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Blockchain Technology in Scientific Literature. Bibliometric Approach

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ABSTRACT

The digital transformation in public administration has redefined the way government services are delivered and managed, marking a significant leap towards efficiency and transparency. The implementation of digital technologies allows public institutions to react quickly and accurately to citizens' needs, streamlining administrative procedures and reducing waiting time and associated costs. It not only improves access to information and services, but also strengthens citizens' confidence in the government's ability to operate efficiently and fairly. Blockchain technology has the potential to transform public services, enabling administrations to organize processes and manipulate information in an innovative way. Bibliometric analysis provides a comprehensive picture of how public management, blockchain technology, and e-government are approached in the academic literature and reflects the growing interest in these areas. The analyzed documents suggest a research community, which contributes substantially to the development and understanding of these innovative technologies and practices.

1. Introduction

Public administration is the instrument that supports the entire machinery of a society; In order to be effective, it must be permanently adapted to the socio-economic-cultural conditions of the national or local community, in relation to the realities of the present. The reform of public administration can therefore be considered a continuous process of adapting the structures and functionality of the governance system to the needs of the governed people; a comprehensive concept, which includes all aspects of the organization of the public sector, among which stand out: the general "architecture" of ministries and agencies, organizations and institutions at local level, systems, structures, processes, motivations, as well as how to supervise them and periodically adapt the system (Beck et al., 2018)

Digital transformation is a complex and multidimensional process that involves profound changes in the way public administration performs its functions and serves its citizens. Artificial intelligence is one of the emerging technologies that can help improve the efficiency, effectiveness and quality of public services, as well as increase transparency, participation and accountability. Public governance models based on innovative technologies involve citizens in carrying out different administrative processes, through digital platforms, contributing to a rapid delivery of services (Roja and Boc, 2021).

In the current period, the reform of this sector is complex enough to lead to the development of innovative methods of organization based on efficiency, competitiveness, knowledge, digitalization in order to be able to respond to the demands of society, operating on the basis of policies and programs at national and European level (Senna et al., 2023). It aims at the purpose of the service from the perspective of the tax-paying citizen: in education we talk about learning outcomes, in health we operate with performance indicators of the system, in infrastructure, with indicators such as the number of kilometers of highway built, public utility networks or rehabilitated buildings etc.

Digital transformation in public administration is a process aimed at improving the efficiency, transparency and accessibility of public services through the use of digital technologies (Zachariadis et al., 2019). This process involves a series of projects and initiatives at national and European level, which aim to modernize public institutions and facilitate interaction with citizens, changes in concepts, procedures and technologies, with the ultimate goal of improving the quality of life of citizens and contributing to the sustainable development of society.

The transition from public administration to public management and the increase in the level of implementation of digital technologies in this sector are not just inventions of the academic world. Reforming

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the way the public sector is managed in Romania is a local reality with global and multidimensional reverberations; it is a specific configuration, but at the same time it is part of *the tendential transition* (Vlăsceanu, 2007), characteristic of Western democracies.

The transition to e-government systems creates challenges in terms of privacy and security of sensitive data of citizens and organizations. Information systems require the implementation of appropriate security mechanisms to ensure the confidentiality, integrity and availability of data. Blockchain technology has the potential to transform public services, providing administrations with new ways to organize processes and manipulate information. The technology's high degree of security is an advantage over other tools and technologies used in data trading and processing (Janssen et al., 2020).

Even though interest in using this technology in the public sector is growing, the actual implementation remained limited. Previous studies highlighted several adoption challenges, such as lack of regulation, security and privacy concerns, insufficient infrastructure and lack of interoperability, inefficient and energy-costly transactions, the need for value-based transitions in administrative processes, and last but not least, the absence of effective governance models (Janssen et al, 2020; Ølnes et al, 2017; Zachariadis et al, 2019).

2. Strategy for the collection and analysis of scientific publications

The public administration needs not only reforms regarding the structure, organization and channeling of personnel towards professionalization; Integrated databases, communication in the virtual environment, IT security and moving operations to the online space are already needs of modern society. However, the operations must be implemented gradually, after studies on the potential of use and the existing infrastructure. The transition to e-government systems creates challenges in terms of privacy and security of sensitive data of citizens and organizations (Cîrnu, Rotună, 2020). The e-government system requires the storage and exchange of data in digital form. The government maintains huge data centers for storing sensitive information, such as: identity, income, medical records, etc. (Dumitrache, 2015).

Information systems require the implementation of appropriate security mechanisms to ensure the confidentiality, integrity and availability of data (Dumitrache, Sandu, 2020). There is often loss of personal data due to errors in the design and implementation of technical systems and the adoption of insufficient security measures.

New management strategies in public administration, in the context of digital transformation, must focus on optimizing and integrating advanced technologies to respond effectively to citizens' needs and improve governance. An important step in this regard is the complete digitization of public services in order to be able to restructure and simplify internal processes and reduce bureaucracy. By analyzing the data collected with the help of digital services, administrations can continuously improve public services, anticipating citizens' needs and responding proactively to them, with better allocation of resources, but also more effective strategic planning, essential in managing public resources in a responsible and transparent way.

The analysis of the scientific literature was carried out using a bibliometric approach, based on advanced tools such as the open-source R program and the Bibliometrix R 3.0.1 package, in the Biblioshiny version for the collection and analysis of scientific publications. It was made an extensive search strategy to gather relevant literature from international databases, such as WoS (Web of Science), and to include keywords related to the research topic. The key terms underlying the bibliometric analysis were: public management, digital transformation, blockchain technology, e-government.

The selected articles were subjected to a bibliometric analysis to identify trends, patterns and relationships in the scientific literature. Publication data, including article titles, authors, years of publication, and number of citations, were extracted and processed to quantify the impact and dissemination of research in the field.

Bibliometric indicators were analyzed, such as the number of citations, the h-index and the impact factors of the journal, to assess the influence and visibility of the publications. Data preprocessing techniques, including reduplication, standardization and normalization, were applied to ensure the accuracy and consistency of the bibliographic dataset. Statistical analyses, including descriptive statistics, network analysis, and clustering algorithms, have been used to uncover hidden patterns and relationships between scientific publications.

Following the data collection process (*Table 1*), we identified a total of 5316 articles published between 2007 and 2023, 54 books, 4824 articles presented at conferences. Of these, 2284 articles were written by a single author, while the rest of the papers had an average of 2.76 authors per document.

Table 1. Main data information

Period under review	2007:2023
Document type	
Article	5316
Book	54
Conference paper	4824

Conference Review	1
Editorial	84
Review	331

Authors	
Number of authors	19024
Authors of documents with a single author	1713
Collaboration	
Single author	2284
Co-authors	2.76
Collaboration index	18.82

Source: Made by the author based on the processing of information provided by Biblioshiny

Figure 1 provides a representation of the data from the bibliometric analysis of the works in the field of public management in the context of the digital transformation in the period 2007-2023. The displayed elements emphasize important aspects of research in these areas and provide insight into the dynamics and collaboration in the literature.

Figure 1. Statistical synthesis of the scientific literature in the field of public management in the context of digital transformation, in the period 2007-2023

Source: Export Biblioshiny

The community of researchers with concerns in the analyzed field is large, with 19024 authors involved and 1713 works with a single author. The international co-authorship rate of 18.82% and 2.76 co-authors per paper indicate an extensive and interconnected global collaboration network, essential for innovation and knowledge sharing. The analysis identified 10610 documents generated by 3759 sources, suggesting a rich academic output and a variety of platforms for the dissemination of research. The average age of the documents of 8.76 years and 12.15 citations per document reflects a sustained relevance of the works over time, indicating that research in these areas continues to enjoy international visibility and to be cited by the academic community.

This data provides a solid foundation for understanding how the academic community develops and interacts around blockchain technology, e-government, and public management, highlighting the importance of international collaborations and the long-term impact of research in these critical areas.

The data illustrated in *Table 2* highlights the evolution of the annual scientific output for the fields associated with blockchain technology, public management and e-government, during the period 2007-2023. The analysis of annual trends can provide valuable insights into the interest and dynamics of research in these areas.

Table 2. Annual scientific output

Year	Articles
2007	491
2008	564
2009	616
2010	629
2011	538
2012	604
2013	702
2014	661

2015	651
2016	695
2017	712
2018	693
2019	717
2020	523
2021	577
2022	618
2023	619

Source: Made by the author based on the processing of information provided by Biblioshiny

The general trend is an increase in the number of articles published annually, from 491 in 2007 to a maximum of 717 in 2019, reflecting a growing interest and expansion of research in these areas. This suggests a growing recognition of the importance of blockchain technology and the digitization of public services in academic research.

The years 2013, 2019 and 2023 mark inflection points in scientific production, possibly due to major events in technology or public policies that have stimulated research. The decline observed in 2020 and the subsequent recovery suggest the impact of the COVID-19 pandemic on academic research, demonstrating the adaptability and resilience of the research community in the face of challenging global circumstances. The results reflects a continuous expansion in this field, highlighting the relevance and need for innovation in public management and administration.

This evolution of scientific production not only illustrates fertile ground for innovation and development in blockchain technology and public management, but also highlights fluctuations in research, which can be influenced by external factors and technological advances. The list of relevant sources in *Table 3* underlines the importance and influence of certain journals and conferences in the field of e-governance and public management.

Table 3. Relevant sources

Name of the publication	No
Government Information Quarterly	474
International Journal Of Electronic Government Research	238
Transforming Government- People Process and Policy	210
Sustainability	97
Digital Democracy: Concepts, Methodologies, Tools, and Applications, Vol 1	94
International Journal of Public Administration in the Digital Age	85
International Journal of Public Administration	78
Electronic Journal of Information Systems in Developing Countries	66
Electronic Government, Proceedings	63
9th European Conference on e-Government, Proceedings	62
Proceedings Of The 13th European Conference on Egovernment	58
International Journal of Information Management	55
Information Polity	53
Information Development	46
Information Technology for Development	45
Proceedings Of The 4th International Conference On E-Government	44
7th European Conference On E-Government, Proceedings	43
Public Administration Review	43
Proceedings of the 11th International Conference on Theory And Practice of Electronic Governance (Icegov2018)	41
International Journal of Public Sector Management	26

Source: Made by the author based on the processing of information provided by Biblioshiny

The "Government Information Quarterly", with 474 papers, leads the list of sources, indicating its central role in publishing significant research on the digitization of public services. The "International Journal of Electronic Government Research" and "Transforming Government: People, Process and Policy" follow with 238 and 210 papers respectively, reflecting a similar focus on the topics of e-government and digital transformation. These journals are recognized for their contributions to the theory and practice of e-government, providing an important platform for debating and disseminating innovative ideas in this field.

Conferences such as the "9th European Conference on e-Government" and the "Proceedings of the 13th European Conference on eGovernment", with 62 and 58 papers, highlight the role these meetings play in bringing together researchers and practitioners to discuss the latest developments and challenges in the field.

Sources such as "Sustainability" and the "International Journal of Public Administration in the Digital Age" highlight the diversity of topics addressed in e-government research. These publications deal with issues related to sustainability and technological innovations in public administration, highlighting the connections between technology, governance and sustainability.

"Digital Democracy: Concepts, Methodologies, Tools, and Applications, Vol 1", with 94 papers, illustrates the importance of reference papers and collections that bring together fundamental research and relevant case studies in the field. These resources provide a broad knowledge base that makes it easier to understand the complexity and dynamics of e-government.

3. Conceptual map of keywords

The analysis of relevant sources demonstrates that the literature in the field of public management in the context of digital transformation is ample and diverse, based on significant contributions from specialized academic journals and international conferences. It reflects the continued interest and research in this evolving field, highlighting the need for multidisciplinary approaches to respond to the challenges and opportunities offered by digitalization in public administration.

The analysis of total citations by country reveals a valuable perception into the impact of global research in the areas of blockchain technology, public management, and e-government. The concentration of citations in specific countries underlines not only the intense research activity, but also the significant influence of the work produced in these regions (*Table 4*).

Table 4. Total number of citations by country

USA (56808)	Germany (9894)	Canada (6910)	Ireland (3239)
UK (28133)	Sweden (4282)	Denmark (3599)	Austria (3958)
China (63790)	Italy (10144)	Portugal (2292)	Brazil (2921)
Netherlands (10811)	Greece (4557)	Turkey (3087)	Romania (1685)
Spain (8097)	Norway (3258)	France (6086)	Slovenia (1390)

Source: Made by the author based on the processing of information provided by Biblioshiny

The U.S. and China have the highest citation numbers, with 56808 for the U.S. and 63790 for China, indicating a major contribution and leading role in advancing research in this area. This reflects consistent investment in research and development, as well as extensive international collaborations. Great Britain, Germany and Italy stand out, with 28133, 9894, and 10144 citations, respectively. These figures highlight a tradition and a solid infrastructure for research in Europe. Other European countries, such as the Netherlands and Spain, also demonstrate significant research activity, with 10811 and 8097 citations, respectively.

Significant contributions are also observed from countries with a lower presence in the literature, such as Norway, Slovenia and Romania, with 3258, 1390 and 1685 citations, respectively. This analysis provides a picture of the global dynamics of research in the fields of e-technology and e-government, indicating centers of excellence and points of influence in different regions of the world.

Table 5 illustrates the most cited papers, highlighting the significant impact of academic research in this field. BERTOT JC's 2010 paper stands out as the most cited, with 1148 citations and an impressive annual average of 76.53, demonstrating the international recognition and continued influence of his research on the academic community. Also, LU J's paper from 2015 follows with 915 citations, with an average of 91.5 citations per year, which reflects a considerable contribution to the literature.

Table 5. Papers with the highest number of citations

Author	DOI	Total number of citations	Total citations/ year
BERTOT JC, 2010, GOV INF Q	10.1016/j.giq.2010.03.001	1148	76.53
LU J, 2015, DECIS SUPPORT SYST	10.1016/j.dss.2015.03.008	915	91.5
MALIN MC, 2007, J GEOPHYS RES-PLANETS	10.1029/2006JE002808	896	49.78
DWIVEDI YK, 2019, INF SYST FRONT	10.1007/s10796-017-9774-y	785	130.83
TEO TSH, 2008, J MANAGE INFORM SYST	10.2753/MIS0742-1222250303	757	44.53
LINDERS D, 2012, GOV INF Q	10.1016/j.giq.2012.06.003	731	56.23
MEIJER A, 2016, INT REV ADM SCI	10.1177/0020852314564308	694	77.11

Author	DOI	Total number of citations	Total citations/ year
BELANGER F, 2008, J STRATEG INF SYST	10.1016/j.jsis.2007.12.002	630	37.06
WILLIAMS MD, 2015, J ENTERP INF MANAG	10.1108/JEIM-09-2014-0088	534	53.4
YILDIZ M, 2007, GOV INF Q	10.1016/j.giq.2007.01.002	528	29.33
SCHEERDER A, 2017, TELEMAT INFORM	10.1016/j.tele.2017.07.007	524	65.5
BONSON E, 2012, GOV INF Q	10.1016/j.giq.2011.10.001	518	39.85
HEEKS R, 2007, GOV INF Q	10.1016/j.giq.2006.06.005	507	28.17
OLNES S, 2017, GOV INF Q	10.1016/j.giq.2017.09.007	479	59.88
VENKATESH V, 2011, INF SYST J	10.1111/j.1365-2575.2011.00373.x	471	33.64
LEE JH, 2014, TECHNOL FORECAST SOC CHANG	10.1016/j.techfore.2013.08.033	466	42.36
BERTOT JC, 2012, GOV INF Q	10.1016/j.giq.2011.04.004	451	34.69
WANG YS, 2008, GOV INF Q	10.1016/j.giq.2007.06.002	436	25.65
MERGEL I, 2019, GOV INF Q	10.1016/j.giq.2019.06.002	434	72.33
OSBORNE SP, 2013, AMER REV PUBLIC ADM	10.1177/0275074012466935	433	36.08

Source: Made by the author based on the processing of information provided by Biblioshiny

The presence of these documents in the cited research over several years underlines their scientific value and their relevance in public management research in the context of the digital age. The list of the most relevant keywords (*Table 6*) highlights the main areas of interest and research in the context of e-government and public management.

Table 6. Relevant keywords

No.	Relevant keywords	Occurrences
1	e-government	1686
2	public management	1470
3	management	1338
4	digital government	334
5	public sector	287
6	blockchain technology	258
7	supply chain	255
8	bitcoin	218
9	big data	206
10	governance	183
11	IoT	171
12	government	167
13	local public institutions	144
14	smart city	137
15	interoperability	131
16	e-participation	126
17	information technology	122
18	e-governance	118
19	smart contract	94
20	transparency	85
21	democracy	63
22	artificial intelligence	98
23	sustainability	94

The keyword "e-government" dominates the list, with 1686 appearances, highlighting the importance of research aimed at digitizing government services. This indicates a significant focus on how digital technologies are integrated into government operations to improve efficiency, accessibility, and transparency.

With 258 appearances for ”blockchain technology”, interest in applying this technology in the public sector is growing. This suggests that innovations in data security and process decentralization are attracting the attention of researchers and policymakers. Other common keywords, such as "public management", "management" and "digital government" reflect a variety of approaches and topics that are explored in the academic literature. From traditional management to more modern notions such as "smart city" and "IoT" (Internet of Things), the research is diverse and reflects a combination of technology with management and governance strategies.

Keywords such as "big data" and "artificial intelligence" illustrate the integration of advanced technologies in the public sector. It demonstrates that digital governance is not only limited to automating processes, but also includes big data analytics, cloud storage, and the application of artificial intelligence to improve public decisions and services. This keyword analysis reveals a wide perspective on how emerging technologies are transforming the public sector, providing new directions and challenges for researchers and practitioners in the field.

Figure 2 illustrates a complex network of connections between” blockchain” and various technological concepts and fields. "Blockchain" is represented as the central node, closely linked to "e-government", demonstrating the essential role of this technology in the digitization of government services. The colored nodes represent different aspects and applications of blockchain technology, such as "smart contracts", "supply chain management", and "cryptocurrency", showing the wide variety of uses of blockchain.

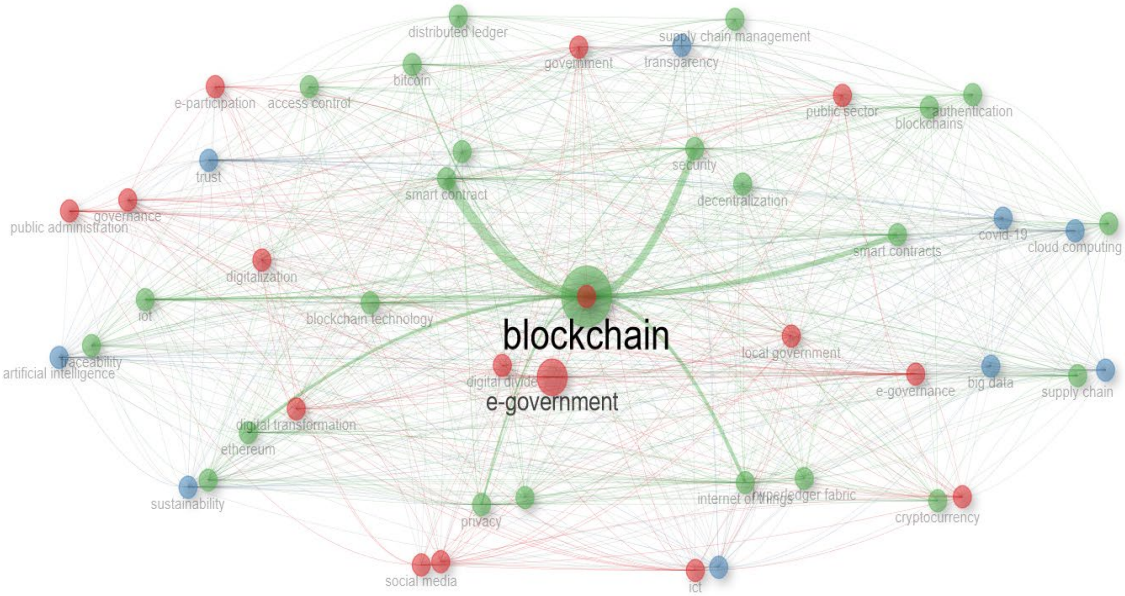

Figure 2. Network of occurrences by keywords

The links between "blockchain" and "privacy", "security", "decentralization" underline its importance in promoting open and transparent governance, but also in data protection and cybersecurity. At the same time, the connections with "artificial intelligence", "cloud computing" and "big data" show the integration of blockchain technology with other technological innovations to increase the efficiency and adaptability of public services.

Edge nodes such as "social media", "public administration" and "e-participation" reflect the influence of blockchain in facilitating public participation and administrative modernization. This graph not only highlights the interconnections between blockchain and various sectors, but also its potential to fundamentally reshape the way public services are delivered and perceived by citizens. *Figure 3* provides a visual perspective of the relationships between different technologies and concepts associated with ”blockchain”, ”public management”, and ”digital transformation”.

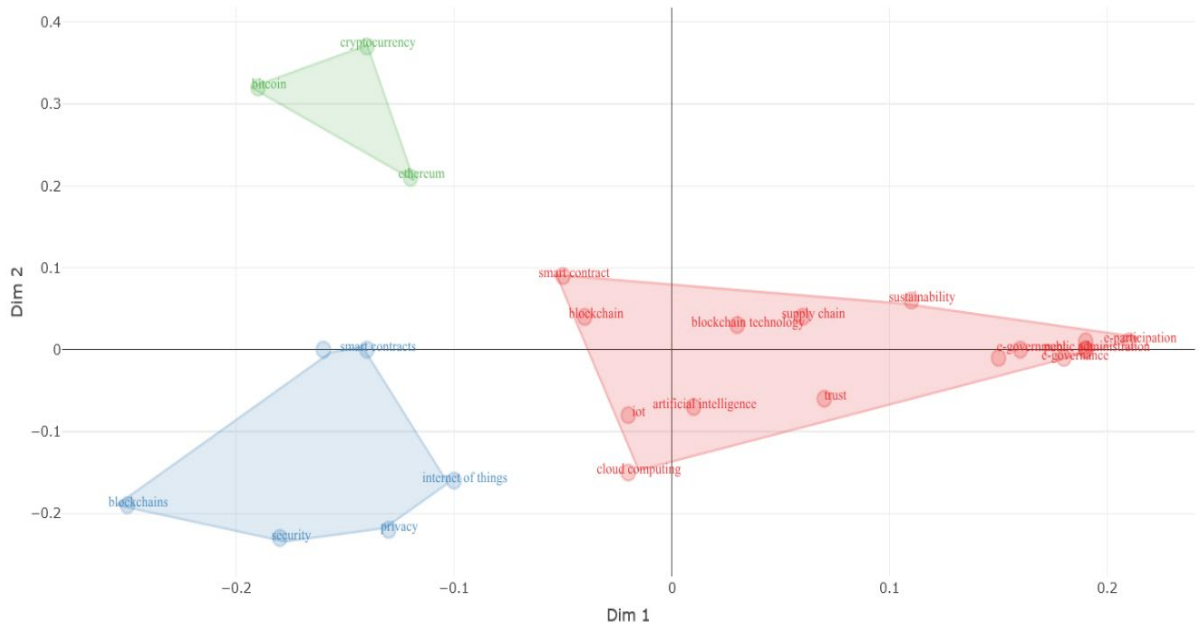

Figure 3. Map of hierarchical clusters

We observe three main groups, each highlighting a series of related themes. In the green zone, "Cryptocurrency" represents a powerful cluster of terms such as "Bitcoin" and "Ethereum," indicating a distinct focus on cryptocurrencies as applications of blockchain technology. The blue zone focuses on technical and security aspects, with terms such as "blockchains", "privacy" and "security", highlighting concerns about data protection and security in the use of blockchain technology. Finally, the red zone integrates concepts such as "e-governance", "public administration", "artificial intelligence", "sustainability" and "trust", linking blockchain technology to uses in e-government, in support of sustainability, as well as the importance of trust and transparency in these processes. This conceptual map outlines how blockchain technology interconnects with various fields, providing a basis for innovation and improvement across multiple economic and social sectors.

Figure 4 illustrates the network of collaboration between different countries in the field of public management in the context of digital transformation.

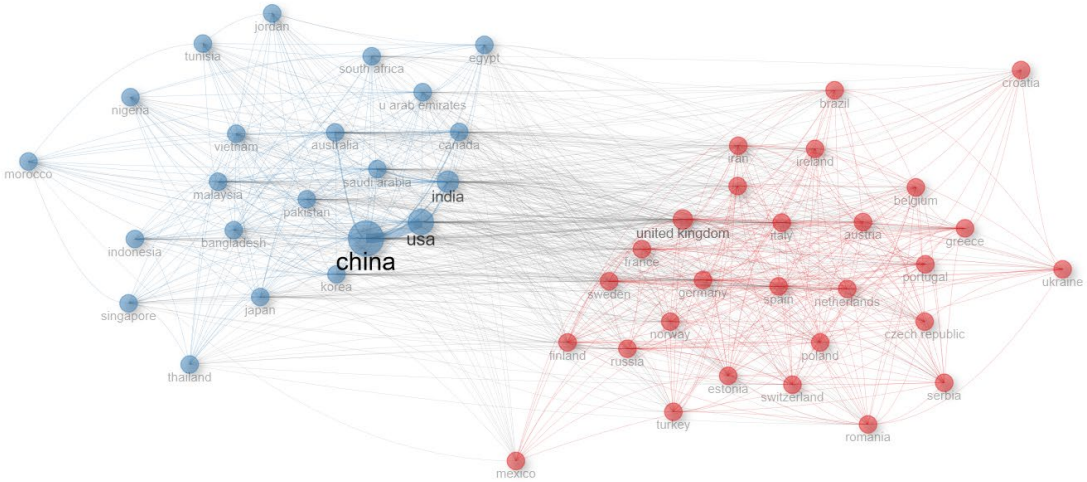

Figure 4. Collaboration network

Each node represents a country, and the lines between the nodes indicate the research collaborations and links between them. There are two main groups visible in the diagram, highlighting the regional dynamics and thematic focus of the research.

Asia-Pacific Group of Countries: this group is dominated by China, which emerges as a central hub in the Asia-Pacific region, highlighted by a large node with numerous connections to other Asian countries such as Japan, Korea, India, and Singapore. This suggests a strong network of academic exchanges and collaborations in technological and digital research in the region, with China at the center of this dynamic.

Group of European countries: on the right, the network is dominated by European countries with the UK, Germany and France having many connections, indicating their role as leading research centers in Europe. This cluster shows a dense network of collaborations between European countries, focusing on innovations in e-government and public management.

The connections between these two main groups suggest that although there are international collaborations, they tend to be more frequent within geographical regions or economic alliances. Such collaborative networks are important for the exchange of knowledge and technologies, contributing to global progress in the fields of digital technology and e-government. The analysis of this network provides valuable insight into how international cooperation can influence the directions of research and technological development.

4. Conclusion

The digital transformation of public institutions is no longer an option, but an obligation and necessity. We are on a one-way street; the administrative performance of any public institution is currently and will continue to be appreciated according to the level of digitalization.

The digital transformation process is a particularly complex one, and the time in which this transformation must take place is relatively short. Lately, citizens have become much more demanding in relation to the public administration. Their expectations are primarily about providing fast, simple and transparent services. The use of digital tools can transform the interaction between citizens and public administration into a positive, constructive one. The efficient digitization of public administration requires first of all determination and flexibility, both on the part of the administration and on the part of citizens (Roja, Boc, 2021).

The digital transformation process should be an integrated one, with the interconnection of digital tools and the exchange of open data being the framework within which the entire process should take place. The digital transformation must not be limited to the digitalization of administrative bureaucracy but requires a favorable context for the revision and simplification of administrative procedures. As can be seen from the analysis carried out in section 2, with the expansion of blockchain technology into areas other than cryptocurrencies, research efforts have expanded radically in recent years. Blockchain technology is considered a revolutionary approach in the field of public services and e-government, and acts as a factor that allows citizens, businesses, and governments to easily interact with each other in a transparent way.

Multiple studies identified governance as a key challenge for the implementation of blockchain in the public sector (Atzori, 2017; Meijer and Ubacht, 2018; Ølnes et al, 2017) and some notable studies explore the implications of blockchain in public governance (Beck et al., 2018; de Filippi et al., 2020; Werbach, 2018; Zachariadis et al., 2019).

Blockchain innovation is a result of the combination of transparency, integrity, privacy, and accountability, when designed accurately. In addition, a distributed blockchain network increases trust among all participants, as transactions are executed securely without the approval of a central authority. Blockchain as a disruptive technology has the potential to significantly contribute to the development of transparent and secure eGovernment services. In the next period, it is necessary to intensify research activities in the field in order to design viable eGovernment services through the use of blockchain technology.

In the near future, blockchain technology is expected to transform, and innovate the way that businesses are conducted. Smart contracts will drive process automation, and absolute digitalization will take control (Frommelt, 2021). While blockchain technology could have significant potential to improve data interoperability, security, and privacy, it is also important to consider the limitations of the technology. Blockchain is not a substitute for a classic database. Blockchain solutions are not optimized for high-volume data. Blockchain solutions are designed for recording data events, specific transactions, which are meant to be distributed across a network, in situations where transparency and collaboration are necessary criteria. Organizations that decide to implement blockchain must design and integrate solutions that support business processes in terms of streamlining the authentication of data transfer information.

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