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Analysing the Global Publication of E-Government During the Period 2003-2023 Using A Scientometric Approach

Agus Taryana
Department of Government Science, Faculty of Social and Political Science, Universitas Padjadjaran

Zhahirah Indrawati Zainuddin
Department of Government Science, Faculty of Social and Political Science, Universitas Padjadjaran

Novie Indraawati Sagita
Department of Government Science, Faculty of Social and Political Science, Universitas Padjadjaran

Ria Arifianti
Department of Business Science, Faculty of Social and Political Science, Universitas Padjadjaran

Aris Irawan
National Research and Innovation Agency

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ABSTRACT: Numerous countries have undergone strategic transformations by integrating new information and communication technologies intensively. This paper critically examines and delineates research contributions in the realm of e-Government, aiming to pinpoint future areas of interest and potentially valuable methodologies. Taking a critical stance, this analysis explores the implications of e-government models on public-sector management, underscoring the strategic use of information and communication technologies. The goal is to identify key research areas and methodologies with the potential to enhance the effectiveness of e-Government initiatives. This study employs diverse scientometric approaches, focusing on 5,540 articles, as research objects extracted from the Scopus database spanning from 2003 to 2023. Leveraging the information visualization software VOSviewer, we delve deeper into the literature data, uncovering insights into publications, citations, subject areas, countries, keywords, and topic clusters. The results of the scientometric analysis shed light on several research gaps, underscoring specific areas that demand attention in future research, particularly within developing countries. The trend of research tends to increase every year although it had a significant decline in 2015. The most cited documents are related to e-Government, emphasizing the critical intersections between e-Government initiatives and analytical factors such as citizen trust, information and communication technologies (ICT), social media, transparency, and digital image analysis. The four fields that dominate the research area are social sciences, computer science, business, management and accounting, and engineering. The United States of America is the most productive country while The United Kingdom is the most citations. Through an exhaustive exploration of current literature, this study provides an updated and concise summary of the knowledge structure and evolutionary path in the field. The findings reveal a developmental shift from basic automation to advanced neural network platforms, with a distinct focus on transformative technologies such as cloud computing, big data, blockchain, artificial intelligence, machine learning, and the internet of things (IoT). This comprehensive overview highlights the key technological advancements shaping the landscape and emphasizes the critical elements contributing to the field's progression.

KEYWORDS: e-government, software VOSviewer, information and communication technologies (ICT), Scopus database

1. INTRODUCTION

E-Government, also referred to as electronic government and its many synonyms or near synonyms such as e-gov, digital government, online government, or transformational government, involves the utilization of internet technology as a medium for sharing information, delivering services, and conducting interactions with citizens, businesses, and various governmental entities (Grigalashvili, 2023). E-Government is the electronic provision of governmental information and services round the clock, seven days a week and it has made an essential change in the whole society's structure, values, culture, and the ways of conducting business by utilizing the potential of ICT as a tool in the daily work (Alshehri & Drew, 2023) (Holden et al., 2003). At present, the development of research and practice on e-Government has been growing over time since its inception in the 1980s (Curtin et al., 2004).

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In the early years, the concept e-Government was initiated by NPR "National Performance Review" under the Clinton administration in the United States (Chung, 2020), and arrived in Asia in the 1990s (Warf, 2016a). This research supports government innovation through the application of information technology and seeks to implement various reforms in government functions in various sectors. International research on e-Government is now more focused on several key topics, such as government transparency, technological innovation and modernization, organizational and institutional transformation, and the digital divide and resistance to change. (Rodríguez Bolívar et al., 2016). To build an effective system for evaluating e-government policies, attention is paid to interoperability, ensuring different organizations and stakeholders can integrate easily. This also includes reviewing the institutional and organizational changes that governments need to make when adopting new technologies, with ongoing evaluation as a basis for better decision-making. In addition, researchers are beginning to investigate the role of e-participation in environmental management (Qi et al., 2018). To build public trust and, in turn, encourage the use of e-government services, recent research on e-government has increasingly highlighted issues related to security and privacy. (Kanaan et al., 2023). In certain areas, such as encouraging citizen participation in public affairs, improving information transparency, accountability, public data disclosure, and critical analysis and discussion of e-government initiatives, research is increasingly focused on the differences between developed and developing countries. Future e-government research will continue to evolve and influence practices by utilizing technology, and focusing on specific audiences and key issues.

E-Government is a crucial topic, especially with the continuous development of new technologies, which have a significant impact on the role of government and how governments interact with society (Welch, 2021). These new technologies are driving major changes in governance, as they are now an integral part of everyday life. These changes include aspects such as democracy, accountability, service delivery and policy evaluation. (Griffin et al., 2007). Several experts have explored the status of e-government in various countries through comparative research methods. Barney Warf studied the history, politics, impact, and geographical spread of e-government. (Warf, 2016b). Mi'rojul Huda and Novy Setia Yunas studied how Indonesia's e-Government system developed to address the growing demands of modernization and globalization. (Huda & Yunas, 2016). Nahleen Ahmed assessed the state of e-Government in several countries, including the US, UK, Singapore, and Canada. This analysis, which focused on aspects such as data collection, online service delivery, and interaction, highlighted both the strengths and weaknesses of each country's e-Government initiatives. Overall, research on e-Government is vital for government efforts to develop more efficient and effective service delivery systems. It also promotes inclusivity and equality within society. By gaining a deeper understanding of e-Government, we can enhance our knowledge and create new opportunities to address society's diverse needs.

Studies have indicated that e-Government enhances public satisfaction with services. (Kuswati et al., 2022) It promotes sustainable development. (Dhaoui, 2022). The enhancement of public service delivery through digital platforms not only meets the needs of citizens effectively but also fosters long-term societal growth and prosperity, aligning with principles of sustainability and progress. While e-Government offers numerous potential benefits, its implementation can be challenging and demands careful planning and preparation. (Muhammad & Hromada, 2023). To effectively implement this transformative governance approach, it is crucial to have a deep understanding of the concept of e-Government and the extensive research that underpins it.

Scientometric analysis is a method used to track the growth of e-Government research. This approach is highly effective for understanding the progression of e-Government studies. As stated by Price (1963), scientometrics is the study of science itself, employing a systematic approach to examine the historical, current, and future directions of a research field. (Price, 1963). Through scientometric analysis, researchers can pinpoint emerging areas of study, significant academic publications, current research trends, and the extent to which research contributes to advancing educational practices. (Olawumi & Chan, 2018). Moreover, scientometrics is a quantitative method that employs mathematical models, cluster visualization, and analytical algorithms to evaluate, map, and uncover structural trends within a specific field of study. (Saka & Chan, 2019). By utilizing scientometric analysis, researchers and educators can establish more effective and efficient priorities for research and development.

This study will use scientometric analysis to examine the number of publications, subject areas, journals that publish them, and the most active institutions in the field of differentiated education. Additionally, text mining algorithms will be employed to analyze article content in order to identify key themes, concepts, and research questions. This approach will help us understand how the field has evolved over time, including the emergence of new research topics, the prevalence of certain subjects, and the impact of prominent researchers and journals. (Mingers & Leydesdorff, 2015). The study will also explore the global distribution of publications on differentiated teaching, including the countries where the research is conducted and published. This will help identify language or geographic disparities in the research and provide insights into the global scope of the field. (Serenko, 2021). Furthermore, this study will explore collaboration patterns among institutions across different research fields, identifying the most productive organizations and countries. It will also analyze citation counts, h-index, and other scientific impact metrics to assess the influence of research in the field of differentiated education.. This will assist in determining the most important papers and journals in the subject as well as the extent and significance of e-Government research. Overall, this study will offer a thorough assessment of the state of e-Government today highlighting important topics, scholarly works, and journals while pinpointing areas in need of more investigations.

In order to obtain the most-up-to-date knowledge both domestically and internationally, numerous academic institutions and businesses continue to conduct e-Government research. This study brings a better understanding of e-Government and paves the way for further research. In particular, it explains the geo-dimensionality and evolution of e-Government and the direction has taken over the past two decades. The study also gives an idea utilization of multiple theories combined with e-Government by authors in different contexts and domains. In addition, the study opens up new theoretical avenues for researchers by highlighting numerous keywords that existing authors have studied in recent years. Driven by the core objective, we propose the following research questions to be addressed in the study:

RQ1. What is the e-Government research trends?

RQ2. What are the various fast-growing subject areas within e-Government over two decades?

RQ3. Which are the predominant institutions, publications, sources, countries, and research areas on e-Government?

RQ4. What opportunities can be explored in future research in this area?

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2. RESEARCH METHODOLOGY

The relevant articles for this study were retrieved from the Scopus database. The detailed inclusion and exclusion criteria for article selection are shown in Table 1. We used the Scopus database because of its wide coverage of publishers, and high-impact journals, and is well-established. In addition, the database also offers comprehensive coverage of multidisciplinary

Table 1. Inclusion and exclusion criteria

Inclusion criteria	**Articles used updated e-Government**
	Publication Time frame: 2003–2023
	Language: English
	Document Type: Journal Articles
	Publication Stage: Final
	Database: Scopus
Exclusion criteria	Articles before the ten-year update [1992–2002]
	Articles excluded outside the time frame
	Non-English articles
	Article in press
	Conference proceedings, Books, Early access, corrections

journals and references, making it effortless to navigate and access manuscripts from diverse geographic regions (Burnham, 2006). Another main reasons for using Scopus are that it offers valuable features such as the ability to export document attributes in an Excel spreadsheet format and provides an extracted file format compatible with network data analysis software like VOSviewer (Faisal et al., 2021).

A keyword search was performed to identify e-Government studies published between 2003 and 2023, primarily with the intention of examining the last two decades of e-Government research and charting when e-Government research began to peak during this period. The search was undertaken on 1 Oktober 2023, and as the flexible retrieval conditions, “e-Government" OR "electronic government" OR "e-gov" OR "digital government" OR "online government" OR "transformational government" were used to extract publications that contained any of these terms in their titles, abstracts, or keyword lists of the publications. To answer the research questions, the inclusion of these document types was needed, resulting in the selection of a total of 18,413 papers from Scopus repositories. All papers were in English and included journal articles, conference papers, books, book chapters, editorials, and other grey literature. The results are shown in Fig.1.

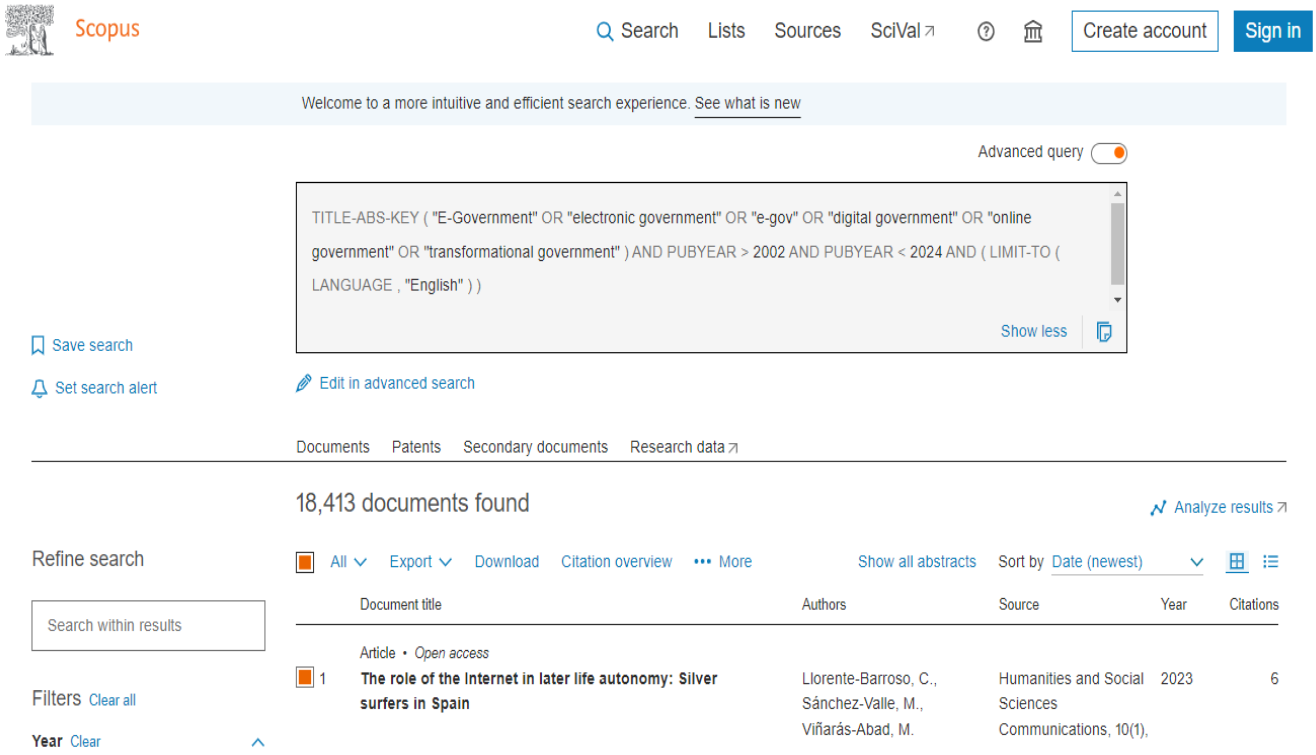


Figure 1. Scopus Documents Found

The extracted Scopus repository, containing 18,413 documents, was exported to a comma summative value (.csv) format with detailed publication information, study content including study keywords or subject areas, and scientometric analysis indicators. These documents underwent a rigorous screening process for completeness (e.g., availability of author details, abstract, organization name, on-road e-Government) and duplicity. This iterative screening process resulted in the final selection of 5,540 publications, reflecting the complexity of the task due to the high volume of initially identified publications.

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The chosen publications were sorted based on their attributes, as mentioned earlier. All publications were then analysed against the individual as well as a combination of the attributes. Author affiliation information as recorded in Scopus repositories was considered as the most recent, also noted the types and locations of these affiliations from Scopus, considering the headquarters as the geographical location when an organization had multiple branches or campuses.

The organizations were categorized into four types: (a) Research and Education, including universities, colleges, and academic institutes; (b) Research and Business, encompassing private entities involved in consultancy or the manufacturing and distribution of goods and services; (c) Research and Government, which includes public authorities and research bodies; and (d) Others, such as research branches of private entities. Following this, a variety of scientometric analysis metrics were generated to examine the extracted results, as detailed below:

Citation analysis: A fundamental concept in scholarly research, operates on the foundational premise that citations serve as signposts guiding researchers towards valuable sources. These references, meticulously documented and strategically employed, function as a gauge of the visibility and influence of scholarly endeavours, encompassing aspects such as the authors' prowess, collaborative efforts, publication titles, affiliating institutions, geographic origins, disciplinary domains, research spheres, and even sources that may non-indexed (Tomaszewski, 2023). By examining precise, quantifiable elements of scientific literature at a given moment in time, this mapping aids in producing a visual representation of the connections between various research papers (Nicolaisen, 2010). Citations are essential for connecting various research publications. They display the number of times a document has been cited across all of the papers in a specific source (Cobo et al., 2011). Citations give researchers the chance to incorporate the ideas of other academics into their own works, enhancing them and helping to build the intellectual basis for their particular field of study (Mou et al., 2019).

Over the past two decades, citations have aided us in developing a visual depiction of the larger framework of e-Government research. Each research publication is represented by a circular node in the illustrations, and the size of these circles is directly correlated with the number of citations each study has received. We used the layout technique that Van Eck and Waltman painstakingly built in 2009 to produce this illuminating graphic, which was effortlessly included into the open-source program VOSviewer. One paper's citation style is shown by the lines joining the circles. If there are circles without lines connecting them, it indicates that none of the articles have cited them. The absence of a line, however, does not imply that these publications have not been cited at all; rather, it indicates that they have not been cited in the context of this specific network study.

Cluster analysis: Clustering is a common practice in scientometrics, frequently employed to categorize research domains, scientific disciplines, or various components of analysis. One notable application involves the grouping of research publications into clusters by assessing their interconnections within a citation network, as demonstrated (Šubelj et al., 2016). In the specific context of our research, we employed co-occurrence analysis of "all keywords (index and author)" with the assistance of VOSviewer to identify hidden research clusters within the final "on-road e-Government publication database."

3. RESULTS

3.1 General Observation

The dataset used in this study consisted of 5,540 scholarly publications published between 1 January 2003 and 1 October 2023. These publications were sourced from 195 countries and involved 5,101 authors, 2,968 organizations, and 3,452 publishing sources

Table 2. Statistical information on the data.

Domain	Specifics
Data Source	Scopus bibliographic repository
Covered period	From 1 January 2003 to 1 October 2023
Number of publications	5,540
Covered country contexts	195
Number of authors	5,101
Number of universities	2,968
Number of publishing sources	3,452

As seen in Figure 2, the number of e-Government publications has increased over time, where exponential growth was observed from 2016 when it first reached above the 300s (n = 301) and over 6 years then increased to the 400s in 2022 (n = 460). The number of publications between 2013 to 2023 accounts for 70.2% of the total publications in the database. The surge in interest surrounding e-Government in all sectors is the result of a convergence of influential factors in recent years.

Technological advances, especially in e-Government and learning, has led to the development and use of more advanced applications for public services. These advancements are in line with the growing availability of data throughout project cycles, providing a basis for insights in e-Government (Malodia et al., 2021). E-Government has the potential to enhance efficiency, predict and mitigate risks, and address deficiencies effectively. With the increasing complexity of modern issues and society's demand for innovative solutions, e-government is well-positioned to handle these challenges. The success of e-Government in various sectors, government initiatives, research advancements, and the pursuit of a competitive edge have prompted industries to adopt e-Government as a transformative tool for progress.

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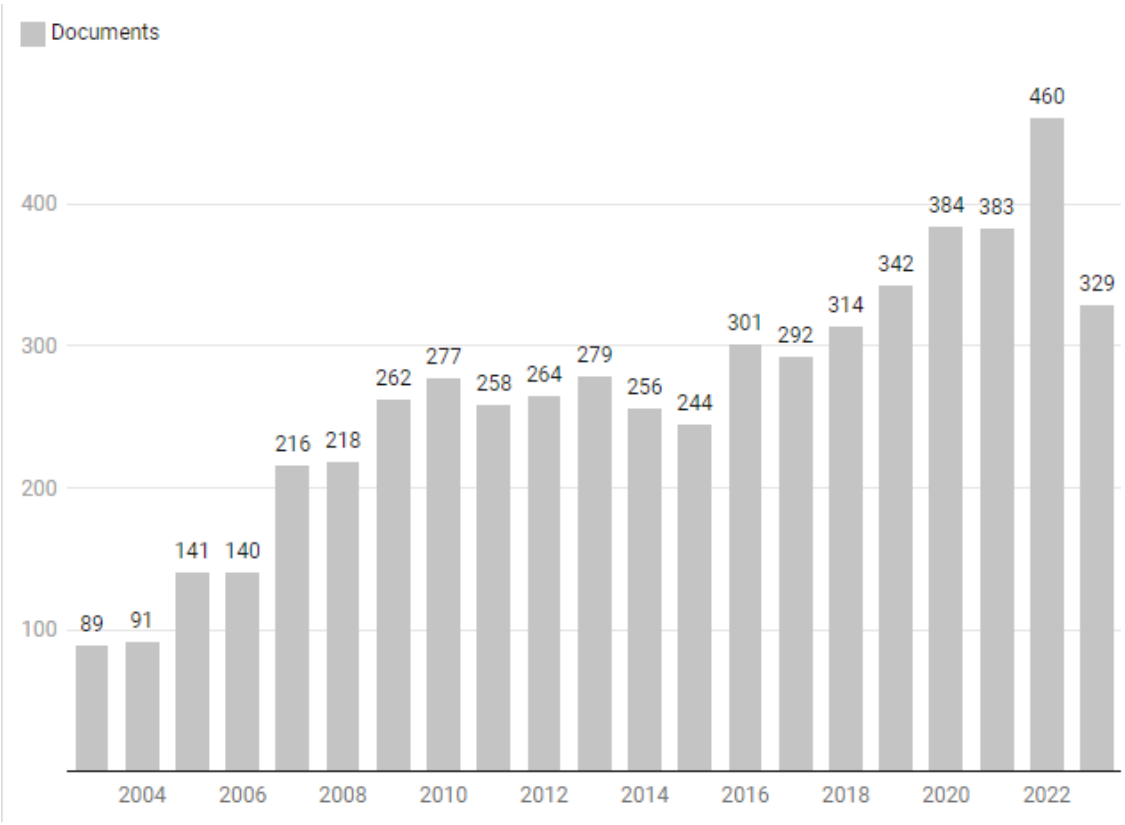


Figure 2 Publication growth trends.

The 18,413 publications before do exclude consisted of fourteen different types (Table 3): 8,059 conference proceedings (43.77%), 6,144 journals (33.37%), 2,511 book series (13.64%), 1,618 books (8.79%), and 80 trade journal (0.43%). To type of documents, this study only processes data in the type of journal articles written in English.

Table 3. Publications volume according to source and document types

Source Types	Conference Proceeding	Journal	Book Series	Book	Trade Journal	Total
Number of Papers	8059	6144	2511	1618	80	18,413
%	43.77	33.37	13.64	8.79	0.43	100

Document Types	Number of Papers	%	Document Types	Number of Papers	%
Conference Paper	8632	46.88	Editorial	148	0.80
Article	5970	32.42	Note	20	0.11
Book Chapter	1731	9.40	Erratum	10	0.05
Retracted	888	4.82	Short Survey	5	0.03
Conference Review	476	2.59	Data Paper	2	0.01
Review	355	1.93	Letter	1	0.01
Book	174	0.94	Undefined	1	0.01

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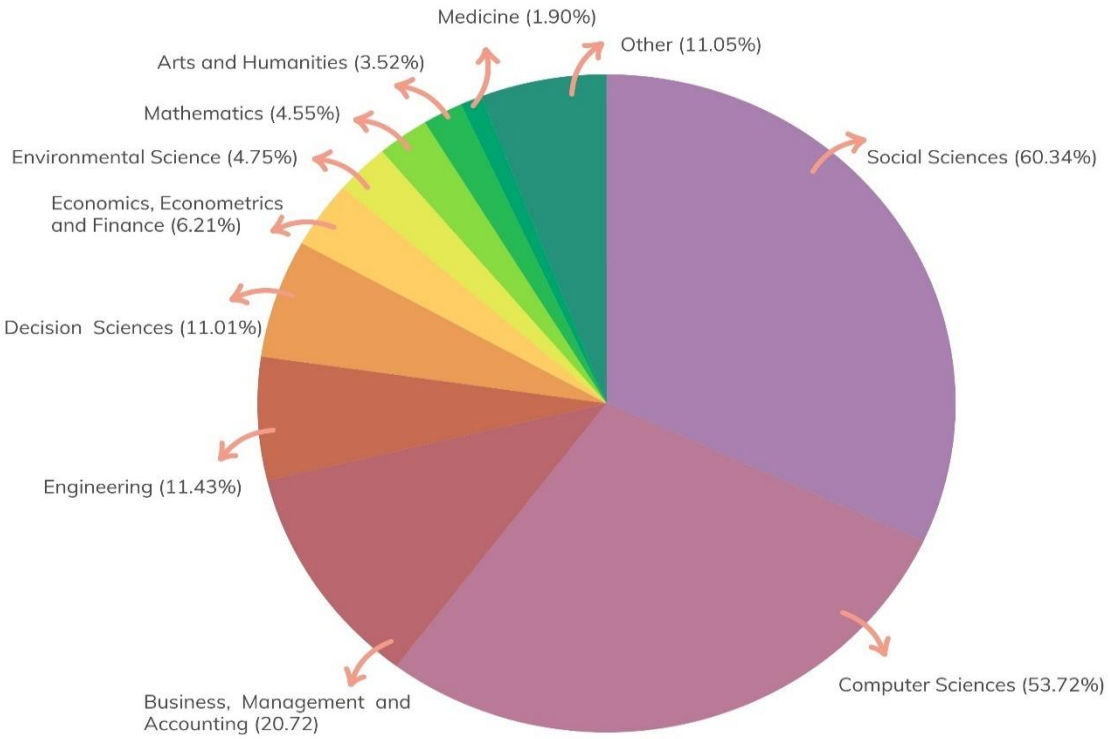


Figure 3. Documents by Subject Areas

The major subject areas of selected publication are Social Sciences (n = 60.34%), Computer Science (n = 53.72%), and Business, Management and Accounting (n = 20.72%) (Figure 3). Based on the countries selected for e-Government, United States (n = 1,016), United Kingdom (n = 522), China (n = 436), Malaysia (n =269), India (n = 257), Australia (n = 235), Spain (n = 225), Indonesia (n = 218), South Korea (n = 193), Greece (n = 185) are the top ten productive counties, which, respectively, account for 18.34%, 9.42%, and 7.87% of the total publications (Figure 4).

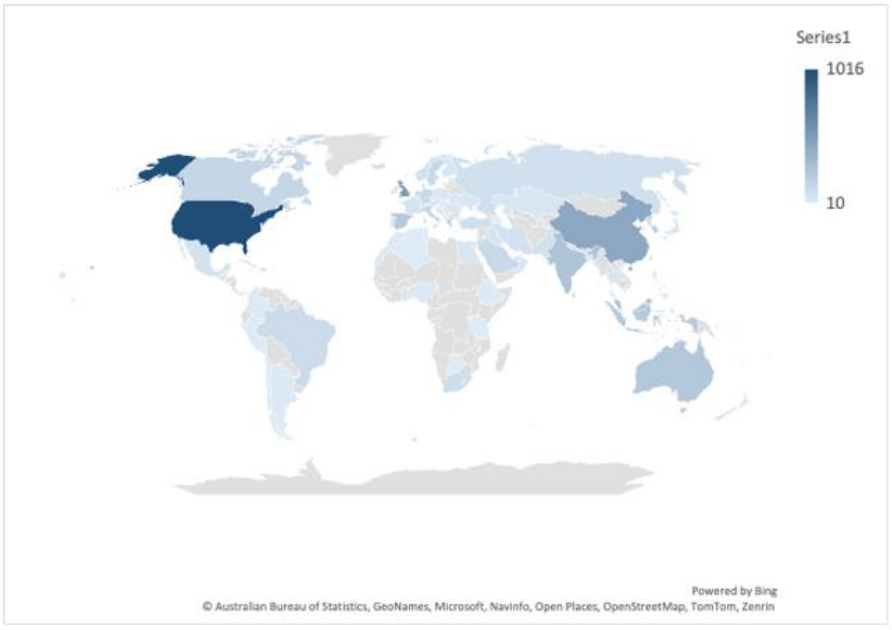


Figure 4. Top highest publishing countries

Based on the literature selected for e-Government, Vishanth Weerakkody, Yogesh K. Dwivedi, and Marijn Janssen emerge as the three most productive authors, with contributions of 3.15%, 2.90%, and 2.90%, respectively. Interestingly, these three authors are affiliated with the University of Bradford and Swansea University, which are based in United Kingdom. Furthermore, these three authors' specific focus and expertise are in information systems and digital transformation.

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Table 4. Top-10 most published authors

Rank	Author	Affiliation	Country	Count	Share
1	Vishanth Weerakkody	University of Bradford	United Kingdom	49	3.15%
2	Yogesh K. Dwivedi	Swansea University	United Kingdom	45	2.90%
3	Marijn Janssen	Delft University of Technology	Netherlands	45	2.90%
4	Zahir Irani	University of Bradford	United Kingdom	32	2.06%
5	Christopher G. Reddick	The University of Texas at San Antonio	United States	32	2.06%
6	Paul T. Jaeger	University of Maryland	United States	30	1.93%
7	J. Ramon Gil-Garcia	State University of New York Albany	United States	24	1.54%
8	Isaac Kofi Mensah	Fujian Jiangxia University	China	24	1.54%
9	Luis Felipe Luna-Reyes	State University of New York Albany	United States	19	1.22%
10	Nripendra P. Rana	College of Business and Economics	Qatar	18	1.16%

Notably, among the top 10 most productive authors, there are from United Kingdom and United States and one are from Netherlands, China and Qatar. For a comprehensive list of the top 10 most productive authors, their affiliated universities, and their respective contribution shares, refer to Table 4.

Table 5. Top-10 most published universities

Rank	Affiliation	Country	Count	Share
1	Brunel University London	United Kingdom	98	3.30%
2	Delft University of Technology	Netherlands	64	2.16%
3	State University of New York Albany	United States	56	1.89%
4	Brunel Business School	United Kingdom	52	1.75%
5	Universiti Utara Malaysia	Malaysia	46	1.55%
6	The University of Texas at San Antonio	United States	42	1.42%
7	Universiti Teknologi MARA	Malaysia	38	1.28%
8	National Technical University of Athens	Greece	36	1.21%
9	National University of Singapore	Singapore	36	1.21%
10	University of Maryland, College Park	United States	35	1.18%

Among the top institutions, Brunel University London originating from the United Kingdom, assumes a preeminent position, exhibiting the highest scholarly contribution with a count of (n = 98), Following suit, the Delft University of Technology in the Netherlands follows closely with a commendable count of (n = 64), while State University of New York Albany from United States holds a notable standing with (n = 56), as delineated in Table 5. This discernible trend underscores the active engagement of diverse nations in advancing the discourse on e-Government. Furthermore, the prevalence of such global collaboration signifies an escalating interest in harnessing the potential of e-Government to augment various facets of public services. This collaborative endeavor not only fosters innovative solutions but also amplifies the efficacy of e-Government applications, thereby propelling advancements in its utilization.

Table 6. Top-10 publication outlets

Rank	Publishing Source	Subject Area	Count	Citations	Share
1	Government Information Quarterly	Social Sciences	416	38,469	12.05%
2	Electronic Government	Computer and Social Sciences	335	4,872	9.70%
3	International Journal of Electronic Government Research	Computer and Social Sciences	206	2,417	5.97%
4	Transforming Government People Process and Policy	Computer, Decision and Social Sciences	184	5,076	5.33%
5	Information Polity	Computer and Social Sciences	105	2,711	3.04%

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6	International Journal of Electronic Governance	Computer and Social Sciences	92	574	2.67%
7	International Journal of Public Administration	Computer and Social Sciences	69	1,734	2.00%
8	Sustainability Switzerland	Energy, Environmental and Social Sciences	63	750	1.83%
9	Journal of Theoretical and Applied Information Technology	Computer Sciences and Mathematics	60	329	1.74%
10	Electronic Journal of Information Systems in Developing Countries	Computer Sciences	54	1,844	1.56%

Prominently, Government Information Quarterly stands out as the leading source, with 416 publications, representing 12.05% of the total publications in this paper (Table 6). This source focuses on research related to e-Government, covering areas such as open data, machine learning, and advanced computational techniques. Following closely is Electronic Government, a prominent journal with 335 publications, making up 9.70% of the overall output. Third, International Journal of Electronic Government Research published 206 papers, representing 5.97% of the total papers used in this paper. These three prolific publishing sources collectively highlight the strong research landscape in this field. Other journals, such as Transforming Government People Process and Policy (n = 184), Information Polity (n = 105), International Journal of Electronic Governance (n = 92), and International Journal of Public Administration (n = 69), demonstrate significant contributions to e-Government research.

All of the publishing sources (n = 10) focus on specific social sciences disciplines. This indicates a strong emphasis on applying e-Government in various social areas. Combine with Computer science is also a prominent subject area (n = 8), which indicates a significant interest in utilizing e-government in computer science applications related to technology. Lastly, subject areas such as Decision Sciences, Energy, Environmental Sciences, and Mathematics are represented by single publishing sources. This indicates a growing trend of integrating e-Government with those aspects.

3.2 Academic Influence Analysis

3.2.1 Citation Analysis by Publication

As shown in Table 7, Cartel and Bélanger (2005) review paper examines the factors influencing citizen adoption of e-government initiatives. The study aims to develop a comprehensive model by integrating constructs from the Technology Acceptance Model, Diffusions of Innovation theory, and web trust models. Overall, the research focus revolves around understanding and identifying the factors crucial for citizens to adopt e-government initiatives, with a specific emphasis on creating services that align with citizen needs and preferences. The integration of established theoretical frameworks contributes to a holistic understanding of the adoption process (Carter & Bélanger, 2005).

Ranked second among the top-10 most cited publications is Bertot et al. (2005). This publication explores the potential impacts of information and communication technologies (ICTs), with a specific emphasis on e-government and social media, on cultural attitudes about transparency specifically e-government and social media, in shaping cultural attitudes toward transparency (Bertot et al., 2010). Additionally, the study seeks to contribute insights into whether these technologies can bring about substantive social change in how transparency is perceived and embraced within a given society.

With a focus on real-world advancements and applications, Lu et al. (2015) provide a thorough analysis of the current trends in recommender system. With an emphasis on useful advancements and applications in a variety of fields, the paper's main goal is to perform an extensive and educational analysis of the current trends in recommender systems. According to Lu et al. (2015), the goal is to provide professionals and researchers in this subject with useful insights and assistance.

The top ten highly cited research articles are shown in Table 7, together with details on the authors, the year of publication, the research emphasis, and the number of citations. The results reveal that the most influential publications primarily around the themes of citizen-centred e-Government services and the factors influencing citizen adoption. The field of e-Government exhibits a diverse range of research focus areas, with particular attention given to social media, trust in technologies, and smart city initiatives. The aforementioned underscores the complexity of questions and research in the e-Government space, stressing the importance of investigating social media usage, building confidence in technology, and developing smart city ideas.

Table 7. Top-10 most cited publications.

Rank	Publication Title	Author	Research Focus	Year	Citation
1	The utilization of e-government services: Citizen trust, innovation and acceptance factors	Carter L.; Bélanger F.	Adoption; Citizen trust; Diffusion of Innovation theory; E-government; Technology acceptance model	2005	1,561
2	Using ICTs to create a culture of transparency: E-government and social media as openness and anti-corruption tools for societies	Bertot J.C.; Jaeger P.T.; Grimes J.M.	E-government; ICT; Social media; Transparency	2010	1,528
3	Recommender system application developments: A survey	Lu J.; Wu D.; Mao M.; Wang W.; Zhang G.	E-commerce; E-government;	2015	1,127

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			E-learning; E-service personalization; Recommender system		
4	E-Government and the Transformation of Service Delivery and Citizen Attitudes	West D.M.	Content Analysis of E-Government websites	2004	1,049
5	Context Camera Investigation on board the Mars Reconnaissance Orbiter	Malin M.C.; Bell III J.F.; Cantor B.A.; Caplinger M.A.; Calvin W.M.; Clancy R.T.; Edgett K.S.; Edwards L.; Haberle R.M.; James P.B.; Lee S.W.; Ravine M.A.; Thomas P.C.; Wolff M.J.	Data assimilation; data set; design; digital image; Mars; pixel; planetary atmosphere; planetary surface; satellite imagery	2007	975
6	Trust and electronic government success: An empirical study	Teo T.S.H.; Srivastava S.C.; Jiang L.	E-government; Intention to continue; IS success model; Public sector; Quality; Trust in technologies	2008	924
7	From e-government to we-government: Defining a typology for citizen coproduction in the age of social media	Linders D.	Coproduction; Crowdsourcing; E-Government; Government 2.0; Government as a platform; Open government; Social media	2012	910
8	Trust and risk in e-government adoption	Bélanger F.; Carter L.	Adoption; Disposition to trust; E-government; Electronic government; Perceived risk; Trust	2008	849
9	Governing the smart city: a review of the literature on smart urban governance	Meijer A.; Bolívar M.P.R.	Collaborative governance; e-government; smart city; urban governance	2016	846
10	E-government research: Reviewing the literature, limitations, and ways forward	Yildiz M.	E-government; Public administration and management	2007	742

3.2.2 Citation Analysis by University

As delineated in Table 8, universities from the United Kingdom and United States dominate the list (n = 6), with Brunel University holding the top positions, respectively. Delft University of Technology from Netherlands attains the second position and is distinguished by the highest volume of published documents (n = 29), indicating significant research impact. University of Granada from Spain occupies the third position. Notably, Universities from Spain and Netherlands, such as University of Zaragoza and Erasmus University Rotterdam are also represented in the top 10, showcasing their contributions to the research in the given field. These findings underscore the considerable influence of the United Kingdom, the United States, the Netherlands, and Spain on the landscape of e-Government research, with discernible repercussions extending to research initiatives in other nations. Furthermore, the inclusion of universities from Asia in the ranking further amplifies the panorama of international collaboration and collective research endeavors in the realm of e-Government.

Table 8. Top-10 most cited universities

Rank	University	Country	Count	Citations
1	Brunel University	United Kingdom	21	1,310
2	Delft University of Technology	Netherlands	29	1,064
3	University of Granada	Spain	6	1,037
4	Swansea University	United Kingdom	14	812
5	Department of Accounting and Finance, University of Zaragoza	Spain	5	562
6	University of Texas	United States	6	409
7	Iowa State University	United States	5	378
8	Florida State University	United States	6	270
9	University of Boswana	United Kingdom	7	261
10	Erasmus University Rotterdam	Netherlands	5	213

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3.2.3 Citation Analysis by Country

Table 7 presents a comparison of the top 10 most cited countries in e-Government research in terms of documents citations, and total link strength. The United States emerges are the most influential country with a significantly higher citation count than any other country. United Kingdom and Netherlands are ranked second and third, respectively, with different citation numbers. The total link strength indicates the strength of a country's academic relationships with other countries. For instance, China has a total link strength of 109,138, which signifies a wider academic network (in terms of citation) with other countries compared to Netherlands (n = 58,536). Figure 5 depicting the citation network through a geographical lens entails the representation of nations as circles, each symbolizing a distinct country, wherein the magnitude of the circles corresponds to the citation count associated with the publications originating from that particular nation. The interconnecting lines between these circles serve as visual indicators of the scholarly interdependence existing between pairs of countries, with shorter lines symbolizing a heightened level of academic interconnectedness. The chromatic variation among the circles is indicative of the scientific communities to which they align, wherein countries sharing the same colour are indicative of profound connections within the realm of citations, thereby signifying a cohesive academic community.

Table 9. Top-10 most cited countries.

Rank	Country	Documents	Citations	Total link strange
1	United States	1,023	48,141	268,086
2	United Kingdom	526	21,503	184,352
3	Netherlands	171	8,892	58,536
4	Australia	236	7,824	77,614
5	Spain	228	7,604	72,403
6	China	449	6,971	109,138
7	South Korea	194	6,016	66,689
8	Taiwan	131	4,994	51,574
9	Canada	145	4,573	52,702
10	Greece	186	3,893	32,425

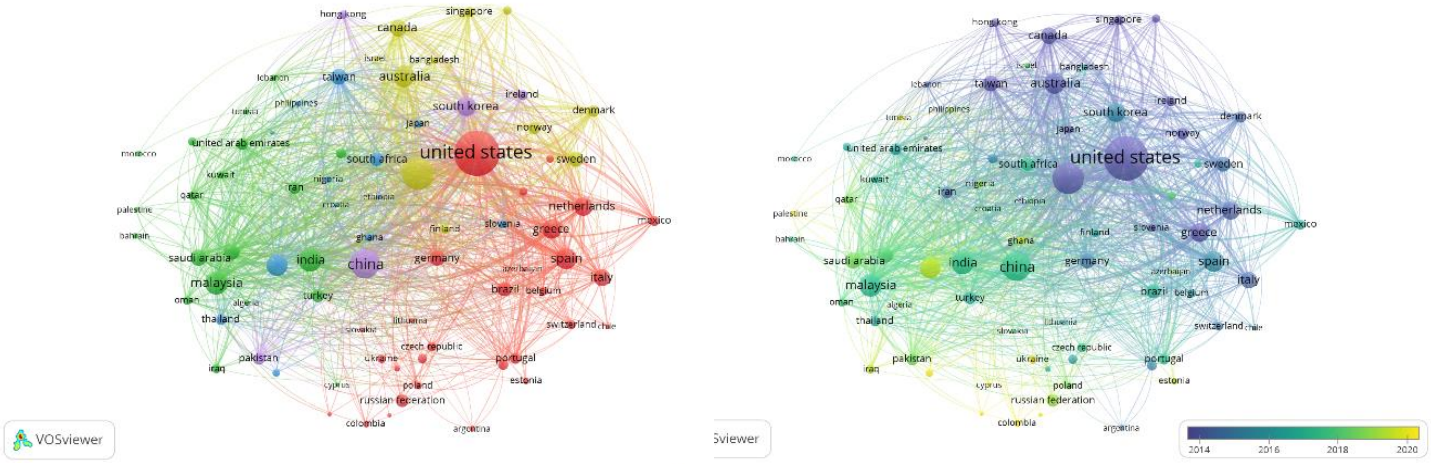


Figure 5 Citation network map by country

In light of the visual representation elucidated in Figure 5, it becomes evident that the foremost three nations in terms of citation counts hail from disparate citation communities, despite being closely interconnected through citations. Furthermore, an absence of conspicuous regional patterns, such as shared continental affiliations among the citation communities within the network, is discernible. These observations underscore a noteworthy inference: over the preceding two decades, research endeavours in the domain of e-Government have not been subject to dominance by any particular subject or cohesive group. Instead, global academia has sustained a palpable level of interest and scholarly exchange in this realm. This revelation holds substantive implications for stakeholders across the spectrum of research, policymaking, and industry practice. It posits that e-Government stands as a subject of universal interest for the global academic community, underscoring the imperative of international collaboration for the advancement of this field.

3.3 Trending and Relevant Topics for Future Research e-Government

3.3.1 Trending topics

In the following, data is presented regarding trending topics for the e-Government theme. Figure 6 depicts the findings of the analysis.

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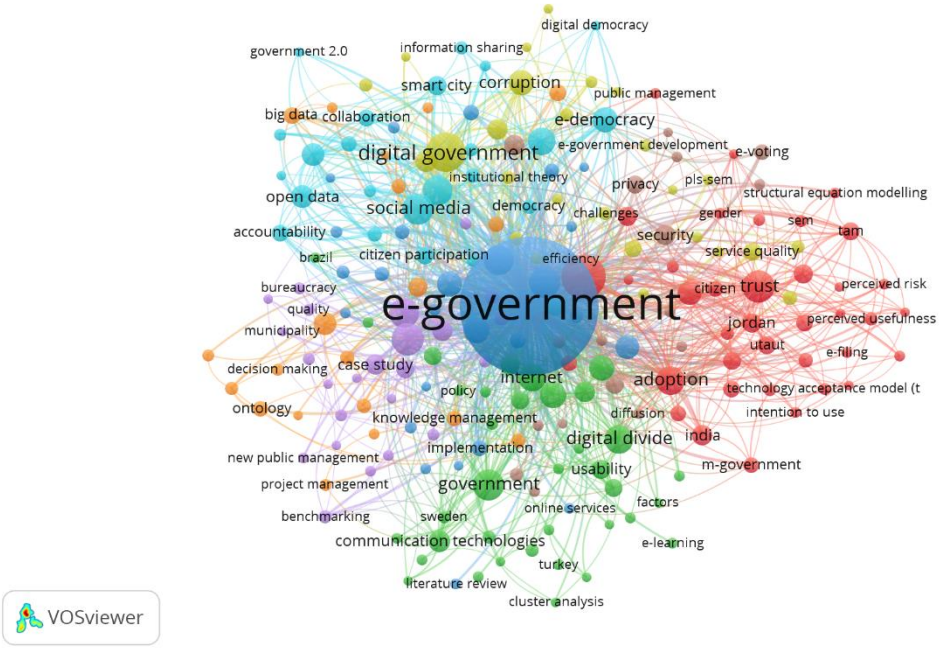


Figure 6. Network Visualization of Author Keyword Articles

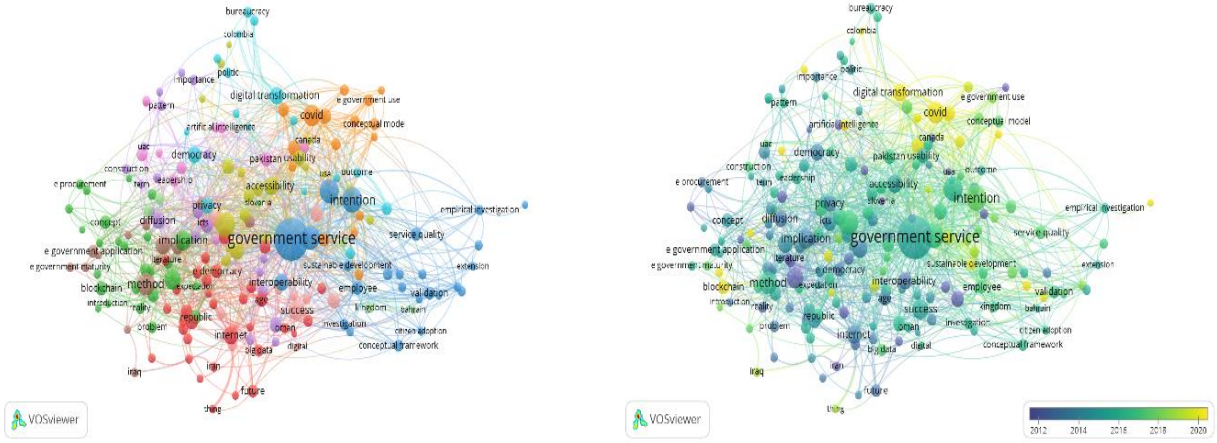


Figure 7. Research cluster network and overlay map by keyword occurrences.

Referring Figure 6, by utilizing frequency and link strength analysis of 11,461 extracted keywords from e-Government database. The keywords were then filtered to meet a minimum threshold of fifteen occurrences, resulting in a total of 214 keywords. The analysis identified eight distinct clusters in the existing e-Government research. The following outlines these clusters:

- *Cluster 1: Technology Adoption* –e.g., intention to use, citizen satisfaction, m-government, and acceptance
- *Cluster 2: Digital Divide* –e.g., developing countries, public sectors, information society, public sector, and digital inclusion.
- *Cluster 3: ICT* –e.g., service delivery, e-governance, and e-services
- *Cluster 4: Corruption* –e.g., digitalization, government effectiveness, digital economy, and digital transformation
- *Cluster 5: Public Administration* –e.g., new public management, local government, bureaucracy, and public services
- *Cluster 6: Social Media* –e.g., smart city, transparency, crowdsourcing, open data, and citizen participation
- *Cluster 7: Interoperability* –e.g., interoperability, big data, artificial intelligence, web services, and machine learning
- *Cluster 8: Cloud Computing* –e.g., authentication, identity management, e-commerce, privacy, risk and security

Figure 6 exhibits the research clusters network map, where each circle represents a keyword, and the size of the circle signifies the occurrence frequency of this keyword. The colour of circles manifests the research clusters of keywords and the distance between circles demonstrates the strength of correlation and similarity between the keywords. The map indicated that: (a) The distributions of Cluster 1 and 8 highly are overlapping, showing that these two clusters are closely connected; (b) Cluster 3 is distributed on the middle of the cluster network map, which takes on the role of connection with each cluster; (c) Cluster 6 and 2 contains various coloured circles from different clusters, which reflects that it has various connections with other clusters; (d) Clusters 4 and 5 are relatively independently distributed, which means these clusters have weak ties with other clusters.

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Table 10. Top-10 occurrence keywords in e-Government literature (2003-October 2023).

Rank	Keywords	Occurrences	Total link strange	Cluster
1	Trust	152	436	1
2	Public Administration	148	339	5
3	Social Media	143	355	6
4	ICT	137	357	3
5	E-Governance	135	280	3
6	Transparency	134	395	6
7	Local Government	127	307	5
8	Adoption	126	343	1
9	Digital Divide	125	266	2
10	E-Participation	109	271	6

Table 10 provides a list of the top ten occurrence keywords and shows the occurrences, total link strength, and subordinate clusters. The list excludes the search keywords and other alternative keywords—e.g., 'e-government', 'electronic government', 'digital government. A set of exclusion criteria can reduce the redundancy on the list and help to identify the research trends of e-Government research, i.e., identify the specific research clusters or extended research orientations. The most frequent keyword 'Trust' and "Public Administration" have the strongest total link strength, indicating that trust and public administration have emerged in e-Government and have been the most popular trend that attracting significant interests from various organisations (Choi et al., 2021). Four out of the top ten occurrence keywords (the 3rd, 6th, and 10th rank keywords) are categorised as Cluster 6 –appears to emphasize aspects of community engagement, the use of technology to enhance urban life, and transparency in governance and decision-making. The sum of the total link strength of these keywords ranks on the list, which reveals the existing e-Government research kept a relatively strong connection with social media, and technology adoption cluster. Besides, no keyword categorized to Cluster 4 is on the list, which means the Corruption cluster is not a popular extended research orientation for e-Government.

3.3.2 Emerging Trends of e-Government Research

Based on the top ten occurrence keywords list created between 2003 and 2023 (Table 10) 'Trust', 'Public Administration', 'Social Media' and 'ICT' holds the top spot of both lists by an overwhelming advantage, namely, the most frequent occurrences and the strongest total link strength. It means that during the last two or three years, that emerging keyword has been extensively mentioned in numerous e-Government publications.

In the publication year (average) visualisation of the research clusters network map (Figure 8), the circle and its size represent the keyword and its occurrence frequency, respectively. The line between each circle represents the academic relevancy between pairs of keywords; a shorter line between two circles represents closer academic relevancy between the two keywords. The colour of circles represents the chronological order of the keyword's average publication year from early (dark coloured) to recent (light coloured) times.

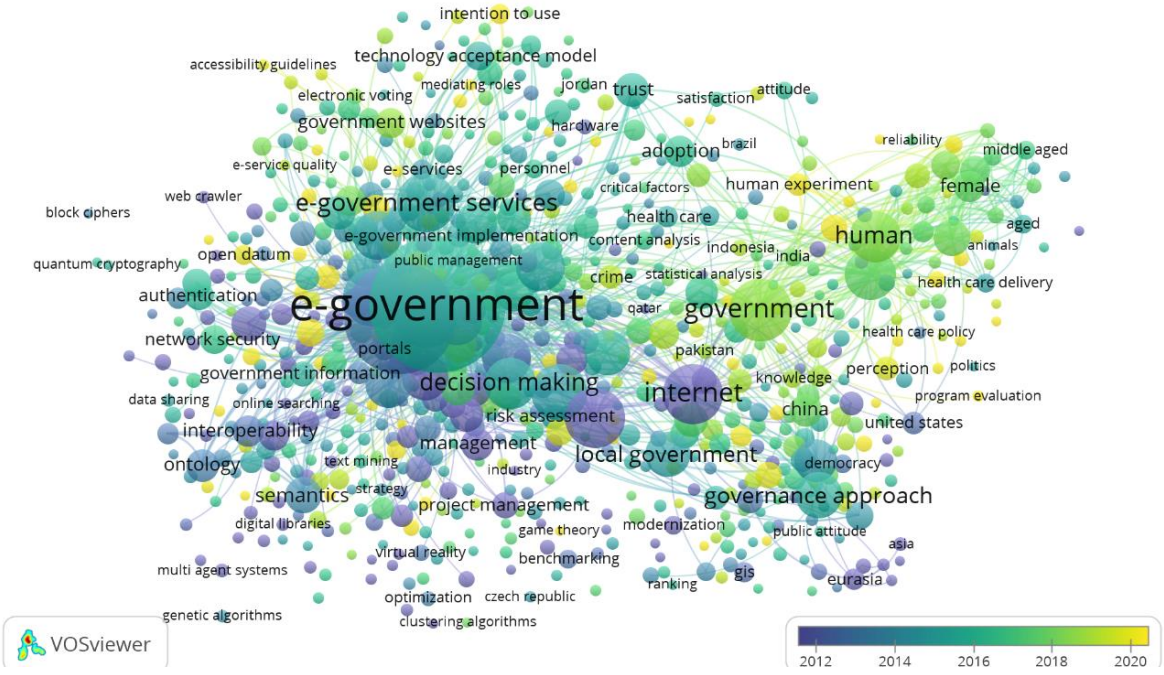


Figure 8. e-Government research clusters network map (by keyword occurrences and average publication per year).

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Based on the map, 'government data processing' is denoted by a larger size circle and 'blockchain and open data" with the lightest colour, which means this keyword only arose in very recent years but has already received significant interest from researchers. Within this cluster, other emerging keywords that have close academic relevancy with the lightest colour are machine learning, digitalization, cloud computing, the internet of things, digital literacies, mediating roles, and intention to use. This points out that with the emerging combination of those keywords and e-Government, researchers did not just only focus on the technical advance, but also started to be concerned about the potential issues posed by these emerging technologies, e.g., the issue of cyber security. Besides, the embedding of open data provides e-Government with a direct link with government data processing, which may be one of the most promising research orientations and has a broad application view in the future.

The colours of circles categorised to the clusters 6 and 7 are relatively lighter and contain some circles with the lightest colour. It means these two clusters are the relatively new research orientations of e-Government, and more new research topics have emerged within these two clusters in recent years, such as mobile applications, electronic health record, sustainability, tax systems and panel data. An interesting finding is the aforementioned emerging topics all have a direct link with the cluster 6 and 7, addition keywords machine learning, digitalization, cloud computing, the internet of things, digital literacies, mediating roles, and intention to use, which means these new advances of other e-Government research clusters may be closely associated with the emergence of that technology. Furthermore, apart from the search keywords (e-Government and its alternative), these are the keywords that have direct links with all other clusters. Therefore, blockchain, IoT, cloud computing, machine learning, and digitalization has potential to become a new hub in e-Government research by establishing the links between all clusters, which may contribute to the reintegration of existing dispersed e-Government clusters.

4. DISCUSSION

This study conducted a scientometric analysis from phase lenses to map over two decades of e-Government research. The study analysed a total of 5540 literature pieces published between January 2003 and October 2023 (spanning over two decades), intending to gain a clearer understanding of the historical clusters and research clusters in e-Government.

The scientometric analysis disclosed that: (a) Literature on e-Government has experienced steady growth during the last two decades; (b) Machine learning, IoT, AI, blockchain, cloud computing, and big data are seen as the key to enabling digital technologies; and exhibit the highest potential for e-Gov adoption.

The identified research clusters in e-Government domain encompass various areas, including open data, artificial intelligent, cloud computing, big data, machine learning, social media, corruption, and smart city. These keywords have expanded the research scope beyond their primary focus and have led to the emergence of new directions in the field. The subsequent overview presents the key findings based on the key research based on the potential keywords.

Table 11. Search terms related to publications on e-Government.

Keywords	Affiliation
Corruption	A critical analysis of corruption's adverse consequences on the effectiveness and transparency of government systems was the most used keyword. Promoting citizen trust, improving the general efficacy of public services, and guaranteeing the responsible and moral application of technical innovations in governance all depend on addressing corruption in the execution of e-government initiatives. Corruption entails trust, criminality, and transparency. (M. Ali et al., 2021; Ibrahimy et al., 2023; Martins et al., 2023). By reducing the likelihood of corruption and encouraging honesty in e-government procedures, scholars may help create strong frameworks that enable governments to use digital technologies to advance society (Sheryazdanova et al., 2016; Balashov et al., 2020).
Open Data	The interplay among open government data, open data practices, and co-creation processes in e-government research highlights the significance of collaborative governance models, data-driven decision-making, and citizen participation. (Xiao et al., 2023). Aspects of data security, such as how governments safeguard individual privacy and control security threats related to open data release, are also discussed in relation to open data. (Esposito et al., 2023). Furthermore, there are many different aspects of open data and e-government that attract public attention, including social impact, empowerment, usability, feedback mechanisms, and awareness. (Lu et al., 2023).
Smart City	A smart city is a multifaceted idea that may be examined from several angles (Kuzior et al., 2023). One of the main topics is the incorporation of smart technologies into city governance. Researchers can assess how well digital solutions improve public services, citizen participation, and general governance efficiency by looking into how e-government practices are integrated into smart city programs. (Shan et al., 2021; Anthopoulos et al., 2022). Smart cities can also talk about how technology can boost economic competitiveness, encourage company innovation, and provide new job possibilities through a thriving business ecosystem. (Ishkineeva et al., 2015; Anas & Cahyawati, 2023).
Artificial Intelligent	In e-Government research, artificial intelligence is essential because it improves decision-making, allocates resources optimally, and boosts public service effectiveness. Artificial Intelligence (AI) techniques provide cutting-edge approaches to threat mitigation by

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	utilizing strong data security protocols and complex anomaly detection. (Al-Besher & Kumar, 2022). Forward-thinking governance, which is distinguished by intelligence and creativity, is envisioned as a step up from traditional e-government in response to the quick development of digital technologies. This evolution looks for creative ways to improve government operations' connectedness, transparency, and citizen participation. (Ruvalcaba-Gomez & Cifuentes-Faura, 2023; van Noordt & Tangi, 2023; Zuiderwijk et al., 2021).
Social Media	Comprehending the influence of social media is crucial. Social media, frequently mentioned in the e-Government and governance pillar, involves dynamic communication channels that play a pivotal role in shaping public opinion and facilitating citizen engagement (Wang & Chen, 2022). The use of social media helps to becomes integral to developing strategies that harness its potential for enhancing government-citizen interactions, promoting transparency, and fostering a more participatory governance model (Bhatia & Mabillard, 2022).
Blockchain	A secure and distributed electronic system for e-governance based on blockchain technology has been proposed (Kamal & Fareed, 2022). Blockchain, as a recent area of study, signals substantial shifts in the delivery of public services, holding the promise to enhance both the transparency of public administration and the trust citizens place in governmental services (Cagigas et al., 2022).
Digitization	The level of digitization in each country is assessed according to its infrastructure. The quality of the data available from the public administration, and e-government development in terms of online services (Splendore, 2016). Unfortunately, E-government is seldom a focal point during the initial stages of digitization, particularly in developing countries where the primary emphasis of the government lies in swiftly promoting digital adoption rather than establishing robust governance structures (Ramadani et al., 2022). Digitization, while offering numerous benefits, can sometimes introduce complexities and administrative challenges. Therefore, the recognition of the importance of reducing these administrative burdens becomes integral to optimizing the user experience and achieving the goals of digitization in public sector practices (Hagen, 2023).
Big Data	In realizing good governance, the government must develop public service innovations through Big Data (Anwar et al., 2022). The integration of large-scale data analytics requires substantial investments in technology infrastructure, skilled personnel, and comprehensive data governance frameworks. Proficient big data management enhances both human and system capabilities, fostering improved smart service performance; however, the direct influence of human capabilities alone may not be significant enough to fully realize the envisioned improvements sought by the government in the context of big data utilization (Alaoui et al., 2021; A. Zhang & Lv, 2021).
Cloud Computing	In the landscape of e-government research, the predominant focus has historically centered on advancing cloud computing and exploring its potential application for service delivery (Karim, 2022). Governments, recognizing the allure of cloud computing, are increasingly drawn to its capabilities in enhancing service delivery, productivity, transparency, and cost reduction (Abied et al., 2022). A solution to long-standing problems is being offered to governments by the increase in public participation on social media platforms. The availability of IT infrastructure and a shift in government advisers' perspectives toward the best possible policy implementation are driving the current development of cloud-based e-governance. This series of events highlights how the landscape is changing and how social media insights, cloud technologies, and changing governmental viewpoints all work together to influence the direction of contemporary e-governance tactics. (Singh et al., 2020).

These keywords make it possible to identify the main potential and difficulties related to e-Government study. The study's conclusions have significant ramifications for the e-government industry and offer practical suggestions. First, it is important to recognize that the body of literature on e-government has steadily grown over the last 20 years. This acknowledgement ought to be a crucial beginning point, encouraging important players in the e-government space to remain watchful and adaptable to the ever-changing terrain to technological developments. By keeping up with the most recent e-government trends and research advancements, the industry may strategically position itself for expansion and innovation.

Second, in the context of e-government, it becomes imperative to prioritize the integration of essential enabling technologies. Fundamental pillars including big data, deep learning, and machine learning have emerged as crucial elements in supporting effective digital transformation projects. Adopting these technologies can provide the sector with data-driven insights, predictive capabilities, and improved decision-making to effectively handle the complex issues that modern e-government frameworks face. The opportunities that follow demonstrate how revolutionary these technologies can be for the field of e-government:

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- *Utilizing advanced algorithms*, in a short amount of time, e-government systems can examine several design configurations. This guarantees ideal system architecture, improving e-government solution design accuracy and efficiency. (Bansal et al., 2022).
- E-government may encounter *scheduling and planning challenges*. Dynamic schedules can be created by strategically analysing past project data and current development. These flexible timelines take into account unforeseen circumstances and possible delays, guaranteeing the prompt and effective execution of e-government projects. (Gong et al., 2020; Malodia et al., 2021).
- *Proactive risk assessment*, allows for more informed decision-making based on project specifications and previous data. By reducing possible risks, this guarantees the successful implementation and seamless operation of e-government projects. (Ali et al., 2020; Zefferer et al., 2023).
- It is possible to identify irregularities and departures from design standards in the e-government space by utilizing *visual recognition algorithms*. This guarantees standard compliance, which aids in the creation of reliable and secure e-government solutions. (Zhang et al., 2022).
- *Systematic analysis of requirements*, availability, and restrictions facilitates optimal resources in the e-government context. By doing this, waste is reduced and resources are better used for the efficient deployment and upkeep of e-government systems. (Glyptis et al., 2020).
- Information exchange is more efficient when *data integration* processes in e-government systems are streamlined. This makes it easier for departments or agencies to work together, guaranteeing a unified and well-coordinated strategy for providing e-government services. Increased cooperation helps e-government programs make better decisions and be more effective overall. (Haryanto, 2023).
- Sustainable practices must be incorporated into the design and functionality of e-government platforms. This entails determining and reducing the environmental impact of technology use. Eco-friendly e-government initiatives are facilitated by tactics like efficient energy use, cutting down on electronic waste, and implementing eco-friendly procedures. Along with supporting global sustainability goals, this also improves e-government projects' standing as socially conscious undertakings. (Firmandayu & Elfaki, 2023; Han et al., 2023).

The results of the study highlight the significant potential for using state-of-the-art technology in these fields, demonstrating their capacity to improve compliance measures, optimize resource allocation, and streamline operations within e-government projects. It is possible to improve economic outcomes and strengthen social and governance standards at the same time by strategically aligning innovative technology with sustainability goals (Nham et al., 2023; Martins & Veiga, 2022; ElMassah & Mohieldin, 2020). Moreover, taking advantage of the many benefits that come with implementing cutting-edge technologies, especially in the early stages of e-government's development and deployment, can result in notable improvements in overall performance. In the end, the e-government industry may improve execution while reducing mistakes and delays by utilizing cutting-edge technological solutions for effective strategic planning, risk assessment, and real-time monitoring.

Despite the difficulties mentioned, the industry has a lot of opportunities thanks to the use of innovative technology and the dedication to sustainable practices in e-government. The fields of planning, design, implementation, and general administration could undergo radical changes if these technology innovations and moral precepts are adopted. The advantages of cutting-edge technology, such as automation, data-driven decision-making, and complex analytics, may result in improved productivity, cost-effectiveness, and operational efficiency. At the same time, implementing sustainable practices has the potential to maximize resource use, reduce environmental impact, and promote beneficial social outcomes. The e-government industry can steer toward a more sustainable future by proactively addressing issues and leveraging the connections between cutting-edge technology and sustainability. This strategic strategy aligns efforts with a commitment to social and environmental responsibility in addition to economic viability. By working together, this integrated approach advances the overall goals of sustainable development and creates the framework for the formation of more sustainable urban futures.

5. CONCLUSION

This research conducts an extensive scientometric analysis of 5,540 e-government-related publications from the previous 20 years, with a focus on sustainability and various implementation stages. This study provides a current and concise summary of the field's knowledge structure and evolutionary trajectory by carefully reviewing the body of extant literature. With a strong focus on cloud computing, big data, blockchain, artificial intelligence, machine learning, big data, and the internet of things (IoT), the results show a transition from basic automation to complex neural network platforms.

Although this study provides a solid basis, there are many facets of e-government that require more investigation. Future research could focus on addressing the issues that have been identified, such as determining whether deploying technology in the e-government sector is cost-effective, guaranteeing equitable and universal access to solutions, and addressing problems with data integration and interoperability. It should also explore the legal implications that technology adoption may bring about in relation to standards, ethics, contracts, cybersecurity, intellectual property ownership, liability, data privacy, employment impact, transparency, and the changing legal environment. Research should also look into the possible ethical and societal repercussions of e-government technology adoption, including how it may affect employment and the function of human workers in an increasingly automated environment. In order to make decisions in sustainability-related fields more accurate and efficient, future research could concentrate on improving models and algorithms. Additionally, it would be beneficial to develop thorough frameworks and rules for integrating sustainability concepts with technology in a smooth manner throughout all e-government phases. Scholars may keep developing the area and paving the way for effective and sustainable e-government activities in the future by following these research avenues.

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