


## Navigating Digital Leadership Through A Bibliometric Lens

Ahmad

Management Study Program, La Tansa Mashiro University, Banten, Indonesia

Article Info	ABSTRACT
<p><b>Keywords:</b> Leadership, digital leadership, e-leadership, literature review, bibliometric analysis.</p>	<p>Digital disruption has changed organizations in unprecedented ways. The rapidly evolving field of digital leadership currently receives little attention, with only retrospective studies of its evolution having been conducted so far. This study presents a bibliometric and network analysis that combines Scopus and Web of Science databases to provide new insights into the evolution of the digital leadership research field. The study is based on a review of 79 publications from 57 journals, published between 2000 and 2020. The novelty of the topic and the range of journals that publish on it confirm that digital leadership has attracted interest from a wide range of fields. The bibliometric analysis provides a description of the research field identifying the leading publishing journals, affiliation statistics, and the most influential authors and publications expressive of the research field. Network analysis identified the evolution of keywords over time, co-citation relationships, and research clusters. Content analysis was used to identify key topics in the field with an eye to the interrelationships between them. A brief description of each paper in the dataset and its methodological approach is provided. The results suggest that this topic will continue to attract more research, as it has not yet entered the maturity stage. This paper contributes to the literature by analyzing the relationship between digital leadership and e-leadership. The study also identifies the most important digital leadership capabilities for a rapidly changing world. Limitations and future avenues are also discussed.</p>
<p>This is an open access article under the <a href="https://creativecommons.org/licenses/by-nc/4.0/">CC BY-NC</a> license</p> 	<p><b>Corresponding Author:</b> Ahmad Management Study Program, La Tansa Mashiro University, Banten, Indonesia Jl. Soekarno – Hatta, Pasir Jati Rangkasbitung Lebak <a href="mailto:dr.ahmadbento@gmail.com">dr.ahmadbento@gmail.com</a></p>

### INTRODUCTION

The COVID-19 pandemic has affected workers in different ways. Lockdowns have forced an abrupt shift from face-to-face and analog interactions to the digital realm (Faraj et al., 2021). Teleworking, distributed teams, and remote management are new experiences for many organizations (Kirchner et al., 2021). Some types of work that were previously uncommon or not accepted in certain organizations (e.g., virtual work) are becoming commonplace for workers around the world (Wang et al., 2020). COVID-19 has encouraged experimentation as digital technologies have made the world more decentralized (Fenwick et al., 2021). However, thanks to digital technology, people are able to maintain connections as they are forced to maintain social distancing (Peng, 2021). Digital transformation leads to work transformation (Nagel, 2020), shaping the way people work, think and interact (Hai et al., 2021). While no one can foresee how the rapid shift to digital work will affect organizations

in the future, an effective digital transformation program may not be easy to achieve and sustain (Wade & Shan, 2020). Therefore, leadership practices must adapt to the new environment to achieve effective and lasting performance (Contreras et al., 2020). The pandemic seems to be a big test for leaders around the world, as it is impossible to predict what will happen in the new world. Although digital transformation presents challenges for leaders (Bartsch et al., 2021), digital leadership (hereafter Digital Leadership) helps organizations deal with continuous risk and uncertainty (Fenwick et al., 2021). Against this backdrop, Digital Leadership has become a key element in efforts to modernize organizations, and needs to be considered in detail (Peng, 2021) as leaders experience new challenges due to digital disruption (Kane et al., 2019).

Bibliometric studies are a quantitative approach to studying bibliographic materials and mapping research fields without subjective bias (Zupic & Čater, 2015). It brings to light the most influential works and authors, the evolution of the most used keywords, the most related topics, and the dominant results, among other evidence. Network analysis visualization techniques complement the analysis of research fields (Cobo et al., 2011a). This research uses VOSviewer for network analysis which uses the VOS (similarity visualization) algorithm. The VOS algorithm visualizes the similarity between objects (e.g., citations) based on their location, and the distance reflects the similarity (van Eck & Waltman, 2010). Network analysis enables the visualization of scholarly fields where network nodes represent units of analysis (e.g., documents, authors, journals, words), and network ties represent sending similarity relationships, with the strongest getting closer (Zupic & Čater, 2015). Bibliometric tools and network analysis foster a unique understanding of the advancement of the Digital Leadership field and connected topics within this domain by making sense of unstructured data in a rigorous way and advancing the domain in a meaningful way (Donthu et al., 2021).

Finally, DL is worth studying because in the current digital trend, the role of leadership is crucial in driving rapid decision-making processes and driving change (Jäckli & Meier, 2020). Studying the phenomenon of DL is relevant due to its importance to organizations, as digital transformation requires leaders to find new ways to thrive amidst uncertainty (Matzler et al., 2018). Therefore, this study provides a comprehensive review of the field using bibliometric tools and network analysis. The review begins by showing the academic evolution of the field, the more influential papers and researchers, the most used keywords, and affiliation statistics. Then, network analysis informs the evolution of authors' keywords over the years and the relationship between authors and academic publications. Additionally, it alogarithmically identifies the three main groups used to examine research topics through content analysis. Finally, additional insights and potential directions for future avenues are also presented.

Virtual work settings provide a high degree of versatility, allowing organizations to gather staff around the world, but also challenge the way of leading (Pradhan, 2019). E-leaders can empower their followers to participate more in decision-making and become more independent in working in virtual teams when they communicate effectively (Walvoord et al., 2008). While communication helps overcome the uncertainty of the digital environment, it also poses another challenge, as most of the information exchanged between leaders and followers is non-verbal, which is reduced in virtual teams (Maduka et al., 2018). In addition, trust is a key aspect of any relationship and is also a challenge for leaders due to the

establishment of trust in virtual teams (Cascio & Shurygailo, 2003). Nonetheless, the concept of e-leadership is changing, moving from electronically mediated forms of interpersonal communication to a broader view of digital technologies (Belitski & Liversage, 2019; Cortellazzo, Bruni, & Zampieri, 2019). According to this perspective, e-leadership is no longer just about electronic tools and communication, but primarily involves effective leadership in digital environments (Roman et al., 2019).

Digital technologies change the context in which people work, increasing ambiguity and the need for change (Pulley, Sessa, & Malloy, 2002). Therefore, many assumptions about leadership must evolve. Many challenges arise for digital leaders, which affect their leadership effectiveness (Amit et al., 2016). The digital scenario changes some skills, as the ability to lead a network instead of through a hierarchy seems to become more important as it facilitates fast and collaborative work, removes barriers, and increases agility (Kane et al., 2019). The digital scenario also has implications for some leadership paradoxes. As technology can change how leadership is done, some dilemmas arise. DL needs to provide autonomy to its teams without making them feel isolated; to maintain focus and purpose in a constantly changing environment that requires strong adaptability; and, also, to efficiently balance familiar responses with new ideas and innovations (Pulley et al., 2002). This scenario brings us to the question of the structure of the DL domain and its evolution and what we can learn from it. Another question is whether new leadership paradigms emerge from digital disruption. Using bibliometric tools and network analysis provides a comprehensive overview of the field. This can help in providing summaries and relationships within the research subject to infer and learn from complementary evidence.

## METHODS

In this study, the authors used bibliometric analysis, which is a summary of previous research to advance the field of research knowledge (Zupic & Čater, 2015). Bibliometric analysis is a quantitative study of written publications (Broadus, 1987; Pritchard, 1969) that analyzes the history of scientific works to measure their impact (Lee et al., 2005). Following Fahimnia et al. (2015), the authors used a four-step methodology (determining search keywords, data cleaning and formatting, preliminary analysis, and data analysis) to identify studies and authors with higher impact and analyze research topics that contribute to insights for future research in the domain. In line with Ertz & Leblanc-Proulx (2018), the use of two databases (Scopus and Web of Science) instead of just one is an important contribution that aims to obtain deeper and more diverse results.

### Defining Search Keywords

First, the authors conducted a search with the terms "e-leadership" or "virtual leadership" or "digital leadership" or "leading online communities" using the Scopus database, focusing on three main subject areas (i.e. social sciences; business, management, and accounting; and psychology) using article titles, abstracts, and keywords for the search. The authors decided to limit the search to articles published after 2000, when Avolio et al. (2000) started using the term "e-leadership" linking leadership and technology. Then, the authors limited the search by selecting only peer-reviewed journal articles in English, as these works constitute a certified body of knowledge and mostly show reliable results (Bhatt et al.,

2020; Haleem et al., 2020). The Scopus database consists of 173 articles. Afterwards, the same search was performed on the core collection of the Web of Science database, aiming to avoid missing articles and resulting in a sample of 86 articles, with most overlapping with Scopus.

### Data Cleaning and Formatting

Due to the use of two different databases instead of just one, more work is required related to data standardization to obtain consolidated information. Since many publications appear in both databases at the same time, duplication is manually suppressed from Web of Science data because its citation format is less complete than that of Scopus (Zhao & Strotmann, 2015). In addition, data retrieved from bibliographic databases also often contain errors, such as misspelled elements, and so on. Therefore, it is necessary to analyze the retrieved data (Cobo et al., 2011b). The authors conducted a review of the bibliometric information and corrected (for example, in one article, the author's name was misspelled) or excluded articles with bibliometric issues. Then the authors read each abstract of the remaining documents. Exclusion criteria followed Gümüset et., al. (2019) and Soriano et., al. (2018), as studies unrelated to the scope of this study, i.e. articles unrelated to organizational studies, were excluded. In this way, the authors excluded thirty-nine articles from non-organizational domains (e.g., education, health), three articles that were non-English studies, and sixty-eight articles that did not have the right search terms (e.g., the search results in the database selected articles with the word "leadership" instead of "e-leadership"). The authors also ascertained whether the articles were within the years specified for the search (see Appendix 1 for all excluded articles). Finally, 79 records remained in the database for further examination (Table 1). The decrease in the number of articles from the initial dataset was significant, although this is not unusual in bibliometric analysis, as has been the case in various other studies (e.g., Figueroa-Rodríguez et. al. 2019; Galvagno & Giaccone, 2019; Gümüş et. al. 2019; Keathley-Herring et., al. 2016).

### Preliminary Analysis

Figure 1 shows the publishing trend in the number of publications on the topic of Digital Leadership from 2000 to 2020. We can notice that from 2009 to 2011, the number of publications was practically stable. However, especially from 2018 onwards, the rate of increase is more pronounced. The volume of published articles increased significantly by 243% in the last decade (2011-2020); even in the last 5 years (2016-2020), the growth rate is still more than 100%. This growth rate is in line with other studies such as Wei et. al. (2021), where the number of published articles increased by 211% in the last decade and more than 90% in the last 5 years. Therefore, not only concerning the emerging subject (Zeike et al., 2019) but also the rate of increase in the number of articles over this period, these preliminary results suggest that this topic will continue to attract more research. The topic is still in its infancy and has not yet entered the maturity stage, in line with the conclusions of Ertz & Leblanc-Proulx (2018) and Davarzani et. al. (2016) regarding the cumulative growth presented over the years.

The 79 articles in the research dataset published by 57 different journals are related to leadership, human resources, business, innovation, government, psychology, and strategy. The novelty of the topic and the range of journals that publish it confirm that Digital

Leadership has attracted interest from a wide range of fields. Such a wide spread of literature, and the different perspectives it enables, confirms the need for structure and discussion of future research avenues. Most articles were written by two (30.4%) or three authors (27.8%), with a maximum of seven authors writing one paper. From a methodological perspective, empirical research represented 64.6% of the total articles in the dataset, evenly distributed between qualitative and quantitative research and with mixed methods representing 13.7% of the total empirical research. These qualitative studies used methods such as general qualitative methods (interviews, content analysis) in 12 articles, case studies in 6 articles, and observation in 1 article. Quantitative studies applied methods such as surveys (17 articles), econometric models (4 articles), experimental designs (3 articles), and secondary data analysis (1 article).

### Data Analysis

Data analysis was conducted in two parts, namely bibliometric analysis (section 4) and network analysis (section 5). Bibliometric analysis used BibExcel as it allows for the analysis of diverse data sets and is the most widely used software for carrying out bibliometric analysis in management and organizations (Zupic & Čater, 2015). VOSviewer works efficiently with various databases (e.g., Scopus and Web of Science), providing visualization and analysis options (van Eck & Waltman, 2010). The visualization of similarity (VOS) algorithm presents similarities between objects (e.g., co-occurrence, co-citation) that provide accurate visual information about the distance between a pair of objects (van Eck & Waltman, 2010). In addition, content analysis followed publication citation analysis to complement the research areas of each cluster.

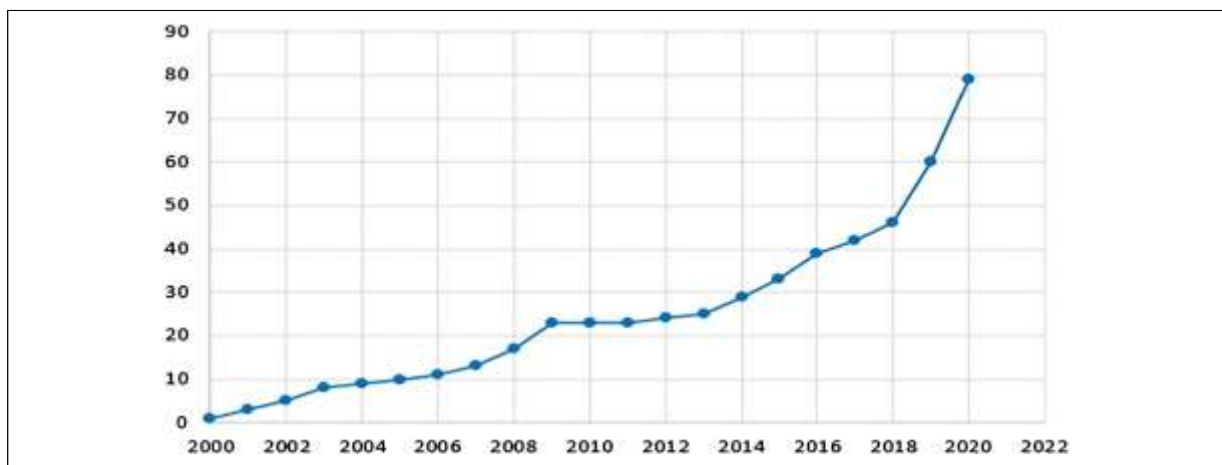


Figure 1. Cumulative growth in the number of source documents.

### Bibliometric Analysis

#### Leading Publishing Journal

From the repository of major journals publishing in the field of Digital Leadership, five major journals responded to 19 studies, equivalent to 24% of all publications studied. These journals are Organizational Dynamics, Leadership Quarterly, Management Science Letters, Frontiers in Psychology, and Leadership and Organization Development Journal. As expected,



among the most published studies were journals related to the topics of organization and leadership and psychology.

### **Influential Authors and Affiliation Statistics**

In terms of the number of local citations of authors, i.e. the number of citations in the 79 publications in this dataset, most authors cite works from the United States, as shown in Table 2. When considering the most cited authors, names such as Bass and Yulk, who have had a particularly large impact in leadership studies, appear in the list as expected.

An analysis of author affiliations shows the international dimension of the research field (Cobo et al., 2011b). Organizational research contributing to the Digital Leadership literature was generated in 28 countries around the world. While most publications on Digital Leadership originated in the United States (39%), Europe accounted for 31.4% of the topical research, with the UK and France leading continental Europe in this domain. This research spans across 13 European countries. After Europe, Asia accounted for 21.9% of the total research organizations, with Indonesia leading on the continent, followed by China.

California State University is the university that publishes the most on the topic of Digital Leadership. In second place, after American universities, are three organizations from Asia, namely Bina Nusantara University (Indonesia), City University of Hong Kong (China), and KDI School of Public Policy and Management (South Korea), with four publications each. Although most of the Digital Leadership literature comes from organizations in the United States, the universities that publish the most are spread across the United States (California State University and University of Southern California), Europe (Aix Marseille University, National University of Ireland, and University of Reading), and Asia (Bina Nusantara University, City University of Hong Kong, KDI School of Public Policy and Management, and Singapore Management University).

### **Keyword Statistics and Most Cited Articles**

Co-word analysis is a technique that considers text in publications and presents co-occurrences among key concepts related to a field (Cobo et al., 2011b). Typically, the words for this analysis come from author keywords, but they can also come from document titles or abstracts (Donthu et al., 2021). A collection of over 336 author keywords was extracted from 79 publications based on the number of occurrences, the authors refined the data (e.g., singular/plural form) to obtain the final keywords (Davarzani et al., 2016). From Table 3, the authors found that most of the keywords matched the search criteria used (Soriano et al., 2018). The most frequently occurring keywords are those related to e-leadership, digital aspects (e.g., digital leadership, digital transformation, digital technology), and virtual leadership and virtual teams.

Table 4 shows that the most cited articles are about e-leadership and virtual teams, including the landmark article on e-leadership by Avolio et. al. (2000). The term "digital" is a newer term and, although it appears in the list of most popular keywords, it has not been seen in the titles of the most cited articles. Although citations are primarily a measure of impact, it is common for the most cited to have enough time to build citations (Zupic & Čater, 2015). The authors acknowledge that these most-cited papers are at least seven years old and that more recent papers are not present in this set of most-cited articles in the citation analysis. In addition, the main subject areas related to global citations are business, management, and

accounting; computer science; social science, and psychology. In conclusion, although the most popular keywords are related to e-leadership, leadership and virtual teams, and digital aspects, the term "digital" has not appeared in the titles of the most cited articles. Usually, the most cited papers take time for other studies to use them as references.

**Table 2.** Most Cited Authors by Number of Publications.

Author	Local Citation*	Country**	Author	Local Citation*	Country**
Avolio, B.	77	United States	Desanctis, G.	15	United States
Bass, B.	38	United States	Zigurs, I.	15	United States
Van Wart, M.	23	United States	Purvanova, R.	14	United States
Cascio, W	21	United States	Bell, B.	13	United States
Jarvenpaa, S.	21	United States	Hambley, L.	12	Canada
Kahai, S.	21	United States	Judge, T.	12	United States
Zaccaro, S.	21	United States	Balthazard, P.	11	United States
Hertel, G.	20	Germany	Dennis, A.	11	United States
Orlikowski, W.	19	United States	Berman, S.	10	United States
Sosik, J.	19	United States	Gibson, C.	10	United States
Kirkman, B	18	United States	Hoch, J.	10	United States
Kayworth, T.	17	United States	Hair, J.	9	United States
Daft, R.	16	United States	Kane, G.	9	United States
Malhotra, A.	16	United States	Kozlowski, S.	9	United States
Yukl, G.	16	United States	Townsend, A.	9	United States

\*Local publication: publications within 79 publications of the dataset.

\*\*Country: author's country of affiliation.

**Table 3.** Most popular keywords.

	Found	Keywords	Found
	28	Digital transformation	6
Leadership	18	Communication	5
Keywords	12	Computer-mediated communication	4
E-leadership	12	Digital technology	4
Digital Leadership	11	Dynamic capabilities	4
ICT	7	Market orientation	3

### Publication Network Analysis

Network analysis enables visualization of scientific fields where network nodes represent units of analysis (e.g., documents, authors, journals, words), and network ties represent connections of similarity, with the strongest getting closer (Zupic & Čater, 2015). Mapping and clustering complement each other. Mapping provides a picture of the structure of a bibliometric network restricted to two dimensions, and clustering has no dimensional restrictions, but works with binary rather than continuous dimensions (Waltman et. al. 2010). VOSviewer creates author or publication maps based on co-citation information and generates keyword maps based on co-occurrence data (van Eck & Waltman, 2010). A co-occurrence network is the linkage of terms based on their relatedness (van Eck & Waltman, 2011).

Once the relatedness of the units of analysis is determined, the VOSviewer clustering technique places each topic into a single cluster, there is no overlap of clusters, and no unit of analysis lacks a cluster (van Eck & Waltman, 2017).

**Table 4.** Collection of Cited Articles Sorted by Number of Local Citations

Cited Publications	Local Citation*	Global Citation
Malhotra, A., Majchrzak, A., Rosen, B., Leading virtual teams (2007) <i>Academy of Management Perspectives</i> , 21 (1), pp. 160–170	10	691
Purvanova, R.K., Bono, J.E., Transformational leadership in context: Face-to-face and virtual teams (2009) <i>The Leadership Quarterly</i> , 20 (3), pp. 343–357	10	545
Zigurs, I., Leadership in virtual teams: Oxymoron or opportunity? (2003) <i>Organizational Dynamics</i> , 31 (4), pp. 339–351	10	704
Avolio, B.J., Sosik, J.J., Kahai, S.S., Baker, B., E-leadership: Re-examining transformations in leadership source and transmission (2014) <i>The Leadership Quarterly</i> , 25 (1), pp. 105–131	8	338
Hertel, G., Geister, S., Konradt, U., Managing virtual teams: A review of current empirical research (2005) <i>Human Resource Management Review</i> , 15 (1), pp. 69–95	8	1,397
Cascio, W.F., Shurygailo, S., E-leadership and virtual teams (2003) <i>Organizational Dynamics</i> , 31 (4), pp. 362–376	7	567
DeSanctis, G., Poole, M.S., Capturing the complexity in advanced technology use: Adaptive structuration theory (1994) <i>Organization Science</i> , 5 (2), pp. 121–147	7	4,946
Kayworth, T.R., Leidner, D.E., Leadership effectiveness in global virtual teams (2002) <i>Journal of Management Information Systems</i> , 18 (3), pp. 7–40	7	1,109
Kirkman, B.L., Mathieu, J.E., The dimensions and antecedents of team virtuality (2005) <i>Journal of Management</i> , 31 (5), pp. 700–718	6	663
Martins, L.L., Gilson, L.L., Maynard, M.T., Virtual teams: What do we know and where do we go from here? (2004) <i>Journal of Management</i> , 30 (6), pp. 805–835	6	1,715
Avolio, B.J., Kahai, S., Dodge, G.E., E-leadership: Implications for theory, research, and practice (2000) <i>Leadership Quarterly</i> , 11 (4), pp. 615–668	5	895
Balthazard, P.A., Waldman, D.A., Warren, J.E., Predictors of emergence of transformational leadership in virtual teams (2009) <i>Leadership Quarterly</i> , 20 (5), pp. 651–663	5	199
Daft, R.L., Lengel, R.H., Organizational information requirements, media richness and structural design (1986) <i>Management Science</i> , 32 (5), pp. 554–571	5	12,216
Gibson, C.B., Gibbs, J.L., Unpacking the concept of virtuality: The effects of geographic dispersion, electronic dependence, dynamic structure, and national diversity on team innovation (2006) <i>Administrative Science Quarterly</i> , 51, pp. 451–495	5	1,178
Maruping, L.M., Agarwal, R., Managing team interpersonal processes through technology: A task-technology fit perspective (2004) <i>Journal of Applied Psychology</i> , 89 (6), pp. 975–990	5	457
Orlikowski, W.J., The duality of technology: Rethinking the concept of technology in organizations (1992) <i>Organization Science</i> , 3 (3), pp. 398–427	5	6,271

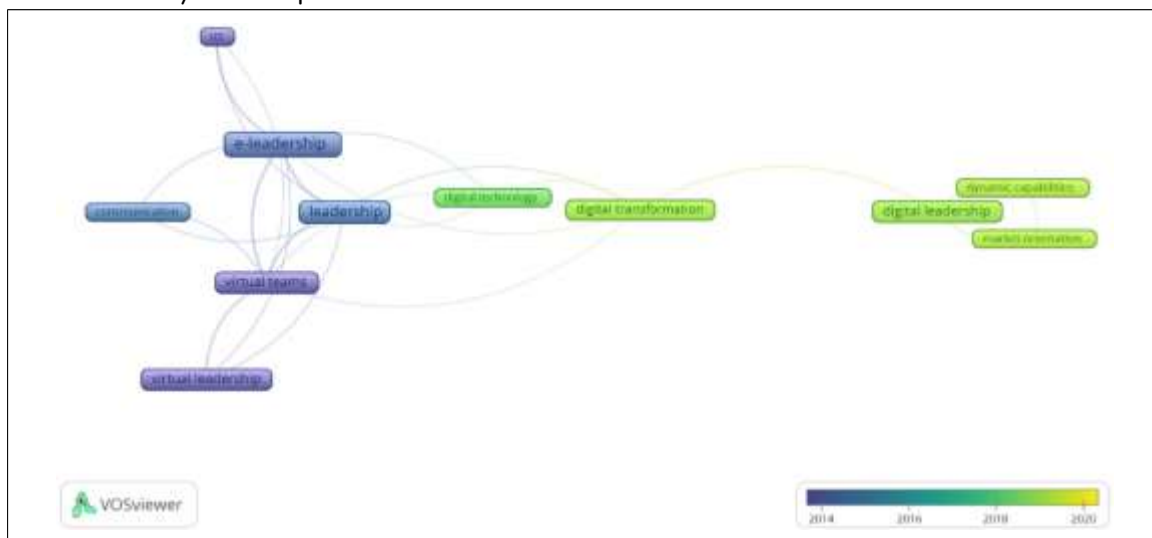
\*Local citations: citations in 79 publications of the dataset.

### Co-occurrence Analysis

Figure 2 shows the author keyword occurrence network to understand the evolution of keywords over the years based on the frequency of words used in the articles included in the



dataset. Thus, corresponding terms extracted from author keywords from Scopus and Web of Science datasets were used in this analysis (Soriano et al., 2018). The examination of co-occurrence networks with keywords incorporates an integrated approach to clustering and mapping bibliometric networks (Waltman et al., 2010). Recent studies have used this method as an effective method to graphically cluster literature data to explore trends (Prashar & Sunder, 2020). The VOSviewer software was used to mine Scopus and Web of Science datasets containing bibliographic information of unmodified articles. The keyword frequency threshold was set at 3 (Dai et al., 2020), which the authors found to cover the main keywords of most articles well. Density-based clustering using the full-count method and association-based normalization algorithm were used (Kriegel et al., 2011; Prashar & Sunder, 2020). The keywords that met the set threshold were then mapped, and cluster and co-occurrence network analysis was performed.



**Figure 2.** Author keyword co-occurrence network of the publication dataset.

From a chronological perspective, aimed at understanding the temporal distribution of keywords, e-leadership, virtual team, and virtual leadership were some of the most used keywords until 2016. The term "virtual", which focuses on the virtual aspect of leadership brought about by the Internet and new types of communication technologies, seems to be changing to "digital". Digital transformation and Digital Leadership are newer keywords, which reinforce the digital aspect of the market orientation of current publications. This finding is in line with the keyword analysis from Table 3.

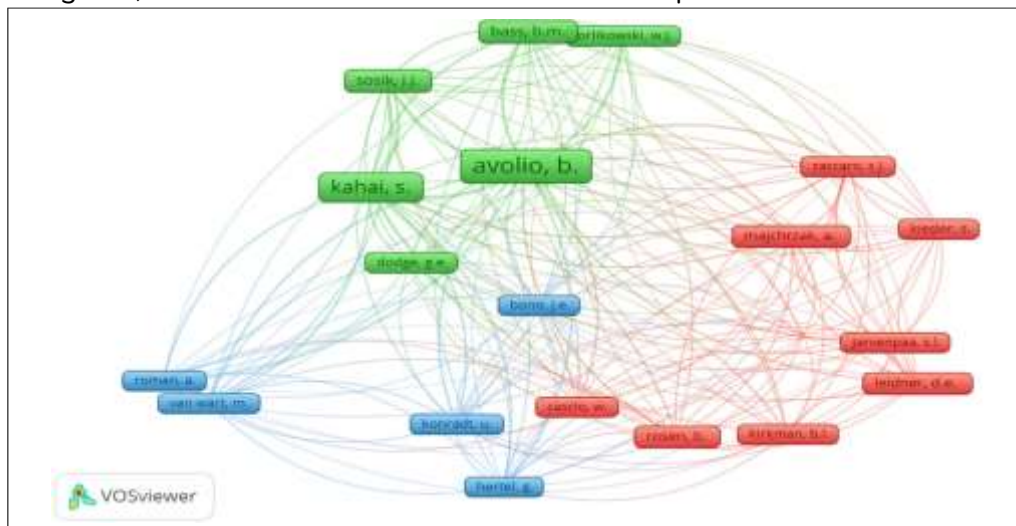
Regarding the cluster analysis, four clusters were created related to the keyword author. The first cluster has the terms "virtual team" and "virtual leadership", while the second cluster has the terms "e-leadership", "ICT", "communication" and "leadership". Digital aspects, such as "digital technology" and "digital transformation" appear in the third cluster, which highlights these terms together. Finally, the fourth cluster relates to market changes, containing the keywords "digital leadership", "dynamic capabilities" and "market orientation", indicating a new market demand for digital leadership and capabilities in a changing business scenario. Therefore, this study concludes that there is a trend in the use of these keywords. The keyword "ICT" (information and communication technology) appears alongside "e-

leadership" and "communication" studies, which reinforces the aspect that e-leadership is mediated by information technology. Nonetheless, the evolution of such keywords transitions from e-leadership and virtual aspects to digital terms (e.g., digital technology, digital transformation, digital leadership), which reinforces the market orientation due to the digitally-oriented era.

### Co-Citation Analysis

Figure 3 graphically shows the network of co-citation relationships for authors generated by VOSviewer, and Figure 4 shows the publication-co-citation relationships by VOSviewer as well. Nonetheless, clustering was run independently for each map. Citation analysis is about the relatedness between items and is determined by the number of times the items are co-cited. This analysis is a reliable measure of the impact of a field's publications in the scientific community through the identification of its core works (Batistič et al., 2017).

More co-cited publications are more likely to present similar subject areas and have strong citation relationships within each cluster, which form the basis of different subfields (Cobo et al., 2011a). Clustering techniques are used to identify groups of related publications, authors or journals (van Eck & Waltman, 2017). The VOSviewer mapping technique resulted in three clusters, each containing a group of articles with similar co-citation profiles. Therefore, each cluster is likely to share a common theme or knowledge base. Cluster sizes ranged from 5 publications in cluster 3 to 11 publications in cluster 1. Afterwards, the authors conducted content analysis to determine the research focus in each of the three clusters. Articles in each cluster were scrutinized to identify specific topics related to each cluster. Careful analysis of the articles in each cluster can illustrate the cluster's research focus area (Fahimnia et al., 2015). Figure 4 shows each cluster generated by VOSviewer. Cluster 1 is shown in red, cluster 2 in green, and cluster 3 in blue. Table 5 shows the publications in each cluster.



**Figure 3.** Visualization of author citation relationships

Both groups 1 and 2 seem to approach the virtuality component and aspects of trust in organizations (Jarvenpaa & Leidner, 1999; Thomas & Bostrom, 2010). It seems that the question of how to build and maintain trust is a concern in virtual teams and leadership effectiveness. The papers in cluster 1 address the characterization of virtual teams and the challenges related to their dynamics and functioning in organizations. Topics covered include

key aspects of virtual teams (Kirkman & Mathieu, 2005; Maznevski & Chudoba, 2000), different elements that push groups to higher levels in terms of team virtuality (Kirkman & Mathieu, 2005), and differences between virtual and face-to-face teams (Zaccaro & Bader, 2003). This cluster has two of the oldest publications among the three clusters, considering electronic mail as a tool to accelerate information exchange within teams (Sproull & Kiesler, 1986) and some aspects of information processing to reduce vagueness and uncertainty in inter-departmental relationships (Daft & Lengel, 1986). In addition, team virtuality (e.g., geographical dispersion, electronic dependency) can inhibit innovation through different mechanisms, but a psychologically safe environment can help overcome it (Gibson & Gibbs, 2006). Communication is important in the effective operation of virtual teams (Maznevski & Chudoba, 2000), and empathy for the team is also important.

Cluster 2 refers to the leadership aspect and its challenges in managing virtual teams. virtual teams. Avolio et al. (2000), a landmark paper on e-leadership, is present in this selection of this publication. In addition, transformational leadership is also approached by comparing face-to-face and virtual aspects (Balthazard et al., 2009; Purvanova & Bono, 2009). A practitioner's view has been created, providing practical guidance for virtual team leaders to establish a strong sense of team identity and minimize uncertainty and ambiguity (Brake, 2006). ambiguity (Brake, 2006). Virtual teams need guidance but leaders are often not adequately prepared to lead effectively, due to the specific challenges of virtual teams. lead effectively, as the specific challenges of remote leadership are not clear (Hertel et al., 2006). are not clear (Hertel et al., 2005).

Finally, cluster 3 approaches the interrelationship between technology and organization. Adaptive structuration theory (AST) is reported as a theoretical perspective on technology and change. AST can be an appropriate approach to study AIT (advanced information technology) in organizations, as it examines technological process change and how people interact with technology (DeSanctis & Poole, 1994). Nonetheless, different perspectives on technology in organizations may have limited this topic (Orlikowki, 1992). In this cluster, the notion of what constitutes e-leadership is expanded, and AIT is related to the shaping of organizational functions (Avolio et al., 2014).

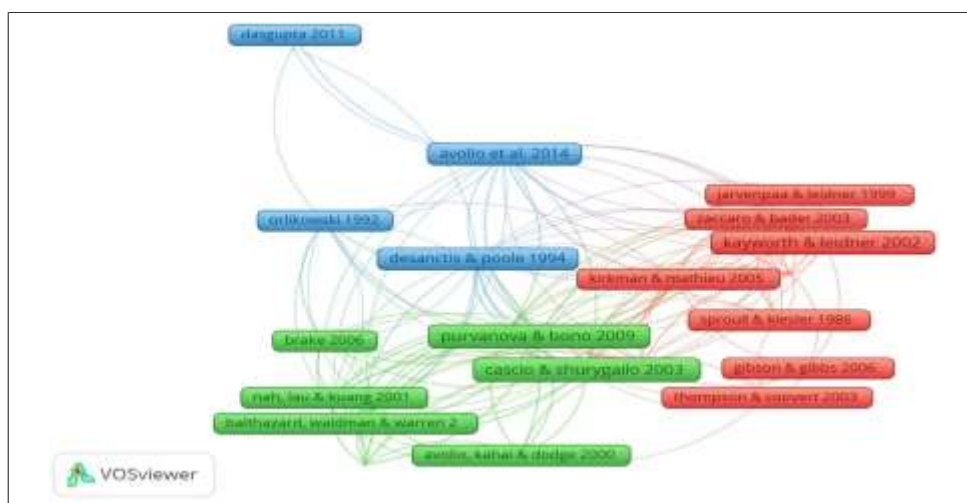


Figure 4. Visualization of publication-citation relationships.

**Table 5.** Publications from Each Cluster.

Cluster 1 (11 items)	Cluster 2 (9 items)	Cluster 3 (5 items)
Daft & Lengel (1986)	Avolio et al. (2000)	Avolio et al. (2014)
Gibson & Gibbs (2006)	Balthazard et al. (2009)	DasGupta (2011)
Jarvenpaa & Leidner (1999)	Brake (2006)	DeSanctis & Poole (1994)
Joshi et al. (2009)	Cascio & Shurygailo (2003)	Kerfoot (2010)
Kayworth & Leidner (2002)	Hertel, Geister, & Konradt (2005)	Orlikowki (1992)
Kirkman & Mathieu (2005)	Malhotra et al. (2007)	
Maznevski & Chudoba (2000)	Nah et al. (2001)	
Sproull & Kiesler (1986)	Purvanova & Bono (2009)	
Thompson & Coovert (2003)	Thomas & Bostrom (2010)	
Zaccaro & Bader (2003)		
Zigurs (2003)		

In summary, the analysis of co-citation relationships between authors and publications was run independently for each VOSviewer map. Citation analysis refers to the relatedness of items by the frequency with which they are co-cited. Each distinct cluster of authors and publications tends to present similar areas. Cluster 1 presents papers on virtual teams and challenges related to their dynamics and functioning in organizations; Cluster 2 focuses on leadership challenges for virtual teams; Cluster 3 discusses the interplay between technology and organizations.



**Figure 5.** Integrated elements for key Digital Leadership capabilities.

## RESULTS AND DISCUSSION

The findings suggest that a significant part of the field is shaped by empirical works that demonstrate the practical relevance of the domain. Such managerial work continues to grow and, along with theoretical studies, spurs additional research interest in the field. It seems that leadership effectiveness through virtuality was a major concern until digital technologies became more present in organizations and it was the emerging leadership capabilities that most impacted the effectiveness of virtual teams (Ziek & Smulowitz, 2014). More recently, the

focus seems to have moved to analyzing the impact of digital transformation in organizations (Peter et al., 2020). Content analysis of the dataset articles helped the authors to better understand the critical DL capabilities required to thrive in the digital scenario. This analysis was used to get the most out of the surveyed articles to frame the theoretical aspects of this study. While bibliometric analysis and network analysis reveal publication patterns and their evolution, content analysis is complementary to both (Takey & Carvalho, 2016). The research findings regarding DL content analysis are in line with Kane et. al. (2019), although many core leadership capabilities remain the same, the unique characteristics of digital transformation require new capabilities as well.

The basic capabilities typically associated with leadership (e.g., communication, direction-setting) remain valid, but are undergoing changes (Pulley et al., 2002). Communication seems to be a constant leadership concern over the years, as it is a continuous topic of discussion both early in the conceptualization of e-leadership (Purvanova & Bono, 2009) and now in the digital scenario (Darics, 2020). It is a fundamental aspect that appears in the list of most used keywords. Communication is a basic component of DL. It is a skill that provides team effectiveness (Ziek & Smulowitz, 2014), assisting leaders in influencing inter-team actions (Hambley et al., 2007). Transparency in the digital age seems to be an important aspect of DL. Transparency helps leaders to communicate clear progress and issues in achieving goals, allowing team members to feel the impact of their work on overall performance (Turesky et al. 2020). Leaders need to clearly indicate strategic goals to their teams so that they can experiment with new ways of doing things in a digital scenario (Kane et al., 2019). In addition, DLs need to keep their teams pointed in the same direction, both intellectually and emotionally. Teams need clear information about what they are working on together, and also care that the work is worthwhile (Amit et al., 2016). A clear vision in a digital environment is essential. DLs need to anticipate trends and solve complex problems that arise due to technology and lead teams in responding to those changes (Kane et al., 2019).

Trust is another important part of leadership and is particularly relevant in virtual environments. Building trust with team members is fundamental to effective DL (Campion & Campion, 2020). However, it is also a challenge for DLs. Trust is easier to build through face-to-face interactions than in a virtual environment, and it is a challenge for DLs to reinvent how to lead teams based on trust rather than control (Maduka et al., 2018). Leading remotely, leaders have little to no control over the group (Amit et al., 2016). Transparency also has a valuable impact on building trust for dispersed teams (Liao, 2017). In virtual teams, trust helps each member to communicate better with each other and encourages people to have initiative, and even take risks when performing their tasks (Liao, 2017). Moreover, recent literature shows that building trust is one of the most important predictors of virtual team performance (Turesky et al., 2020).

The relationships that digital leaders build with their teams are essential for a rapidly changing environment. Building relationships in DL helps avoid a sense of isolation from followers and supports leaders in dealing with diversity (Fernandez & Jawadi, 2015). DL is collaborative and supports collective action (Ziek & Smulowitz, 2014). Speed is mandatory in the digital scenario, so leaders must have the ability to lead networks of people rather than



leading through linear hierarchies. A network approach results in fast and collaborative leadership interactions with teams, facilitating decision-making processes, removing barriers, and helping groups increase agility and innovation in their work (Kane et al., 2019). Collaboration also helps teams overcome potential anxiety stemming from working in a virtual environment and increases their motivation (Liao, 2017). Nonetheless, an aspect of leadership that has remained important over the years is empowering followers, as DLs must enable their followers to pursue new initiatives (Kane et al., 2019).

Innovation and adaptability are topics that have come to the fore a lot lately, probably because nowadays, organizations need to change continuously and rapidly in order to thrive in the digital world. DLs must be change-oriented and, therefore, must be open-minded, adaptable, and innovative (Kane et al., 2019). DLs seem to have a key aspect in driving innovation across organizations as a competitive advantage (Doghri et al., 2020; El Sawy et al., 2016). Digital leaders must have an innovative mindset, which allows their followers to try new things, make mistakes, adjust, and scale up (Kane et al., 2019). Figure 5 shows the different abilities of DLs regarding the four elements of the content analysis. DLs seem to have interpersonal orientation (i.e., interacting successfully with others), personal attributes (i.e., managing themselves), strategic focus (i.e., helping the organization achieve future goals), and delivery-related aspects (i.e., capacity to achieve desired outcomes). The articles in the data set reveal new realities for leaders working in the digital age. However, none of them offer the new definitions needed to clearly understand key aspects of DL. The articles use many different definitions of the topic. One of the most widely adopted definitions by many authors for e-leadership is that of Avolio et al. (2000), which states that e-leadership is a process of social influence mediated by information technology to produce changes in the attitudes, feelings, thoughts, behaviors, and/or performance of individuals, groups, and/or organizations (Hambley et al. 2007; Jawadi et al. 2013; Jiang et al. 2017; Roman et al. 2019). Despite this, there has been little progress in the concept of e-leadership from 2000 to the present (Avolio et al., 2014; Liu et al., 2018). Therefore, more recent articles have started to distinguish e-leadership from DL, and use the concept of DL instead. Some of the definitions of DL that appear in the dataset are DL is doing the right thing for the strategic success of digitalization in organizations and their ecosystems (Sawy et al., 2016); the leadership perspective needed to successfully face challenges in the digital age (Jäckli & Meier, 2020); the human aspect of a leader operating with digital tools in a virtual world (Narbona, 2016); or is a combination of leadership capabilities and digital technology to support the decision-making process (Sasmoko et al., 2019). However, existing definitions of DL are vague about the main aspects of DL that are evolving today.

Although the relationship between e-leadership and DL is not clearly stated in the literature, perhaps the difference is that DL is not only mediated by technology but has evolved into a complex way of thinking and behaving over time. The co-occurrence network of the keyword author (Figure 2) provides a pattern of evolution of the most used keywords over the years. Keywords change focus on e-leadership, virtual teams, virtual leadership, and communication to a broader view of digital transformation and technology to address demanding aspects of market orientation and dynamic capabilities through DL approaches. This evidence reinforces the need for a new DL definition that addresses the key points for

DL in the current scenario. Therefore, the authors propose the following definition: Digital Leadership (DL) is an ethical and agile mindset that quickly responds to change and learns from it, fosters a trust-based culture that values people and their diversity, trains them to collaborate and thrive in the digital scenario.

Finally, many scholars rely on established leadership theories to explain the relationship between DL and digital scenarios (Boje & Rhodes, 2005; Cortellazzo et al., 2019). However, topics such as leading in digital ecosystems, leading in different organizational structures, collaboration to generate ideas and strategies for digital change, dealing with large amounts of data, and artificial intelligence are some of the topics that have not received much attention so far. Perhaps different leadership theories and leadership capabilities may emerge due to the organizational characteristics of digital disruption. Therefore, the potential for important contributions to the DL field may lie there. Finally, it seems that the digital scenario brings a new leadership paradigm, namely DL, which has unique challenges related to digital technology. As can be observed in the evolution of buzzwords over the years, DL must manage the dynamic capabilities of the company while keeping up with market orientation to thrive in a rapidly changing and complex digital environment.

## CONCLUSION

The results show that interest in the field of DL will continue to attract significantly more research, as the field has not yet entered its maturity stage (Ertz & Leblanc-Proulx, 2018; Soriano et al., 2018; Zeike et al., 2019), indicating the relevance and actuality of the theme. Additionally, the various journals in this research dataset show that DL has gained attention from several different fields, indicating the breadth of the field. Although the publications are dominated by the academics in the research team, the topic is of interest to both academics and practitioners. Perhaps this explains why empirical studies represent a large portion of the total publications in the dataset. The continued integration of market data into academic studies is likely to be beneficial to both practical and theoretical progress. Affiliation statistics, which is the international dimension of the field research studied (Cobo et al., 2011b), show that DL works were produced in 28 countries around the world. Most DL publications originate from the United States, followed by Europe, and Asian publications are not far behind. Citation analysis makes it possible to study the past influence of a domain (Cobo et al., 2011b). The authors chose citation analysis for its broader coverage, although it lacks consideration of recent publications. Older publications accumulate citations over the years, so they are preferred over more recent publications. As expected, the results show that the more influential works are older works. Nonetheless, in terms of author citations in the data set, the most cited authors were from the United States, indicating the strong influence of American authors in the DL field.

Although the most cited articles were about "virtual" and "e-leadership", speculating on the impact of technology on leadership and teams, the keyword analysis detected, in both the bibliometric analysis and the network analysis, that the term "digital" has become more relevant in addressing the types of challenges organizations face today. These findings reaffirm the idea stated by Belitski & Liversage (2019) and Cortellazzo et al. (2019) that the concept of e-leadership is changing from a form of electronically mediated communication to

a broader view of digital technology. Therefore, it becomes about how to lead effectively in a digital environment (Roman et al., 2019). Therefore, it seems that a new leadership paradigm is emerging from the digital disruption we face.

The emerging DL paradigm seems to have the leadership characteristics needed to thrive in a digital environment, such as communication, direction setting, transparency, trust, agility, collaboration, innovation, empowerment, and adaptability. In addition, DLs must manage the dynamic capabilities of the organization while pursuing market orientation to thrive in a rapidly changing business scenario.

This research contributes to the literature by presenting a comprehensive analysis of the up-and-coming DL field, examining the characteristics and relationships of the DL publication field from a defined timeframe. While some aspects of leadership seem to have changed due to digital transformation, not all. The authors agree with Kane et al. (2019) that DLs must have a combination of identified leadership skills with insights from the past, with an agile mindset to meet the needs of a rapidly changing environment. This study provides a broad and holistic perspective on the domain that has never been offered before. In addition, this study also differentiates between a literature review and a meta-analysis, as this study is very broad and evaluates the relationship between publications in the area.

Although this research review is timely and includes recent publications, it is not without limitations. Despite the rigorous systematic review procedure, the authors only considered peer-reviewed articles as these works constitute a certified body of knowledge and mostly show reliable results (Bhatt et al., 2020; Haleem et al., 2020). Nevertheless, future reviews could include conference proceedings and other non-peer reviewed manuscripts to expand the boundaries and analyze the broad and current nuances of the DL phenomenon. Another limitation is the sample size (79 articles). Although the authors used two databases for broader coverage, and many similar studies in other fields have used only one database for this type of analysis (Fahimnia et al., 2015; Galvagno & Giaccone, 2019), the authors may have missed some relevant articles.

The avenues for future research are numerous. Furthermore, the literature review may consider the expansion of keywords in different searches on digital phenomena. The bibliometric study on this research shows that digital transformation affects leaders and organizations in different ways and, therefore, future research will likely consider different topics and approaches. The DL field will probably focus more on digital technologies (e.g., artificial intelligence, machine learning, internet of things) as the main backbone so that new leadership characteristics may emerge as this topic matures in organizations and academic literature. With the rise of AI-based organizational processes and leaders interacting simultaneously with humans and robots, a case study based on a technology company could analyze the impact of AI on the capabilities needed by leaders in the context of human and non-human interaction as a collaborative unit. In addition, other future studies could focus on ethics and eliminating bias. Datasets used in machine learning systems need to ensure diverse representation to avoid reinforcing bias and consider inclusion (e.g., Bolukbasi et al., (2016) as an example of gender bias in machine learning datasets). Future research could use a mixed methods approach to offer a holistic view of this phenomenon (Venkatesh et al., 2013). These findings may have implications for HR practices regarding training and hiring

policies, as there is more human interaction with machines. Therefore, leaders need to focus attention on it. As leadership is related to context, another potential study is on the metaverse ecosystem and its impact on leaders working in this environment. In a recent study, Dozio et al. (2022) discussed design elements in virtual environments to elicit different emotions in humans. For example, the interaction between leaders and followers can occur with a avatar person in the metaverse. How might this background affect the construction of trust and relationships between them? Perhaps grounded theory can provide a methodological way to explain the manifestations of contextualized social interactions (Kempster & Parry, 2011). Furthermore, exploratory and confirmatory studies can be used for this new study scenario. In addition, future research could examine the development of the clusters identified in this paper for cross-validation and development purposes. It will be interesting to see if some clusters disappear while others emerge or if they will split into smaller but more focused sub-fields of research. For example, the new digital technology cluster may break up cluster 3. Finally, bibliographic analysis could be used in future work to study recent publications. Bibliographic coupling uses the number of references shared by two documents to calculate their similarity. The more references two comparison articles have, the stronger their relationship (Zupic & Čater, 2015). This type of research can increase the visibility of newer publications in the field.

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