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Review article

Scientometric analysis in e-leadership and competencies for its development

Análisis cientométrico en e-liderazgo y competencias para su desarrollo

Ronny Omar Molina-Morán[1], Santiago Castañeda-Betancur[2], Gustavo Ardila-Niño[3] y Freddy Villao-Santos[4]

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ABSTRACT

The aftermath of the COVID-19 pandemic has witnessed an exponential surge in the literature on e-leadership, establishing it as a prominent research topic in both industrial and academic organizations. However, the existing literature remains disparate, with a conspicuous absence of studies that connect cohesively the principal contributions with the current subareas. This investigation's primary objective is to delineate the evolution of e-leadership and its connection with competencies and provide an overarching view from a scientometric standpoint. The methodology employed is divided into two sections: the initial section elucidates the annual scientific production, country-specific contributions, journal publications, and author collaboration analysis. Subsequently, researchers deploy the Tree of Science algorithm to discern the roots, trunk, and branches of e-leadership; findings reveal a remarkable growth trajectory since 2020, with three primary subareas emerging: e-leadership in the educational context, virtual teams competencies, and innovation leadership. The implications of this study are instrumental for managers, aiding them in identifying the pivotal skills requisite in this burgeoning digital era.

Keywords: E-leadership; Competencies; Scientometric analysis; Evolution of leadership; Digital leadership.

RESUMEN

La secuela de la pandemia de COVID-19 ha presenciado un aumento exponencial en la literatura sobre el e-liderazgo, estableciéndolo como un tema de investigación destacado tanto en organizaciones industriales como académicas. Sin embargo, la literatura existente permanece dispersa, con una ausencia notoria de estudios que conecten de manera cohesiva las principales contribuciones con las subáreas actuales. El objetivo principal de esta investigación es delinear la evolución del e-liderazgo y su conexión con las competencias, y proporcionar una visión general desde una perspectiva cienciométrica. La metodología empleada se bifurca en dos secciones: la sección inicial aclara la producción científica anual, las contribuciones específicas por país, las publicaciones en revistas y el análisis de colaboración entre autores. Posteriormente, desplegamos el algoritmo Árbol de la Ciencia para discernir las raíces, el tronco y las ramas del e-liderazgo. Los hallazgos revelan una notable trayectoria de crecimiento desde 2020, con tres subáreas principales emergentes: e-liderazgo en el contexto educativo, competencias de equipos virtuales e innovación en liderazgo. Las implicaciones de este estudio son fundamentales para los gerentes, ayudándoles a identificar las habilidades cruciales requeridas en esta floreciente era digital.

Palabras clave: e-leadership; competencias, análisis cienciométrico; evolución del liderazgo; liderazgo digital.
JEL: M1; M120; M140.

[1] Mag. Universidad de Guayaquil, Ecuador. ***Email:*** ronny.molinam@ug.edu.ec **ORCID:** https://orcid.org/0000-0002-1146-1545
[2] Mag. Universidad Nacional, Colombia. ***Email:*** scastanedab@unal.edu.co **ORCID:** https://orcid.org/0000-0003-3842-9411
[3] Mag. Universidad Francisco de Paula Santander, Colombia. ***Email:*** gustavoan@ufps.edu.co **ORCID:** https://orcid.org/0000-0002-4294-3088
[4] Mag. Universidad Península de Santa Elena, Ecuador. ***Email:*** fvillao@upse.edu.ec **ORCID:** https://orcid.org/0000-0002-9114-9606

INTRODUCTION

E-leadership, or electronic leadership, is a modern leadership style needed in today's digital era. It involves acquiring new leadership skills to effectively manage teams across different locations using digital communication platforms like video conferencing and email. One of the main challenges for e-leaders is building strong team relationships despite physical distance; they must also maintain team cohesion in a virtual environment, requiring unique skills and strategies. E-leadership goes beyond managing people; it involves making strategic decisions about adopting new technologies to ensure smooth organizational operations in the digital world. Ultimately, e-leadership leverages digital tools to guide teams and drive success in today's global economy.

Given the burgeoning significance of e-leadership, particularly in the wake of the pandemic, the academic literature on this topic remains relatively nascent and dispersed. Consequently, the primary objective of this study is to consolidate the seminal contributions in this field and provide a comprehensive scientometric overview of e-leadership together with the competencies required to carry this out. Recent literature reviews have predominantly employed qualitative methodologies to elucidate key contributions within specific facets of e-leadership. For instance, Yuting et al. (2022) conducted a review utilizing the PRISMA method to explore e-leadership's impact on student learning. Similarly, Chamakiotis et al.(2021) employed a semi-systematic literature review to delineate the challenges in leading virtual teams. Contreras et al.(2020) identified the novel skills managers require in the post-pandemic era. However, to our knowledge, this study represents the first attempt to provide a holistic overview of e-leadership from a quantitative perspective, utilizing scientometric analysis. This approach enables a more comprehensive understanding of the field's evolution and current state, thereby contributing to the ongoing discourse on e-leadership in the digital age.

The study comprises two main sections. Firstly, it presents a thorough scientometric overview, covering annual scientific production, country-specific contributions, journal publications, and author collaborations in e-leadership. The second section outlines the Tree of Science (ToS) methodology regarding e-leadership and competencies, which tracks the research topic's evolution. Researchers gathered data for these analyses from prominent databases Scopus and Web of Science (WoS), merging it using R packages to create a refined dataset suitable for detailed scientometric analysis. Notably, this study stands out for its innovative methodology, incorporating novel approaches to citation and collaboration networks (Hurtado-Marín et al., 2021) and offering a fresh perspective to the existing literature on e-leadership and competency development.

METHODOLOGY

Scientometric analysis has been performed traditionally using one of the two largest databases (Web of Science or Scopus); however, recent studies suggest merging both databases to have a wider and deeper understanding of a research topic (Aguirre & Paredes Cuervo, 2023; Grisales et al., 2023). This study searches both databases using the parameters in Table 1. The results in WoS were 190 and in Scopus 462, and when researchers merged the datasets using Bibliometrix and tosr, the final dataset contained 511 documents; among these, 141 (27.59 %) were in WoS but not in Scopus.

Table 1. Parameters used in the search

PARAMETERS	WEB OF SCIENCE	SCOPUS
Range	2000-2023	
Date	May 9, 2023	
Document types	Papers, books, chapters, and conference proceedings.	
Search field	Title, abstract, and keywords	
Words	(“e-leader*” OR “virtual leader*” OR “electronic leader*” OR “digital leader*” OR “online leader*” OR “remote leader*” OR “leadership in virtual teams” OR “technology leader*”) AND (“skill* OR “competen*” OR “abilit*”)	
Results	190	462
Total (Wos+Scopus)	511	

Source: Own elaboration based on data from the WoS and Scopus.

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Scientometric Mapping

This study split the scientometric mapping into scientific production, country, journal, and author analysis; annual scientific production permits understanding the valleys and peaks within the research topic and the most relevant documents in a specific year. Other analyses are divided into two sections: a table with the most productive items (country, journals, and authors), followed by a citation network of each of them.

Tree of Science

The TOS methodology uses the SAP algorithm as a scientometric analysis technique; the Tree of Science algorithm is a technological tool created to recommend relevant and pertinent literature on an academic topic based on scientometric analysis of citation networks (Robledo et al., 2022; Zuluaga et al., 2022). ToS makes a citation network and applies the SAP algorithm to locate papers in roots, trunk, and branches, and was created as part of a doctoral thesis and the starting point of a start-up corporation called Core of Science (Eggers et al., 2022). ToS has been applied in fields such as entrepreneurship (Zuluaga Arango et al., 2023), water management (Hoyos et al., 2023), and marketing (Barrera et al., 2023), and has gained a place in scientometrics techniques. Researchers identified the branches of the ToS through citation analysis using the algorithm; consequently, the contributions within the trunk reveal the maturation and practical application of e-leadership within organizational contexts proposed by Lancichinetti & Fortunato (2009).

RESULTS

Scientometric Analysis

Scientific Production

Figure 1 illustrates the temporal evolution of scientific production from 2000 to 2022 regarding the Scopus and WOS databases. 2023 is excluded from the analysis because, as of the search equation's date, only a non-representative number of months is considered, thereby distorting the figures of scientific progress.

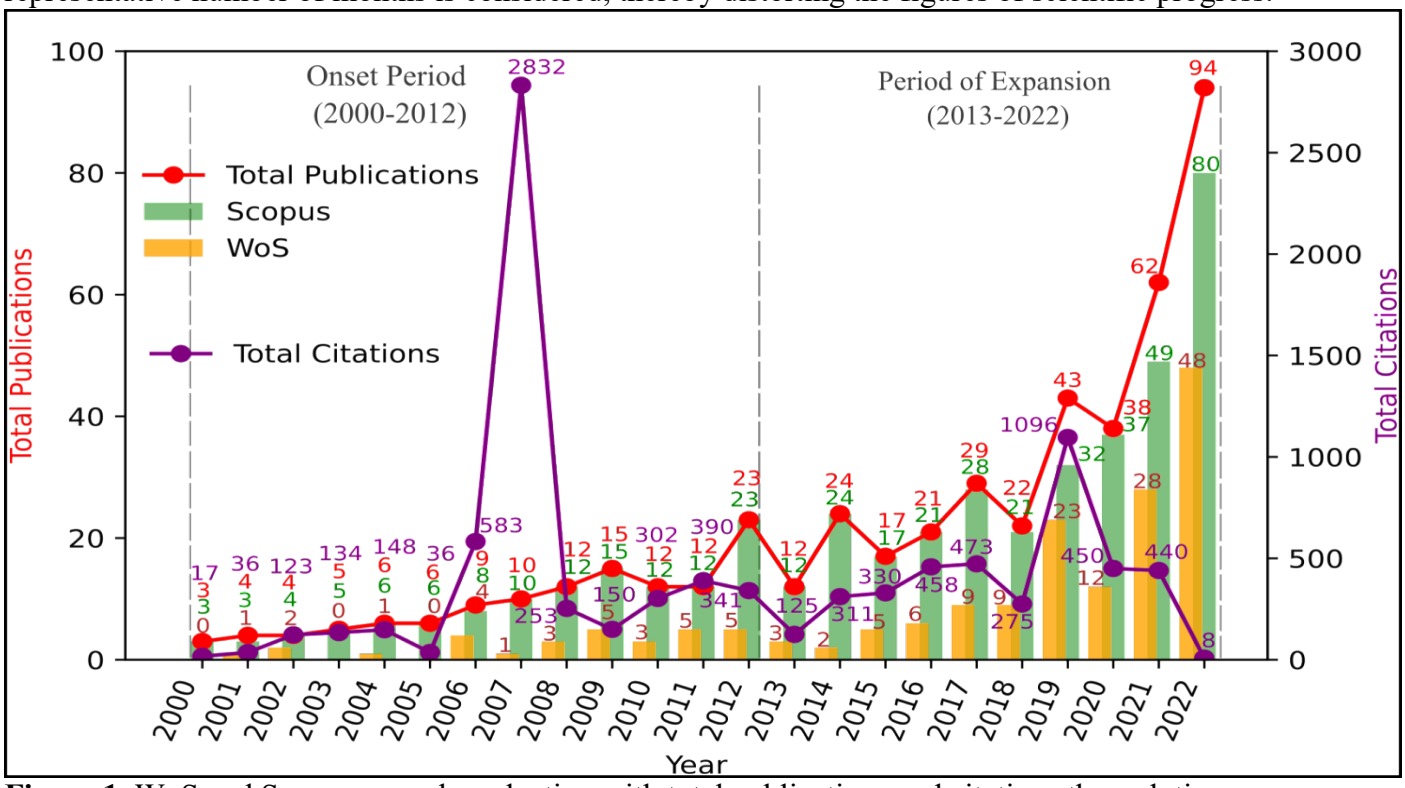

Figure 1. WoS and Scopus annual production with total publications and citations through time.
Source: Own elaboration based on data from the WoS and Scopus.

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The study encompasses two phases, namely an initial phase (2000-2011)
during which three to twelve articles appeared in both sources, representing a growth of 13.43 % with 98 articles. Notably, the total number of articles in this phase is equivalent to the figure in Scopus, indicating that the articles published in Scopus encompass those published in WOS. Regarding citations, two peaks appear; the first in 2006 with 583 citations and the second in 2007 with 2 832 citations. The most cited article is by Colquitt et al. (2007), which addresses the significance of trust and focuses on identifying the relationship between trust variables, risk-taking, and job performance. The authors conclude that trust dimensions are directly associated with commitment.

The study transitions to a growth phase (2012-2022)
This period sees a significant acceleration, evident in a 15.12 % increase with 385 articles. It is worth noting a significant change in scientific production occurred in 2020, possibly influenced by the COVID-19 pandemic in the same year, which forced organizations to choose the virtual work modality as a security measure to guarantee the quality of work life; this is a well-known but complementary virtual scenario, and it became the main and only work environment for human interaction within and between organizations during the pandemic's critical phase. For instance, one of the sectors most impacted by digital transformation was education, where researchers emphasized that digital leadership was needed to foster a learning culture (Karakose et al., 2021). Such leadership should aim at strengthening those competencies inherent to virtual interaction.

Country Analysis
The following Table 2 presents three variables: the first one is scientific production, which refers to the number of written documents; the second variable is the impact in terms of citations; and finally, production quality measured in quartiles, ranging from Q1 as the highest to Q4 as the lowest, considering the top 10 countries.

Tabla 2. Top 10 most productive countries

Country	Production		Citation		Q1	Q2	Q3	Q4
USA	156	31.77 %	1 633	33.11 %	36	27	10	4
China	28	5.7 %	398	8.07 %	11	6	0	2
United Kingdom	28	5.7 %	329	6.67 %	11	4	1	1
Germany	27	5.5 %	69	1.4 %	5	2	3	0
Malaysia	27	5.5 %	208	4.22 %	6	4	4	2
Turkey	19	3.87 %	99	2.01 %	2	3	6	1
Spain	15	3.05 %	59	1.2 %	2	1	1	5
Indonesia	14	2.85 %	27	0.55 %	1	4	2	0
Australia	13	2.65 %	195	3.95 %	5	3	0	0
India	13	2.65 %	22	0.45 %	0	3	3	2

Source: Own elaboration based on data from the WoS and Scopus.

Researchers observed that the USA has the highest scientific production, accounting for 31 %. Similarly, it holds 31 % of the total citations and has the highest number of articles in Q1, indicating superior quality. The most cited article from this country is Carte et al.(2006), which addresses the concept of leadership in virtual teams; it details that high-performing virtual teams possess developed leadership competencies. Notably, Australia exhibits an interesting pattern with a production of thirteen documents and 3.95 % of citations. The most cited article from Australia is Barnett & Kendall (2011), which investigates the application of

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technological tools in promoting health through the Stanford Chronic Disease Self-Management Program (CDSM) among three Aboriginal (Murri) communities in Queensland (rural, regional, and urban areas). This study highlights community participation and leadership. For a more detailed analysis of the relationships among different countries, Figure 2 presents a cocitation network illustrating how research is concentrated and distributed.

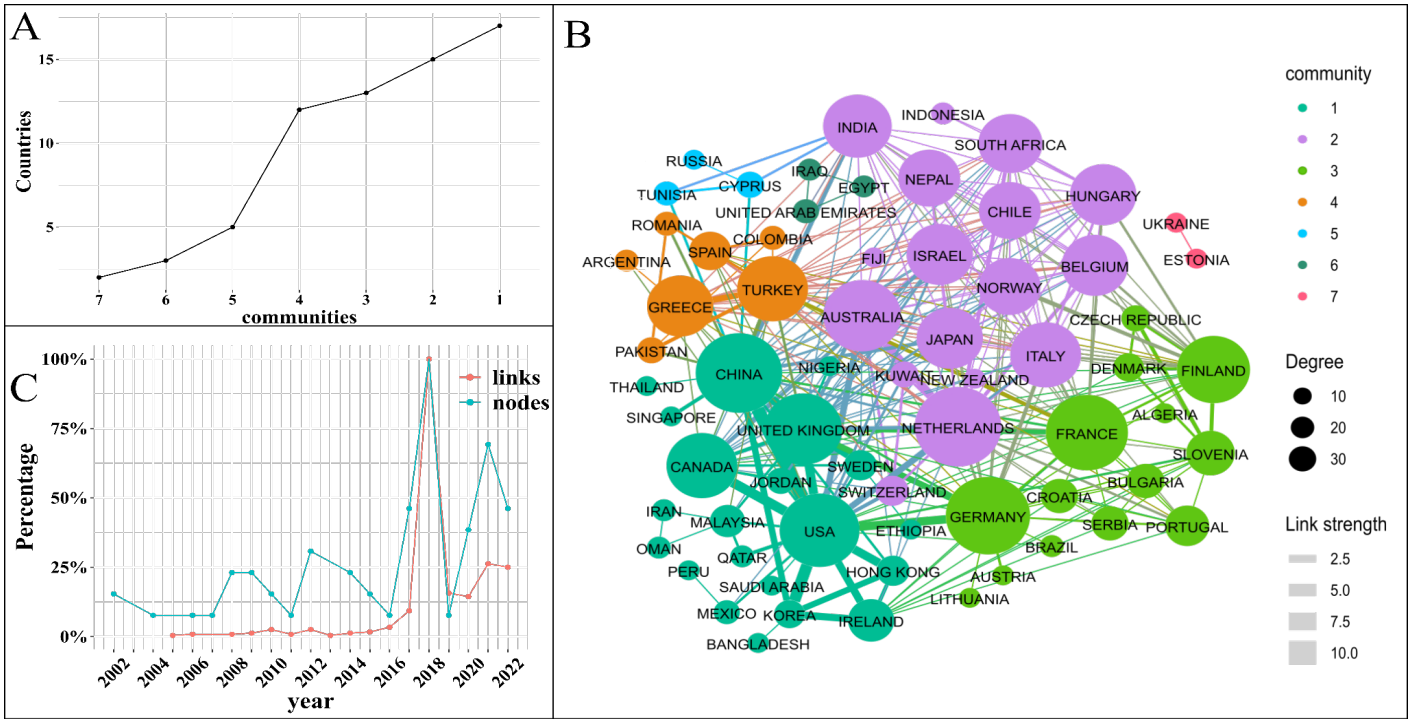

Figure 2. Network of Country Collaborations. 2A. Total Number of Communities by Size 2B. Nodes and Links Over Time. 2C. Scientific Collaboration Network of Countries.`1
Source: Own elaboration based on data from the WoS, Scopus, and Scimago Journal Rank.

Various collaboration networks are evident, such as the one between the USA, the UK, China, Canada, and Ireland. Germany primarily maintains relationships with European countries, with exceptions like Brazil and Algeria, and among these European countries are Croatia, Serbia, Austria, Portugal, Bulgaria, and France. Notably, France has established a connection with a new intercontinental network led by the Netherlands, linking with Australia, Japan, Chile, South Africa, and other European countries like Italy, Belgium, and Hungary.

In Figure 2, the top left section illustrates the number of countries in each community. Node 1 represents the community with the most countries, approximately 20 collaborating nations, followed by community 2 with 15, and community 3 with 12 countries. The bottom section of the figure indicates the consolidation of communities in 2017, contrasting with previous periods where country connections were more dispersed.

Journal Analysis

Table 3 lists academic journals with the highest productivity in e-leadership. Due to the pandemic, this topic has experienced a surge in scientific literature in recent years, reflected in the quartiles of the journals, as they have gradually gained prominence. For instance, Table 3 includes two journals in Q1: Education and Information Technologies and Leadership and Organization Development Journal (LODJ). The former focuses on issues at the intersection of education and technology, while the latter explores leadership and its impact on organizational development. For example, LODJ recently published a study highlighting the importance of hiring technology experts for organizations to undergo digital transformation, emphasizing the role of new competencies that leaders must acquire.

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Table 3. Most productive journal in e-leadership.

Journal	Wos	Scopus	Impact Factor	H Index	Quantile
Asee Annual Conference And Exposition, Conference Proceedings	0	13	0	39	-
Frontiers In Psychology	6	8	0.89	157	Q2
Lecture Notes In Networks And Systems	0	6	0.15	27	Q4
Proceedings Of The Annual Hawaii International Conference On System Sciences	0	5	0	95	-
Sustainability (Switzerland)	0	5	-	-	-
Acm International Conference Proceeding Series	0	4	0.21	137	-
Education And Information Technologies	3	3	1.25	61	Q1
Leadership And Organization Development Journal	0	4	1,01	78	Q1
Online Collaboration And Communication In Contemporary Organizations	0	4	-	-	-
Proceedings - Frontiers In Education Conference, Fie	0	4	0.22	45	-

Source: Own elaboration based on data from the WoS, Scopus, and Scimago Journal Rank.

Researchers constructed a citation network from 741 nodes and 926 links to identify the main themes and applied a filter to the three largest clusters (Figure 3).

The themes are varied in the clusters, first, because they are the new trends in e-leadership, published in journals in quartiles 1 and 2 of the Scopus database.

The first cluster is associated with leadership in the healthcare context, the second cluster is related to leadership in educational settings, and the third cluster focuses on virtual teams, technology, and competencies to respond to the demands of the digital era.

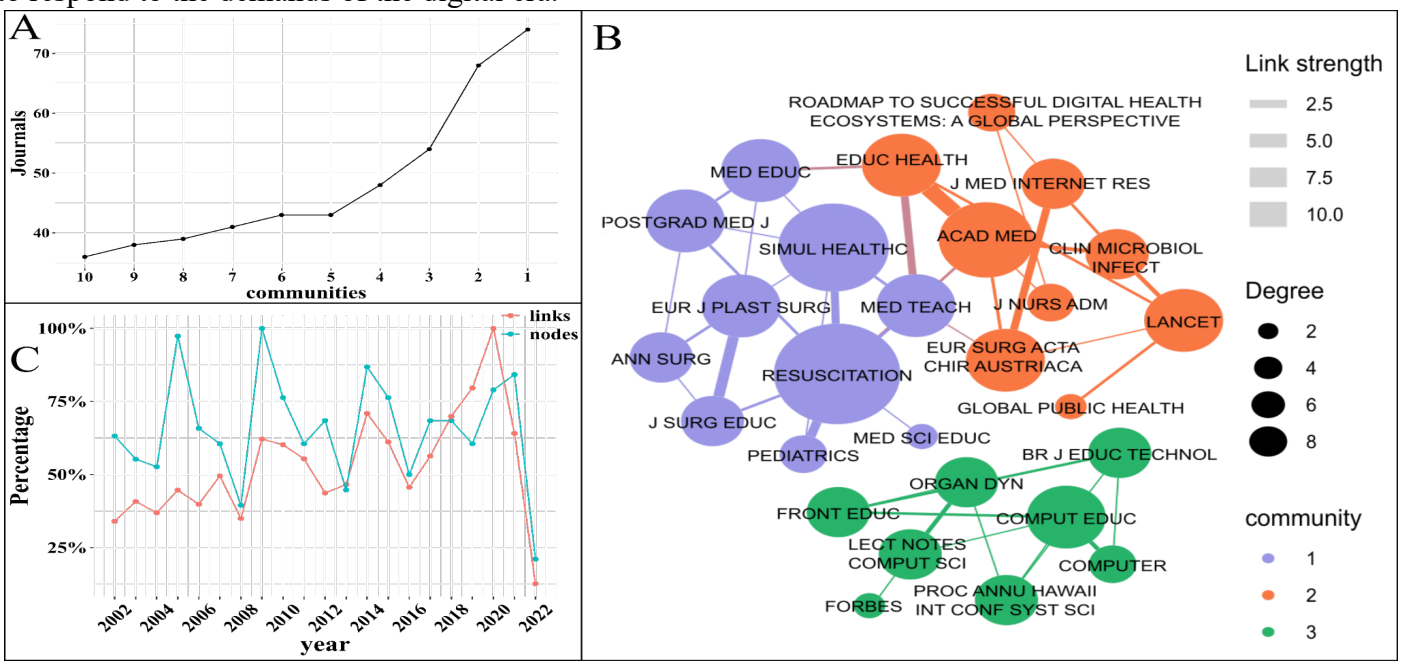

Figure 3. Citation network of journals about e-leadership.3A. Total Number of Communities by Size. 3B. Nodes and Connections Over Time. 3C. Scientific Collaboration Network among Journals.

Source: Own elaboration based on data from the WoS and Scopus.

Author Collaboration Network

Table 4 emphasizes the most prominent researchers in e-leadership and competencies, accounting for their academic output and the various collaborative networks in knowledge construction; their affiliation is distributed worldwide, but there is a concentration of researchers in the USA and Greece.

Table 4. Production by author

No	Researcher	Total Articles*	Scopus H-Index	Affiliation
1	Van W M	6	16	California State University, San Bernardino, San Bernardino, United States
2	Abbu H	5	5	Bell & Howell, Howell, United States
3	Gudergan G	5	8	
4	Liu C	5	10	Kdi, Sejong, South Korea
5	Mugge P	5	5	
6	Wang X	5	21	City University Of Hong Kong, Kowloon, Hong Kong
7	Antonopoulou H	4	8	University Of Patras, Rio, Greece
8	Barlou O	4	4	University Of Patras, Rio, Greece
9	Beligiannis G	4	16	University Of Patras, Rio, Greece
10	Halkiopoulos C	4	5	University Of Patras, Rio, Greece

Source: Own elaboration based on data from the WoS, Scopus, and Scimago Journal Rank.

Figure 4 evidences three distinct research communities, where Van stands out as the most prolific author, focusing on leadership in public organizations and integrating Information technology and communications (ICT) into leadership theory. Meanwhile, Wang, the most cited author, explores technology, culture, and digital competencies in e-leadership. Their seminal work (Van et al., 2019) highlights the digital revolution's impact on social interactions, particularly between leaders and employees. It emphasizes the need to develop digital competencies mediated by ICT to tackle new challenges effectively. Subsequently, the authors' contributions and engagement within this topic's research community are further analyzed.

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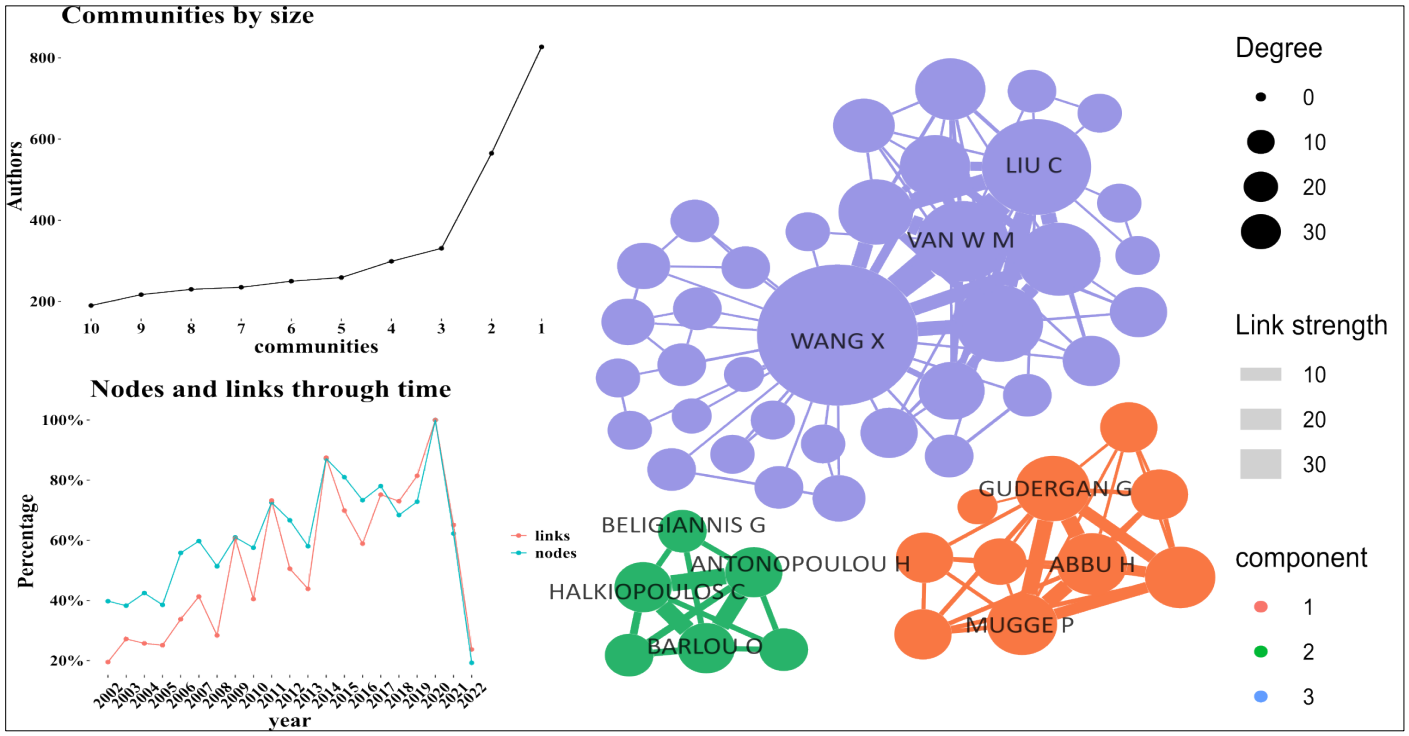

Figure 4. Ego-network of the top 10 researchers in e-leadership. 4a. Total Number of Communities by Size. 4b. Nodes and Connections Over Time. 4c. Scientific Collaboration Network by Authors.
Source: Own elaboration based on data from the WoS and Scopus.

Tree of Science

Roots

The first article in the "roots" contributed to the concept of e-leadership based on the theory of adaptive structure, which underpins the link between ICT and individuals working face-to-face and online. (Avolio et al., 2000) Furthermore, Avolio & Kahai (2003) mention that the reexamination of traditional leadership concepts focuses on hierarchical organizational structures to enhance leader-follower relationships in the context and with the support of ICT. Subsequently, Malhotra et al.(2007a) identify six leadership practices for virtual teams: 1) trust in the use of ICT, 2) understanding and appreciation of cultural diversity, 3) organization of virtual activities, 4) monitoring team improvement through the use of ICT, 5) visibility of off and on-team actors within the organization, and 6) benefits for team members.
Dasgupta (2011) conducted a literature review, affirming that the concept of e-leadership has evolved from the traditional leadership concept without changing its objectives. Despite this, e-leadership has brought forth a series of opportunities, such as instant communication with various stakeholders, allowing hiring qualified personnel from anywhere in the world, cost reduction, and improved knowledge management.
Consequently, it fosters the development of competencies that positively impact competitive advantages. In the case of (Avolio et al., 2014a), they construct the concept of e-leadership as an element influenced by advanced information technologies such as the internet, email, videoconferencing, and virtual teams; they assert that understanding these technologies enables leadership to be propelled to the next level.

Cortellazzo et al.(2019) emphasize that leaders are key agents in developing digital culture, acting as facilitators to align multiple stakeholders and foster collaborative processes; their analysis splits into two sections: a macro analysis encompassing e-leadership and organization and a microanalysis focusing on practices for leading virtual teams and the competencies of digital leaders.

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Lastly, Zeike et al.(2019a) elaborate that challenges posed by digital transformation must be addressed through digital leadership, where factors such as age, gender, and experience do not influence the quality of leadership; on the contrary, organizations should develop complementary skills to digital leadership to optimize its effectiveness, which, in turn, is associated with improved well-being of leaders in their management processes.

Malhotra et al.(2007b) explore the challenges and best practices for leading virtual teams in an increasingly globalized business environment; they identify critical skills, such as effective communication and trust-building, and propose strategies to overcome geographical and cultural barriers that may hinder the success of virtual teams.
Avolio et al.(2014b) review the role of technology in the evolution of leadership and how leaders can adapt to an increasingly digital business environment; they propose a framework for "e-leadership" that includes skills such as information management and virtual collaboration and discuss the implications for developing leadership in the future.

Cortellazzo et al.(2019) examine the existing literature on the role of leadership in a digitized world and highlight the importance of adapting to technological changes; they identify essential skills that leaders need to succeed in an increasingly digital business environment, such as the ability to innovate and collaborate virtually.
Zeike et al.(2019a) examine the relationship between digital leadership skills and the psychological well-being of leaders; they find that digital skills, such as information management and virtual collaboration, are positively associated with psychological well-being, suggesting that leaders who adapt to an increasingly digital business environment may experience personal and professional benefits.

Trunk

Despite the initial definition of e-leadership in the preceding section (roots), the progression during this period was relatively modest. Consequently, Liu et al.(2018) proposed a model, segmented it into four quadrants, and subjected it to structural equation modeling to foster research within the domain. Concurrently, Cortellazzo et al.(2019) conducted a literature review to discern macro and micro categories, underscoring the significance of e-leadership in cultivating relationships with various stakeholders inside an organization. Moreover, Roman et al.(2019) proposed a model for enhancing the competitiveness of e-leadership within virtual communications. Thus, the seminal contributions within the trunk primarily concentrate on fortifying the underpinnings of e-leadership by proposing innovative models to facilitate comprehension and advancement within this research area.

As the proposed models began to gain traction within the academic literature, the subsequent phase involved identifying variables that could enhance e-leadership. For instance, Zeike et al.(2019b) empirically demonstrated that well-being positively influences e-leadership competencies. Concurrently, Raman & Thannimalai(2019) underscored the necessity of expediting the integration of digital technologies within educational institutions to cultivate a learning culture. Liu et al.(2020) pinpointed the significance of culture regarding innovation and e-leadership; they conducted a cross-country analysis and posited that a robust conceptualization of e-leadership should incorporate cultural variables. Given the well-defined and established concept of e-leadership, Torre & Sarti(2020) sought to ascertain whether organizations with e-leaders knew of the various implications of this novel leadership paradigm. The findings underscored a shift towards soft competencies and the necessity to categorize the diverse types of e-leadership within organizations.

Branch 1: e-leadership in the educational context

Starting with Frazier & Tolbert (2023), their study delves into the pandemic's impact on various educational

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facets, including remote learning, educational equity, and students' emotional well-being. Strategies and policies implemented to tackle these challenges are discussed, underlining the importance of addressing the pandemic's adverse effects on teaching and providing robust support to students and teachers for effective and equitable learning during such trying times.

Next, Awang et al.(2022) explore the influence of virtual educational leadership on teacher engagement in Malaysia; they investigate how virtual educational leadership can bolster teacher motivation and engagement, ultimately enhancing educational quality. Key findings highlight factors like effective communication, emotional support, and constructive feedback, stressing the pivotal role of educational leadership in fostering teacher engagement, motivation, and quality.

Subsequently, Zhang et al.(2022) investigate the correlation between technology leadership and participation in technology-enhanced teaching and learning activities through a quantitative survey design involving teachers and students from two Chinese universities; they identified significant connections between technology leadership practices and engagement in technology-enhanced teaching and learning. The article underscores the benefits of technology leadership in higher learning, offering valuable insights for policymakers and leaders navigating the digital landscape.

Aktaş & Karaca (2022) explore the link between technological leadership self-efficacy among Turkish high school administrators and their attitudes and competencies concerning technology use in education. They analyze how technological leadership self-efficacy influences administrators' attitudes and competencies toward technology integration, emphasizing factors like technology experience and leadership abilities. The article underscores the pivotal role of effective technological leadership in shaping administrators' attitudes and competencies toward technology use in learning, highlighting its significance for educational advancement.

The study conducted by İbili & Özbaş(2022) examines how environmental factors influence the technological leadership competencies of school administrators; they identify key factors, such as institutional support, resource availability, and professional training, and their study underscores the significance of the institutional environment in enhancing technological leadership competencies and facilitating the effective utilization of technology in education.

A'mar & Eleyan (2022) investigated how the technological leadership of school principals impacts the integration of technology by teachers; they identify crucial factors, including professional development and access to technological resources, and their study highlights the importance of effective technological leadership in enhancing successful technology integration by teachers and, consequently, improving educational quality.

Omar & Ismail (2020) studied the relationship between principals' technological leadership and teachers' self-efficacy using ICT in education by employing two measurement instruments and 376 teachers in Malaysia as participants. The study adopted a quantitative approach, and the results revealed a moderate relationship between technological leadership and teachers' self-efficacy; technological leadership had a 24 % influence on teachers' self-efficacy, particularly in the aspects of excellence in professional practice and digital citizenship. In summary, principals can foster teachers' self-efficacy by intelligently promoting the use of ICT; they should serve as role models for teachers and students, ensuring that the pedagogical approach in the classroom is implemented through an ICT focus.

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Branch 2: Virtual Teams competencies

The authors Busulwa et al.(2022) assert a disconnection between competencies and digital technologies exists, so they propose an integrative framework of competencies focusing on digital technologies. Some competencies specifically encompass the term "digital," such as digital leadership, digital ethics, digital innovation, digital governance, digital culture, and digital learning. Others are cross-cutting competencies, including data analysis, adaptability, enterprise architecture management, and cybersecurity management. Emphasizing digital leadership, Mutsuddi & Sinha (2022) outline some key skills and competencies for digital leadership, such as adaptability, tolerance for ambiguity, teamwork, and collaboration. Additionally, Ghamrawi & Tamim (2023) conducted a study in a higher education institution where they detail five elements that encapsulate digital leadership: digital competence, digital culture, digital differentiation, digital governance, and digital promotion.

Philip et al.(2023) argue that leaders must possess specific competencies to address the challenges of digital transformation and identify visionary thinking, agility, understanding the value of data, data-driven decision-making, strategic knowledge, and embracing change as the main competencies required. In addition, Erhan et al.(2022) assert that the shift from conventional to digital leadership is necessary given the current digitalization processes in the workplace, and the results of their study demonstrate that leaders with digital competencies are perceived positively by their employees, who are inclined to enhance their digital and innovative skills. On the other hand, Habsi et al.(2022) conducted a systematic literature review exploring how digitalization leads to a new leadership style; they suggest a series of competencies for leading in digital environments, including strategic thinking, conceptual thinking, openness to change, comprehensiveness, and a combination of traditional leadership traits.

Branch 3: Innovation learning

This subfield pertains to the influence of transformational leadership in virtual environments. For instance, Mutha & Srivastava(2021) identified that transformational leadership influences the engagement of virtual employees and examined the role of leadership in the engagement of geographically dispersed virtual teams. Simultaneously, they reviewed the subfactors of transformational leadership, including idealized influence and inspirational motivation, to understand how leaders can leverage the commitment of virtual employees. The study provides a comprehensive insight into how leaders can enhance engagement in virtual teams.

Rosing et al.(2022) demonstrated how autocratic and democratic leadership relates to followers' trust during emergencies. The study found that autocratic leadership is associated with higher trust in early emergencies, while democratic leadership is associated with higher trust in later stages and emphasizes the importance of timing and adaptability of leadership in emergencies.

Kustiyono et al.(2022) examined how supportive technology, digital literacy culture, intelligence, and leadership influence virtual collaboration in university settings. The findings revealed these factors significantly impact virtual collaboration and highlight the importance of leadership in fostering a culture of effective online collaboration.

Cristea & Dinu(2022) evaluated the perceived effectiveness of virtual leadership during the COVID-19 pandemic. In this regard, they found that virtual leaders were perceived as equally effective as in-person leaders in crises and emphasized the importance of communication skills and effective use of technology for successful virtual leadership. Turesky et al.(2020) identified the perspectives of virtual team leaders on trust, conflict, and the need for organizational support; their results highlight the importance of leadership in building trust and resolving disputes in virtual teams, as well as the need for organizational support to ensure the success of

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virtual teamwork.

Norman et al.(2019) analyzed the development of trust in virtual leader-follower relationships; they discovered that effective communication, competence, and integrity are key factors in developing trust in virtual relationships and emphasized the importance of establishing clear expectations and maintaining open communication to foster successful virtual relationships. Sağbaş & Erdoğan (2022) examine the added value of digital leadership in digital smart organizations. Additionally, they highlight the importance of digital leadership in change management and innovation and suggest that digital leaders need technical and leadership skills to succeed in digital smart organizations.

DISCUSSION

These findings hold significance for managers, enabling them to discern the requisite skills for leadership in today's digital landscape. Nevertheless, it is imperative to acknowledge the rapid evolution of technology, necessitating leaders in virtual settings to embrace adaptability to disruptive changes and engage in continuous learning to remain abreast of the latest digital trends and tools; additional empirical research is warranted to comprehensively grasp how e-leadership and digital competencies can positively influence long-term organizational success.

CONCLUSION

This study employs the ToS methodology to conduct a literature review on e-leadership and the requisite competencies. Initially, researchers conducted a scientometric analysis to trace the evolution of scientific production, identify primary journals, and discern various communities among countries and authors. Utilizing Scopus and Web of Science databases with data preprocessing and analysis techniques has significantly enriched the literature in this domain.

The ToS algorithm delineated three principal areas. The first pertains to e-leadership within educational contexts, underscoring the imperative of integrating education into e-leadership cultivation through pedagogical processes. The second area delves into Virtual Teams competencies, offering nuanced insights into the proficiencies required to navigate the challenges of the digital age and remote work. The third area revolves around Innovation learning, accentuating the pivotal role of innovation in e-leadership development.

Since 2020, there has been a noteworthy surge in research on electronic leadership and competencies essential for its cultivation, with three distinct emerging subareas: e-leadership in education, virtual team competencies, and innovation leadership. Future research in e-leadership in education may focus on integrating e-leadership principles into educational curricula, evaluating pedagogical impacts on digital leadership skills, and assessing the effectiveness of e-leadership training programs. Subsequent studies could explore essential competencies for virtual teams, factors influencing their performance, and the role of emerging technologies. Further research might investigate fostering innovation within e-leadership, including promoting creativity, implementing innovation processes, and understanding innovation's impact on organizational success.

Declaration of conflict of interest

The authors of this article affirm that the information within this document does not impact the companies that worked together on this research. Affirmations were provided through hermeneutic synthesis, so every assertion is the accountability of the investigators.

Authors' involvement

The writer of this manuscript attests to being the exclusive individual responsible for carrying out the research, encompassing its inception, composition, and organization of the present paper.

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