available were excluded.
- 4) The titles and summaries of all the remaining articles and documents were then analyzed using content-related selection rules. This stage of the process resulted in 724 valid articles (832 were excluded).
- 5) The full texts of the remaining articles were analyzed using the same content-related selection rules as in step 4, above. This resulted in a total of 585 articles being excluded, which gave a final result of 139 acceptable articles for the analysis.

Once the final set of articles and documents for analysis had been obtained, the following stage of the SLR process was to extract and summarize the data. This is a complex and iterative process in which the articles are reviewed in depth allowing similarities and differences to be found, and, limitations and research gaps to be identified for future research in this field of study. The next section describes the data extraction and summary stages in detail.

D. PRELIMINARY DESCRIPTIVE ANALYSIS PRIOR TO THE SLR

A preliminary descriptive analysis was carried out prior to the SLR analysis. The reviewed articles and documents were grouped according to citations, type of publication, language used, and country of publication. This was done to identify the general profile of the different documents found in the bibliographic search.

1) ANALYSIS OF CITATIONS

Table 4 above shows the queries used to obtain the articles and documents for this study from the databases. The software with the queries was applied to the data retrieved from the SCOPUS database and the articles and documents were grouped by year, document type, and author. The initial 5-year search range was extended to see how the groups of publications had changed over the years. The difference between the total number of articles found in this search (1782) and those obtained in the search carried out in the complete process (2354) is due to the fact that in this case only the Scopus database was used, since the objective was

TABLE 4. "Virtual Team" citation measurements. Scopus database. Year 2020.

Measurement	Data
Reference date	16/01/2020
Publication years	1991-2020
Citation years	28(1991-2020)
Papers	1782
Citations	34201
Citations/year	1221.6
Citations/paper	19.19
Citations/author	2.64
Authors/paper	2.64
Hirsch h-index	84
Egghe g-index	156

Source: Authors

an initial approximation and the Scopus database contains the largest number of documents about this research topic.

The table 4 shows the period of time, 28 years, which was analyzed in the initial review. Also shown are the total number of citations of "Virtual Team", and the number of citations per year, per document and per author. It should be noted that the average number of authors in each publication was 2.64.

The h-index (Hirsch index) and g-index proposed by Egghe were then calculated. These are two of the most relevant measures in a bibliometric analysis [57]. The h-index shows the publications of an author that have had the most citations and the g-index shows the number of articles published by an author and the number of citations they have had. An h-g metaindex also exists, which is calculated as the geometric mean of the two indices, but it is not a relevant measurement for this study.

2) DOCUMENTS AND SOURCES

The analysis of the Scopus database gave information about two different periods of time. One was the Historical Scopus ("Scopus H") and the other was the 5-year Scopus ("Scopus 2015+"). The information obtained was grouped for the type of scientific document it was, i.e., conference paper, article, book, etc. The source of the document refers to whether it is from a magazine, a document from a congress, a book or a commercial publication.

Table 5 also includes more types and sources of document, such as, editorial, note, short survey, errata and indefinite document type. However, these types only have a rating of less than 1% each. It can be seen that the vast majority of the publications were scientific articles, and account for 41,72% of the total number of publications. Documents from conferences were the next largest group (39.93%) and the other types of documents collectively accounted for less than 18% of the total. It is interesting to note the low number of books, that only accounts for about 1% of the publications.

The results of the search were grouped into five different types of media source (Table 6). Journals accounted for the largest group (47,43%). The next biggest group, 356 (36,55%), was conference papers. Books accounted for

TABLE 5. Classification according to document type. Scopus database. Year 2020.

Document Type	SCOPUS H	SCOPUS S 2015+	SCOPUS H % (N=3077)	SCOPUS S 2015+ % (N=2354)
Article	1323	982	43,00%	41,72%
Book	1218	23	39,58%	0,98%
Book Chapter	255	219	8,29%	9,30%
Conference Paper	123	940	4,00%	39,93%
Conference Review	100	87	3,25%	3,70%
Editorial	27	10	0,88%	0,42%
Erratum	14	1	0,45%	0,04%
Note	7	5	0,23%	0,21%
Retracted	5	1	0,16%	0,04%
Review	1	78	0,03%	3,31%
Short Survey	1	5	0,03%	0,21%
Undefined	3	3	0,10%	0,13%
Total	3077	2354	100%	100%

Source: Authors

TABLE 6. Number of publications by source type. Scopus database. Year 2020.

Source Type	Frequency	%
Journals	462	47,43%
Conference Papers	356	36,55%
Book Series	62	6,37%
Books	89	9,14%
Trade Publications	5	0,51%
Total	974	100,00%

Source: Authors

almost 10% of the results and there were only 5 commercial publications (0.51%).

Table 7 shows the number of documents published in 9 different languages found in the bibliometric study. Most of the documents found were published in English (97.66%). The second most common language was German (1.02%) and the other languages, such as French, Chinese or Spanish, were less than 1% each.

Table 8 shows an ordered list of the 20 countries with the most publications. The United States ranks first with a total of 1686 publications, which is more than 40% of the total number of documents. This is followed by the United Kingdom (5.61%) and Germany (5.36%). In the lowest positions are Greece, New Zealand and Norway.

IV. RESULTS

The articles and documents were obtained from the databases so that they could later be analyzed to find the information about the research topic. A summary of the information found in the documents and articles was then used to answer the

TABLE 7. Languages used in publications. Scopus database. Year 2020.

Language	Frequency	Percentage (%)
English	958	97,66%
German	10	1,02%
French	4	0,41%
Chinese	3	0,31%
Spanish	2	0,20%
Portuguese	2	0,20%
Malayo	1	0,10%
Polish	1	0,10%
Total	981	100,00%

Source: Authors

TABLE 8. Countries with most publications about virtual teams. Year 2020.

Country	Frequency	% (N=3953)
USA	1686	42.22%
UK	224	5.61%
GERMANY	214	5.36%
AUSTRALIA	196	4.91%
CHINA	136	3.41%
CANADA	106	2.65%
FRANCE	99	2.48%
NETHERLANDS	96	2.40%
TAIWAN	95	2.38%
SPAIN	87	2.18%
FINLAND	80	2.00%
INDIA	77	1.93%
MALAYSIA	60	1.50%
IRELAND	51	1.28%
ITALY	51	1.28%
DENMARK	49	1.23%
BRAZIL	46	1.15%
NORWAY	45	1.13%
GREECE	38	0.95%
NEW ZEALAND	36	0.90%

Source: Authors

research questions defined in the primary and secondary aims.

Table 9 below, lists, in descending order, the top 20 Journals in which articles about Virtual Teams were published. The top three were the International Journal of E-Collaboration, IEEE Transactions on Professional

TABLE 9. Top 20 publication sources. Year 2020.

Sources	Articles	h_index	g_index	PY_start	R_h-index	R_g-index
INTERNATIONAL JOURNAL OF E-COLLABORATION	29	16	23	2007	1	1
IEEE TRANSACTIONS ON PROFESSIONAL COMMUNICATION	25	10	19	2008	4	2
INTERNATIONAL JOURNAL OF NETWORKING AND VIRTUAL ORGANISATIONS	22	12	17	2007	2	3
SMALL GROUP RESEARCH	20	6	11	2007	12	6
TEAM PERFORMANCE MANAGEMENT	17	11	17	2007	3	3
GROUP DECISION AND NEGOTIATION	16	8	14	2008	5	5
GROUP AND ORGANIZATION MANAGEMENT	11	8	11	2011	5	6
GRUPPENDYNAMIK UND ORGANISATIONSBERATUNG	9	8	9	2007	5	8
INFORMATION AND MANAGEMENT	9	8	9	2008	5	8
INTERNATIONAL JOURNAL OF PROJECT MANAGEMENT	9	7	9	2007	9	8
JOURNAL OF MANAGEMENT INFORMATION SYSTEMS	9	7	9	2007	9	8
HUMAN RESOURCE MANAGEMENT REVIEW	9	2	3	2007	20	20
INFORMATION SYSTEMS RESEARCH	8	7	8	2007	9	12
JOURNAL OF COMPUTER INFORMATION SYSTEMS	8	6	8	2008	12	12
JOURNAL OF INTERNATIONAL MANAGEMENT	8	5	8	2010	15	12
MIS QUARTERLY: MANAGEMENT INFORMATION SYSTEMS	8	5	8	2017	15	12
BUSINESS HORIZONS	8	4	8	2009	18	12
DATA BASE FOR ADVANCES IN INFORMATION SYSTEMS	7	6	7	2007	12	17
INFORMATION SYSTEMS JOURNAL	7	4	7	2007	18	17
COMPUTERS IN HUMAN BEHAVIOR	6	5	6	2008	15	19

Source: Authors

Communication and the International Journal of Networking and Virtual Organizations. The Journals with the least number of articles published about Virtual Teams were the Information System Journal and, Computers in Human Behavior.

The h and g indices were then calculated for the results presented in Table 9 and the last two columns show the rankings for the Journals using these indices. The International Journal of E-Collaboration is in the top position for both indices. However, the International Journal of Networking and Virtual Organizations ranks second for the h-index, but third for the g-index. Team Performance Management takes third place for the h-index and joint-third place with International Journal of Networking and Virtual Organizations for the g-index. Human Resource Management Review can be seen to be the Journal in the lowest position for both of the indices. Specialized journals and those concerned with business administration are in the most highly ranking positions.

Figure 3 below shows the number of documents and articles published about Virtual Teams over time. The first of these was published by Cohen in 1991 [58].

Unfortunately, research in this field was not very popular until 1995 with only one (1) article in this research area being published. However, from 1996 to 2010, publications about

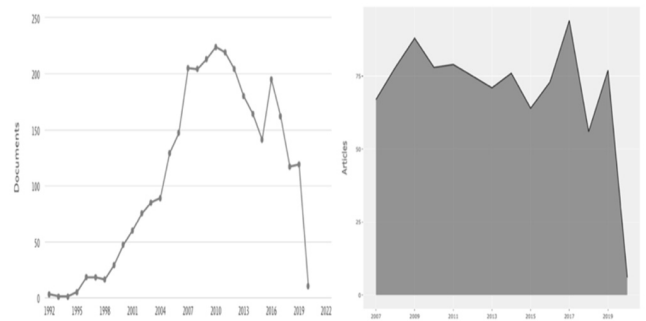


FIGURE 3. Historical trend of publications about Virtual Teams. Software Publish or Persih. Year 2020 [56].

Virtual Teams increased from 8 to 129 articles published in 2010. After a drop in 2013, there was an increase in 2016, but the number of publications has declined until today, with only a slight increase in 2019.

Table 10 shows the details of the results of the “Virtual Team” search including columns for the historical Scopus search with no time limit, and another for the information found on WoS.

TABLE 10. Searches for the term “Virtual team”. Year 2020.

Database	Scopus 1969+	Scopus 2007+	Wos
Document Types	Frequency		
Article	1323	982	312
Book	1218	23	1
Conference Paper	123	940	6
Publishing	27	10	2
Review	1	78	18
Total	3077	2354	344

Source: Authors

These columns are included for comparison. It can be seen that there are significantly fewer publications in WoS than in Scopus. Articles are clearly the most common type of document found in all the searches. In Wos, Literature Reviews are the second most common, whilst in the historical search on Scopus they are the third.

Table 11 gives detailed information about the results of the database search for the term “Virtual Team” and its equivalents. It also includes the results from the Scopus historical search and the search on WoS. Significant differences can again be seen in the results from the two databases, whilst the frequencies of each document type have a similar order to that in Table 9.

Table 12 shows the number of documents published about virtual teams for each research area. The largest number of publications are for computer science, business, social sciences and engineering. Virtual teams for medical specialties have the least number of publications.

TABLE 11. Historical search for “Virtual Team” equivalents. *Year 2020.

Database >>	Scopus 1969+	Scopus 2007+	Wos	Scopus 1969+	Scopus 2007+	Wos
Document Types	Frequency			%	%	%
Conference Paper	2664	2066	31	43.42	42.93	2.093
Article	2577	2032	1369	42	42.22	92.438
Book Chapter	407	360	4	6.63	7.48	0.270
Review	215	142	63	3.5	2.95	4.254
Conference Review	173	132	-----	2.82	2.74	-----
Book	46	39	14	0.75	0.81	0.945
Publishing	19	12	17	0.31	0.25	1.148
Note	11	9	-----	0.18	0.19	-----
Short Survey	9	7	-----	0.15	0.15	-----
Letter	2	2	-----	0.03	0.04	-----
Erratum	1	1	-----	0.02	0.02	-----
Retracted	1	1	1	0.02	0.02	0.068
Undefined	10	10	-----	0.16	0.21	-----
Total	6135	4813	1530			

Source: Authors

* Equivalent terms used: "virtual teams", "virtual collaboration", "online group", "computer mediated team", "distributed team"

TABLE 12. Published topic. Year 2020.

Area	Frequency	%
Computer Science	832	27.44%
Business management and accounting	596	19.66%
Social Sciences	454	14.97%
Engineering	429	14.15%
Decision science	190	6.27%
Psychology	145	4.78%
Math	103	3.40%
Arts and Humanities	89	2.94%
Economy, Econometrics and Finance	77	2.54%
Medicine	41	1.35%
Environmental science	12	0.40%
Health professions	9	0.30%
Materials Science	8	0.26%
Physics and astronomy	8	0.26%
Earth and planetary sciences	7	0.23%
Energy	7	0.23%
Biochemistry, Genetics and Molecular Biology	5	0.16%
Nursing	4	0.13%
Agricultural and Biological Sciences	3	0.10%
Chemical Engineering	3	0.10%
Indefinite	3	0.10%
Chemical	2	0.07%
Neuroscience	2	0.07%
Pharmacology, Toxicology and Pharmacy	2	0.07%
Multidisciplinary	1	0.03%
Total	982	100.00%

Source: Authors

Table 13 shows the 20 most relevant keywords used in publications on “Virtual Teams”. The most frequently used keywords in publications after “virtual teams” were found

TABLE 13. Frequency of word/term. Year 2020.

Words	Frequency	% (N=17007)
virtual team	834	4.03%
virtual reality	317	1.67%
management	223	1.42%
project management	198	1.09%
human resource management	175	0.96%
communication	158	0.81%
human	126	0.79%
information technology	124	0.77%
knowledge management	112	0.77%
virtual teams	108	0.63%
trust	107	0.61%
students	102	0.56%
computer supported cooperative work	92	0.52%
computer mediated communication	84	0.48%
decision making	83	0.48%
leadership	80	0.46%
software design	78	0.46%
distributed computer systems	77	0.44%

Source: Authors

to be “virtual reality” and “management”. The terms which were least used were ones related to software and computers.

Table 14 shows a coded sample of the 25 most-relevant articles per construct since 2015, in order of number of citations.

V. DISCUSSION OF RESULTS

The bibliographic analysis provided a number of results which can be used to answer the research questions:

Q1. What are the main topics of current research on virtual teams?

This question was answered after the journals that published the largest number of articles had been analyzed and, of course, from the results of the keyword searches for “Virtual Team” and related terms.

- The keywords (apart from “virtual team”) that appeared the most in the bibliographic search were: virtual reality, management and project management, which shows the importance of the work being done in this area. However, the term “leadership” which describes the performance of the people involved in the areas was one of the terms which appeared least, along with software design, which is an essential element of remote communication.
- The journals which published the greatest number of articles in the period studied were specialized in technology and, business administration and management. This demonstrates, once again, the interest that exists for this type of remote work in the two areas mentioned above. The years with the highest values of g and h indices were 2007 and 2008.

TABLE 14. Essential publications by construct.

N	Cultural diversity	Distribution index	Task characteristics	Interdependence of tasks	Leadership	Cohesion	Empowerment	Trust	Degree of Virtuality	Communication	Performance
1		X			X				X	X	
2							X				X
3				X						X	X
4			X	X	X		X				X
5	X		X				X	X	X		X
6					X			X			X
7											X
8					X						
9		X		X			X				
10		X			X		X				
11									X		
12				X				X			X
13		X		X			X		X	X	X
14		X			X			X			X
15								X			X
16							X		X		X
17			X					X			
18			X	X			X		X	X	X
19			X						X		X
20		X		X			X				
21		X			X				X		X
22		X			X				X		
23				X	X		X		X		
24											X
25			X		X				X		X

- In addition, the most common format of publication depended on the database used. In the main keyword search, WoS included many more academic articles than the other databases. Scopus, on the other hand, included a variety of formats. When other related keywords were analyzed however, there were more conference papers than articles in this database. The proportion of books in the total number of revised documents was low.

While some key concepts such as virtual teams and technologies have been extensively studied, there are still a lot of areas, such as software, leadership or design, which are all essential for high-performance virtual teams, that have still not been studied in depth [48], [49]. One of the most important technologies for improving the performance of virtual teams is virtual reality. Studies, such as that carried out by Lee *et al.* [50] conclude that it is the perceived enjoyment, and not the usefulness, that influences the use of this technology.

Some videogame companies have used this idea to develop methods of interaction that allow players to perform joint tasks realistically, something that can be extrapolated to the virtual team. There have also been advances, not only in medicine or psychology, but also in other areas such as museum tours, where once again, the user demands a realistic experience [59]–[61].

Therefore, the potential of using this type of application in virtual teams, where interaction is important, seems obvious. Virtual reality can be used to make remote relationships

similar to interpersonal ones, thus removing one of the drawbacks of virtual teams and remote communication which are not face-to-face [62]. Therefore, correct software design is critical for an effective and efficient virtual team and this should be studied further.

However, technology is not the most important factor of performance, as [7] showed. Virtual teams are made up of people who have emotions and different needs in all areas of their lives. This has inspired these authors to investigate trust and commitment.

There are also other factors which are not investigated in the literature, such as leadership and, where appropriate, e-leadership. An efficient leader can implement different technological tools effectively so that they are accepted by the whole team. Another essential responsibility of the leader is to monitor projects without having a negative effect on the team [63].

Q2. What are the constructs that have been examined by current research on virtual teams?

A detailed analysis of the most relevant publications was carried out to answer this question. Most of the constructs which were studied were related to the performance of virtual teams. These included:

- The technology that is used for remote relationships between team workers. Most researchers consider this to be a very important variable.
- Trust is essential in face-to-face relationships at work and is also essential in virtual ones. It was considered a relevant construct when working remotely in a large number of the documents.
- Communication technology affects personal relationships and even more so in virtual relationships.
- The equipment needed for remote relationships, especially the different types of technology which can be used.
- Although the term “leadership” only appeared in 2.60 % of the documents, many authors consider it an important characteristic of a good manager which is useful for gaining the trust of the group.
- Education, including online training, is considered a key factor for performance. While it is true that this term did not appear as such in the bibliographic searches, it should still be considered important.

According to Gilson *et al.* [52] previous research on virtual teams mainly occurred in laboratory conditions using teams of students and comparing them with their face-to-face counterparts. All the articles found in this study shared several key points, which were, firstly, that studies now use a diverse range of disciplinary approaches and study virtual teams in different areas, such as accounting, applied psychology, business management, communication, computer technology, education, engineering, information systems and software design. Second, much of the work uses the same constructs and indicators (e.g., Task Functions, Composition Factors, Technology and Leadership), Mediators (e.g. communication, coordination, conflict and trust),

TABLE 15. 25 Essential publications.

DB	YR	TITLE	AUTHOR	CIT	
1	WOS	2015	VIRTUAL TEAMS RESEARCH: 10 YEARS, 10 THEMES, AND 10 OPPORTUNITIES	GILSON LL;MAYNARD MT;YOUNG NCJ;VARTIAINEN M;HAKONEN M	159
2	WOS	2015	EXPERT CLOUD: A CLOUD-BASED FRAMEWORK TO SHARE THE KNOWLEDGE AND SKILLS OF HUMAN RESOURCES	NAVIMIPOUR NJ;RAHMANI AM;NAVIN AH;HOSSEINZADEH M	76
3	WOS	2015	SOCIAL MEDIA: A CONTEXTUAL FRAMEWORK TO GUIDE RESEARCH AND PRACTICE	MCFARLAND LA;PLOYHART RE	68
4	WOS	2016	TRUST AND TEAM PERFORMANCE: A META-ANALYSIS OF MAIN EFFECTS, MODERATORS, AND COVARIATES	DE JONG BA;DIRKS KT;GILLESPIE N	68
5	SCO	2016	DOES TRUST MATTER MORE IN VIRTUAL TEAMS? A META-ANALYSIS OF TRUST AND TEAM EFFECTIVENESS CONSIDERING VIRTUALITY AND DOCUMENTATION AS MODERATORS	BREUER C;HFFMEIER J;HERTEL G	38
6	SCO	2015	LEADERSHIP EMERGENCE IN FACE-TO-FACE AND VIRTUAL TEAMS: A MULTI-LEVEL MODEL WITH AGENT-BASED SIMULATIONS, QUASI-EXPERIMENTAL AND EXPERIMENTAL TESTS	SERBAN A;YAMMARINO FJ;DIONNE SD;KAHAI SS;HAO C;MCHUGH KA;SOTAK KL;MUSHORE ABR;FRIEDRICH TL;PETERSON DR	24
7	SCO	2015	MANAGING INFORMATION OVERLOAD IN VIRTUAL TEAMS: EFFECTS OF A STRUCTURED ONLINE TEAM ADAPTATION ON COGNITION AND PERFORMANCE	ELLWART T;HAPP C;GURTNER A;RACK O	23
8	SCO	2017	TEAM PERSONALITY COMPOSITION, EMERGENT LEADERSHIP AND SHARED LEADERSHIP IN VIRTUAL TEAMS: A THEORETICAL FRAMEWORK	HOCH JE;DULEBOHN JH	22
9	WOS	2016	TRUST INVOLVEMENT IN HYBRID TEAM COLLABORATION: A LONGITUDINAL CASE STUDY EMPOWERING LEADERSHIP AND EFFECTIVE	CHENG X;YIN G;AZADEGAN A;KOLFSCHOTEN G	22
10	WOS	2016	COLLABORATION IN GEOGRAPHICALLY DISPERSED TEAMS	HILL NS;BARTOL KM	21
11	WOS	2016	ENHANCING COLLABORATION IN BIM-BASED CONSTRUCTION NETWORKS THROUGH ORGANISATIONAL DISCONTINUITY THEORY: A CASE STUDY OF THE NEW ROYAL ADELAIDE HOSPITAL	MIGNONE G;HOSSEINI MR;CHILESHE N;ARASHPOUR M	21
12	SCO	2015	RETHINKING VIRTUALITY AND ITS IMPACT ON TEAMS	FOSTER MK;ABBEY A;CALLOW MA;ZU X;WILBON AD	21
13	WOS	2016	TRUST DEVELOPMENT IN GLOBALLY DISTRIBUTED COLLABORATION: A CASE OF US AND CHINESE MIXED TEAMS	CHENG X;FU S;DRUCKENMILLER D	21
14	WOS	2017	VIRTUAL TEAMS IN ORGANIZATIONS	DULEBOHN JH;HOCH JE	21
15	SCO	2015	EFFECTS OF GUIDED REFLEXIVITY AND TEAM FEEDBACK ON TEAM PERFORMANCE IMPROVEMENT: THE ROLE OF TEAM REGULATORY PROCESSES AND COGNITIVE EMERGENT STATES	KONRADT U;SCHIPPERS MC;GARBERS Y;STEENFATT C	19
16	WOS	2015	HOW TEAM FEEDBACK AND TEAM TRUST INFLUENCE INFORMATION PROCESSING AND LEARNING IN VIRTUAL TEAMS: A MODERATED MEDIATION MODEL	PENARROJA V;ORENGO V;ZORNOZA A;SANCHEZ J;RIPOLL P	19
17	SCO	2017	THE VIRTUAL TEAM PLAYER: A REVIEW AND INITIAL MODEL OF KNOWLEDGE, SKILLS, ABILITIES, AND OTHER CHARACTERISTICS FOR VIRTUAL COLLABORATION	SCHULZE J;KRUMM S	19
			VIRTUAL TEAM		

TABLE 15. (Continued.) 25 Essential publications.

18	WOS	2017	EFFECTIVENESS: THE ROLE OF KNOWLEDGE SHARING AND TRUST	ALSHARO M;GREGG D;RAMIREZ R	19
19	WOS	2017	COMMUNICATION IN VIRTUAL TEAMS: A CONCEPTUAL FRAMEWORK AND RESEARCH AGENDA	MARLOW SL;LACERENZA CN;SALAS E	17
20	WOS	2017	WORKING SMARTER AND GREENER: COLLABORATIVE KNOWLEDGE SHARING IN VIRTUAL GLOBAL PROJECT TEAMS	OLAISEN J;REVANG O	17
21	WOS	2017	LEADERSHIP IN VIRTUAL TEAMS: A MULTILEVEL PERSPECTIVE	LIAO C	16
22	SCO	2015	PRECURSORS TO ENGAGED LEADERS IN VIRTUAL PROJECT TEAMS	IORIO J;TAYLOR JE	16
23	SCO	2017	STRATEGIES FOR BUILDING EFFECTIVE VIRTUAL TEAMS: TRUST IS KEY	FORD RC;PICCOLO RF;FORD LR	16
24	SCO	2016	STUDENT EVALUATION OF A VIRTUAL EXPERIENCE FOR PROJECT MANAGEMENT LEARNING: AN EMPIRICAL STUDY FOR LEARNING IMPROVEMENT	GONZLEZ-MARCOS A;ALBA-ELAS F;NAVARIDAS-NALDA F;ORDIERES-MER J	16
25	WOS	2015	TASK DIVISION FOR TEAM SUCCESS IN CROWDSOURCING CONTESTS: RESOURCE ALLOCATION AND ALIGNMENT EFFECTS	DISSANAYAKE I;ZHANG J;GU B	16

Source: Authors

moderators (e.g., Virtual model and Interdependence), and results (e.g., performance and affective reactions). However, the ways these constructs have been treated are quite different. There has also been a lot of research about the professionals who use virtual teams, including information technology professionals (Baruch and Lin) [64], software developers (Muethel, Gehrlein and Hoegl) [65], research and development professionals (Stark and Bierly) [66], consultants (Suh, Shin, Ahuja and Kim) [67], developers of new product (Stark and Bierly) [68] and engineering teams (Forester, Thoms, y Pinto) [69].

The software used by virtual teams has to be produced by creative people, who use and promote non-traditional development teams that are different to normal business routines (Nash) [70]. These non-traditional teams may consist of individuals working non-traditional hours or in non-traditional locations. Software development usually happens in a globally distributed environment (Agerfalk *et al.*) [71]. More and more companies use these types of teams, which include members from various backgrounds, as they communicate more clearly and effectively than teams that are homogeneous (Granered) [72]. This has led companies to not only assemble teams with members from different locations, but also to ensure that such teams work efficiently.

A. COMMUNICATION IN VIRTUAL TEAMS

Communication in virtual team has been widely investigated. The action processes, communication, coordination and knowledge sharing are the areas which have been studied the most (Gilson *et al.*) [52] at they are critical for predicting team efficiency and effectiveness (Kock and Lynn) [73]

According to Argaña [74], it is important to consider separately how the content of the communication is interpreted, and also the ease and monitoring of it. Limitations of the interpretation of virtual communication have been identified. One of the challenges of virtual teams is that information must be communicated, shared, and interpreted without the help of gestural language. Some authors have also pointed out that the communication about projects must be very clear and the information must be handled appropriately.

Research on virtual teams usually considers that team members may encounter difficulties when communicating with computers (Gilson *et al.*) [52]. Despite the barriers and difficulties shown in previous research, current research has shown that as the next generation of employees (i.e. millennials) enter the workplace, many of the previous difficulties lose importance (Gilson *et al.*) [75]. As Gorman and his colleagues state [76], millennials have the “ability to effectively use networked digital communication technologies to perform a wide variety of tasks quickly and smoothly”. Indeed, younger generations might see working in virtual teams as commonplace and working in a face-to-face environment as the exception.

B. TRUST IN VIRTUAL TEAMS

The literature about this states that building trust and having members identify with the team are two important sources of concern. In fact, if team members don't know each other, they don't know if they can trust each other, so before becoming an effective virtual team, the members have to know each other.

Trust is defined as a person's willingness to become vulnerable to the actions of others with the expectation that others

will continue with their commitments. Two types of trust have been defined in the literature on the subject. These are called cognitive trust and affective trust (Mayer *et al.*) [77], [78].

Creating trust in virtual teams is often connected with the exchange of knowledge (e.g. Liu and Li) [79]. Pinjani and Palvia [80] investigated the role of functional and deep-level diversity, finding that deep-level diversity is more relevant to trust and knowledge sharing. In addition, interpersonal trust and trust in technology were also found to be relevant to knowledge sharing (Golden and Raghuram) [81], whilst the lack of interpersonal trust and confidence in technology can be obstacles (Breu and Hemingway) [82].

In a longitudinal study of global virtual teams, Goh and Wasko [83] found that when the team member's actions were visible, trust was not a key factor in resource allocation. In globally distributed teams, trust greatly diminished the negative effects of the diversity of members on performance (Garrison, Wakefield, Xu, and Kim) [84]

C. CULTURAL DIVERSITY

Cultural diversity is the construct which is used for the globalization of virtual teams (Hoch and Kozlowski) [85], and the findings suggest that perceived differences in national culture and language barriers can adversely affect teams (Au and Marks) [86].

Taking a more detailed approach, Mockaitis *et al.* [87] found that members of a global virtual team who had a collective mindset accepted team processes favorably. Duranti and Almeida [88] found that some cultures (Brazil) prefer advanced computer-mediated communications such as audio and video conferencing, while others (the United States) preferred less advanced computer-mediated communication tools, such as email and chat.

Some ways to alleviate issues associated with cultural differences include cultural training, face-to-face meetings, and team-building activities. However, team interactions should be monitored to identify potential difficulties (House) [89].

D. TEAM DISTRIBUTION

The physical separation of virtual teams was investigated in the work by Allen [90] on geographic distancing and dyadic communication. The study of the dispersion of teams by O'Leary [91] analyzed three dimensions of dispersion, (1) spatial, which is the actual geographic separation of teams, (2) temporal, which is the time difference of normal working hours in different places, and (3) configuration, which is the distribution of team members across the sites.

E. CHARACTERISTICS OF TEAM TASKS

The literature found in this study included research on the interaction between the type of task a team does and the type of communication used and the impact on team performance (Rico *et al.*, Bell *et al.*, Montoya-Weiss *et al.*) [92]–[94]. As virtual teams rely heavily on communication technology to coordinate their work, the relationship between the nature of the task and the effectiveness of communication and its

impact on team performance must be studied. The variety of tasks is the frequency of unexpected and novel events that occur during information processing. A low variety means that team members can be sure about which future events will occur. A high variety means that team members cannot predict future activities. High variety would also involve a lot of unplanned communication between team members.

F. COHESION

Cohesion is a sense of unity in a team. Cohesion is important for virtual teams, and is associated with an improvement in performance (Lurey and Raisinghani, 2001, Maznevski and Chudoba) [95],[96] and satisfaction (Chidambaram) [97]. According to Salisbury *et al.* [98] classical research suggested that the physical distance between team members can create a psychological distance between them. Salisbury *et al.* [98] suggested that the physical dispersion of the virtual team may inhibit the development of cohesion compared to on-site teams. In addition, virtual team members may have different perceptions of what cohesion is. In other words, the perception of cohesion, which is based on communication between the members of the team, is affected by the method used to communicate.

G. LEADERSHIP

A classic definition of leadership states that it is when a person makes other people do something (Kort) [99]. Leadership is an influential relationship between leaders and followers who try to make changes that benefit their mutual purposes (Kort) [99].

Research on leadership in virtual teams has increased rapidly, especially in areas about behavior and leadership traits (Gilson *et al.*) [52]. Several studies examined the interaction between leadership and virtual work, finding that team members are more satisfied with their team and leader and perceive that their leader is more able to decode messages when the leader is geographically distant from the team (Henderson) [100]. Hoch and Kozlowski [85] found that virtual work reduced the relationship between hierarchical leadership and performance while improving the relationship between structural support and performance.

H. EMPOWERMENT

Empowerment means having the favorable backing of the team leader, especially when this allows members to participate in decision-making. Kirkman *et al.* [101] showed that teams experience empowerment in four ways, power, which is the collective belief of a team that it can be effective, meaning, the extent to which team members take intrinsic care of their tasks, autonomy, in which team members are free to make decisions, and impact, the degree to which team members feel that their tasks make important contributions. Initially, Gondal and Khan [102] studied the impact of team empowerment on virtual team performance at ten telecommunications companies located in Islamabad. In that study, they found that there is a positive relationship between team

empowerment and team performance in telecommunications teams. Also, Kirkman, Rosen, Tesluk and Gibson [101] studied 35 sales and service teams at a high-tech firm and investigated the impact of team empowerment on team performance and the intermediary role of face-to-face interaction. They found that team empowerment is positively related to the two constructs of virtual team performance, which are process improvement and customer satisfaction.

I. AMOUNT OF VIRTUALITY AS A MODERATING VARIABLE

Martins *et al.*, [103] suggested that the amount of virtuality in a team affects processes (especially in communication) and team results (performance and satisfaction) and that it should be considered as an important variable to understand the performance of the team. Cuevas *et al.* [104] found that the technological intermediation required for the communication of virtual team members can generate what is known as team opacity. Basically, opacity is described as the experience of ambiguity and artificiality caused by this type of intermediation in geographically dispersed work. It can limit coordination and communication in teams and therefore affect their performance. Martins *et al.* [103] and Gibson and Gibbs [105] investigated geographical dispersion in the processes and results of the team, considering coordination and communication (both implicit and explicit) as critical processes, as well as the foundations for the performance of a virtual team (Fiore *et al.*) [106].

J. INTERDEPENDENCE OF TASKS

In traditional environments each sub-team usually has its own goals and objectives, and the tasks of the different sub-teams are not dependent on each other, while virtual teams usually have distributed tasks that are highly dependent on the other members and their tasks (Saldaña) [107].

Several studies state that the interdependence of tasks can improve the performance of virtual teams (Chi, Chang and Tsou) [108].

The interdependence and complexity of tasks has been found to influence the inputs and processes of a team and to also have an effect on the relationship of the process with the result (Bell and Kozlowski, 2002, Bowers, Pharmed, and Salas, Hambrick, Humphrey and Gupta) [93], [109], [110].

In the collaborative environment of software development, the tasks performed by team members are highly interdependent. The interdependence of tasks is the extent to which the team members depend on each other to perform their individual work (Van de Ven) [111] and is considered to be one of the structural variables that most influences team performance (Langfred) [112].

Q3. What are the gaps in existing research and possible areas of future research?

The most important research gaps were identified from the results of the systematic literature review, and are explained below.

- Virtual teams still need to be investigated so that this new type of organization can be fully understood, especially as new technologies for collaboration are constantly being developed. The previous sections include bibliometric and systematic analyses of the existing research in this area.
- The main points and ways in which virtual teams operate are still not fully understood and these areas should be investigated further. One of the fields which has not been widely investigated is that concerning emotions and how they influence performance.

The guidelines for future research can be summarized as follows:

- Classification of terms: The classification of terms, which means ordering the concepts and terms. This is necessary not only for existing research, but also for future research.
- Model-based study: The variables and constructs found in this study can help researchers understand the type of constructs which have already been investigated and whether these constructs were dependent or independent. In addition, researchers may refer to the documents to find more information about any construct and whether it influenced, or was influenced by, other constructs.
- Study the adoption of new collaborative technologies, as well as the patterns of adoption

The adoption and use of virtual teams are driven by new technologies that enable better collaboration of team members. Currently, projects and teams need this new collaborative technology (Matthiesen and Bjorn, Stray *et al.*) [113], which goes beyond the classic video conferencing software that is often used for distributed meetings. The number of communication tools and platforms has increased substantially in recent years (Cardon and Marshall, Cardon, Huang and Power) [115], [116].

An interesting application of technology for virtual and distributed teams is the electronic task board. Some of these are based on Kanban, which was successfully used by Toyota in factories in the 1950s. It started being used for software development in 2004 at Microsoft (Anderson) [117]. Examples of the Kanban method include Trello or Canvanizer. The use of Kanban in software development is still an emerging area and it is currently being promoted (Ahmad, Markkula, and Oivo) [118], not only for software development, but to manage the tasks of teleworkers. The main reported benefits of using the Kanban method are, improved software delivery times, better software quality, better communication and coordination, greater delivery consistency, and a reduction in defects reported by customers.

Other collaborative tools include social software (e.g. instant messaging, tools and wikis) (Giuffrida and Dittrich) [119]. These tools are compatible and integrate with social networks and messaging. The most urgent and informal conversations use instant messaging (IM) tools, such as Whatsapp, Telegram or Webchat, among others. These tools

reduce coordination problems in distributed projects (Dittrich and Giuffrida) [120].

Another group of applications are known as social network platforms (SNPs), telecommunication platforms (TCP), or enterprise social software (ESS) (Dittes and Smolnik) [121]. Examples of this type of applications are Slack, Yammer, Microsoft Team, and Facebook Workplace (Leroy *et al.*) [122]. These applications aim to promote collaborative communication with all levels of an organization (Cardon) [123]. They work on mobile devices and improve transparency the virtual teams (Stray *et al.*) [124]. These applications improve trust (Moe and Smite, 2008) [125] and transparency in virtual teams, compared to the classic method of communication by email.

The reasons why new collaboration technologies are constantly being developed can be found in recent studies (Stray and Moe) [114]. This study found that collaborative technology has important positive effects, such as increasing the feeling of belonging to a team, increasing informal communication, and reducing the need for e-mails. They also found that essential team members being unavailable, the lack of organizational support for unscheduled meetings, and the varying participation of team members in meetings were all obstacles to effective coordination of virtual teams.

VI. INTERNAL AND EXTERNAL VALIDITY

This research is an example of the application of the formal systematic review methodology proposed by Ramey and Rao [1] and Rao and Ramey [50], who proposed a formal systematic review process after modifying a method used by medical doctors so that it could be used in scientific research. The methodology proposed by Pulsiri and Vatananan-Thesenvitz [2] was included to incorporate automation and bibliometry in a study in which terms were systematically classified using the methodology given above. This classification summarized the main research topics investigated in the field of virtual teams in companies over a five-year period. The researchers identified the main topics in the field, and the external validity [28]. The main constructs identified in the results provided the researchers with a set of dependent, independent, moderator and mediator variables, and their corresponding relationships. These variables and the relationships which exist between them can be used when designing regression or structural models in studies of quantitative analysis of Big Data. The internal validity or causal relationships can be found in this way [30].

VII. CONCLUSION

Rapid developments in information technologies have resulted in the rapid advance of virtual convergence. The aim of this study was to systematically review the literature about virtual teams. This article is an example of using a systematic literature review with a bibliometric review. The main conclusion was that although there is still a lot of research to be done and that in the last few years there have not been as many publications on the subject as there were in the

period 1998-2010, studying this area has become increasingly important since the appearance of the coronavirus pandemic or covid-19. Technological advances permit teleworking and collaboration in virtual teams. Fear of new pandemics and savings in transport costs will definitely promote this technology in coming years.

The number of published documents about virtual teams was higher in the United States than in other developed countries such as the United Kingdom or Germany. The most commonly published format was the article, followed by conference papers. There are still only a limited number of books published on this subject.

In line with previous research [29], [126], the main factors that need to be researched are related to emotions, which is an area of study that is becoming increasingly important in a wide variety of areas such as marketing. Other areas which can be investigated are communications, technology and trust. A considerable amount of knowledge has been gained about virtual teams over the last five years. However, the relationships between the different aspects of virtual teams and how they interact has not yet been researched.

In the future, researchers could collect more bibliometric information from other academic databases, such as Web of Science, Google Scholar, and Dimensions, in order to complement and add to the information in this study. Above all, the relationships between constructs should be investigated using statistical techniques such as regression and structural equations. In addition, research can use a SLR combined with a bibliometric analysis to identify the constructs which are to be investigated.

This work contributes to the existing research about the constructs and relationship between them in research on virtual teams, and by suggesting future research in this area. It also suggests a system which can be used, by combining existing methods, to identify a higher number of more precise results in literature reviews, which is an essential first step in any investigation.

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