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The Concept and Future of Electronic Voting in Election Systems

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Abstract:
The purpose of this study is to explain the development of research on the topic of e-voting. This research uses a qualitative method using a scoping review approach. Documents retrieved in the Scopus database are limited from 2013-2023. The findings of this study show that the development of research on e-voting has a significant impact on the dynamics of various countries that organize elections. Theoretically, the mapping of research on e-voting is inseparable from the concepts of e-democracy and e-government. This illustrates that the application of e-voting is a consequence of technological developments in politics that require countries to modernize the democratic system to form and run the government legally. Furthermore, practically speaking, for future research on this topic, taking the point of view of e-voting machines is a huge opportunity and greatly contributes to the development of this method of implementation in all countries that adhere to democratic systems.

Keywords:
E-voting; A-Meta Analysis; Election; Scopus

Introduction

The employment of software and hardware to support individual voting through a computer information system is known as electronic voting (or "e-voting") (Samihardjo & Lestari, 2021; Sheranova, 2020). E-voting offers more rapid and accurate results, better data quality, increased efficiency, and lower costs (Sadykova et al., 2018). A lot of people have adopted it all across the world, while emerging nations like Russia, Azerbaijan, Brazil, Paraguay, and India have either adopted e-voting at polling places or conducted e-voting experiments (Essex & Goodman, 2020). Meanwhile, developed nations like Australia, Belgium, the Netherlands, the US, France, Germany, and Canada have quickly accepted e-voting technologies(Y.-Q. Zhu et al., 2020).

The majority of EMBs worldwide have been inspired by the advancement of technology and information to adopt new technologies with the purpose of enhancing a

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more credible election process (Crothers, 2015; Shat & Pimenidis, 2017). A majority of the 106 nations adopting electoral technology as tracked by International IDEA utilize it for tabulating votes, followed by 55% for voter registration, 35% for biometric voter registration (fingerprints, retina, etc.), 25% for biometric voter verification, and 20% for electronic voting. There are still manual and modern electoral systems that are appropriate for each nation's circumstances; not all nations use technology exclusively in their elections (Samihardjo & Lestari, 2021). The data show that e-voting technology is still only sometimes used. Due to limited technology, security concerns, and extremely high credibility, technology-based voting, such as e-voting, has not been implemented universally. It is not always readily accepted, put into practice, and effective—not even in industrialized nations in the world. It is not uncommon for what occurs to be even better, namely being rejected by the community or political elites and/or failing to implement it successfully such that the general public does not trust it (Shankar et al., 2021).

Previous research relevant to this topic points to the viewpoint of Secure E-voting. The integrity of democracy is supported by secure voting procedures. The procedure of tallying is essential in deciding the winner in paper-based voting. Yet, it is also the point where a lack of transparency makes a voter's ballot the most susceptible to being changed, miscounted, or excluded without their knowledge (whether unintentionally or on purpose). A typical countermeasure is to set up public oversight with independent observers present during the physical tallying process in the hopes that any misconduct by the TAs would be noticed and documented (Al-Ashoush et al., 2023; Mccorry et al., 2021; Shankar et al., 2021).

Other studies have also discussed e-voting from the perspective of candidate selection. Candidate selection is the process through which the most qualified applicants are chosen for a given position. Keep in mind that human resources are directly responsible for the efficient operation of government, and the engagement of skilled employees with appropriate skills in governance is a matter of national significance. This viewpoint refers to current concerns when discussing the selection of candidates with the requisite abilities in the appointment of the elected candidates to administrative positions as a consequence of electronic voting (Alguliyev et al., 2019a, 2019b). Then, research from (Essex & Goodman, 2020; Marcacini & Barreto, 2019; Schulz & Schafer, 2017) discusses e-voting from a legal protection perspective. As elections around the world become digital, governments have begun adopting regulations to govern the use of voting technologies and protect electoral integrity.

Based on the explanation of previous research, it can be grouped into three namely secure, candidate selection and legal protection e-voting. Therefore, the novelty contribution of this research is more focused on explaining the development of research on the topic of e-voting. This research visualizes data using the Vosviewers software application and analysis features on the Scopus database. VOSviewers has been utilized extensively to carry out bibliometric mapping investigations in a variety of research disciplines(Subekti et al., 2022).

E-voting is a combination of technology with a democratic process so that voting is more efficient and convenient for voters (Sheranova, 2020). E-voting is a democratic technology that enables individual citizens to participate electronically in political decision-making. This voting system primarily records, stores, and processes election data as digital data (Al-Ameen & Talab, 2013; Khan et al., 2021). An audit trail is created and maintained by the electronic voting system, which uses electronic devices and digital information to create ballots, allow voters to cast ballots, count votes, convey results, and

broadcast vote counts (Alguliyev et al., 2019a; Cserny & Nemeslaki, 2018; Wenda & Stein, 2017). Many developing nations are attempting to transition their political processes to electronic voting. This is due to the numerous benefits that come from employing electronic voting instead of traditional elections (Müller-Török, 2019).

The advantages of e-voting over the conventional system / ballot according to Kumar & Walia, (2011) include: Removing the risk of disputed and invalid votes, which is frequently the main source of election conflict. making counting more quicker and more precise than with traditional approaches. reducing the amount of paper used in order to protect the environment. lowering the price of committee, printing, and distribution. Meanwhile, according to (Mamokhere & Mabeba, 2022; Marcacini & Barreto, 2019), quick and precise vote counting is one of the benefits of electronic voting. Spend less on ballot production and distribution. allowing those with disabilities access. granting those with restrictions access. There are numerous language versions of ballot sheets. allowing access to more vote options information. can be used to suppress political parties that lack voting rights.

There are two different kinds of electronic voting systems that can be used, in theory. First, electronic voting at the pooling booth: electronic voting take place at specific preset locations, and voters go to those locations to make their selections. The second is online e-voting, which is done in real time and eliminates the need for voters to travel to specific locations. Instead, they can vote from any location with an internet connection (AlAbri et al., 2022). An electronic voting system should be concerned with the following minimum requirements: guarantee that only individuals with the right to vote are able to vote; guarantee that each vote is taken into account and that it is only counted once; maintain the voter's right to form and express their opinions without fear of intimidation or undue influence; protect the vote's confidentiality throughout the entire voting process; and guarantee accessibility to the greatest number of people (Chotim & Pramanti, 2020; López García, 2016; Maurer, 2018).

Methodology

This research uses qualitative methods Creswell & Creswell, (2017) using a scoping review approach. Scoping reviews are a thorough and open process for locating and thoroughly examining all pertinent literature associated with the research issue. A scoping review's goal is to map the body of research on a subject (van Twist et al., 2023). Scoping reviews aim to offer an overview of a potentially huge and diverse body of literature relevant to a wide issue (Pham et al., 2014; Tricco et al., 2016). The article in the Scopus database served as the study's data source. Scopus is the world's largest index and has a solid reputation among academics, it is used as a database (Moed et al., 2016; J. Zhu & Liu, 2020). Documents retrieved in the Scopus database are limited from 2013-2023. The reason is that in that period, the use of technology in politics, especially elections, has become increasingly widespread. Technology is used in the context of organizing elections. Article data obtained from the Scopus database amounted to 51 articles relevant to this research problem.

Research strategies in retrieving data in the form of documents in the Scopus database are: Title (E And Voting) And Pubyear > 2012 And Pubyear < 2024 And (Lim TTo (Subjarea , "Soci")) And (Limit To (Doctype , "Ar")) And (Limit To (Language , "English")) And (Limit-To (Srctype , "J")). In analyzing and displaying data, this study uses two features. First, the analysis feature in Scopus which aims to display bibliometrics of the articles that have been obtained such as the number of publications each year,

author, publication source, affiliation and country. Second, Vosviwers software is used to analyze and display data about network, and topic density from the theme of electronic (Van Eck & Waltman, 2020).

Results and discussion

Bibliometrics Analysis of E-Voting Research Publication

The bibliometric analysis displayed is in the form of the number of publications each year, publication sources, authors, countries and affiliations that contribute to publishing research on the topic of electronic voting. It aims to see how theories on the topic of electronic voting are developing around the world. Moreover, this bibliometric analysis is also important, to map which research publications on the topic of electronic voting in elections have a significant impact in academia, in this case based on the number of citations.

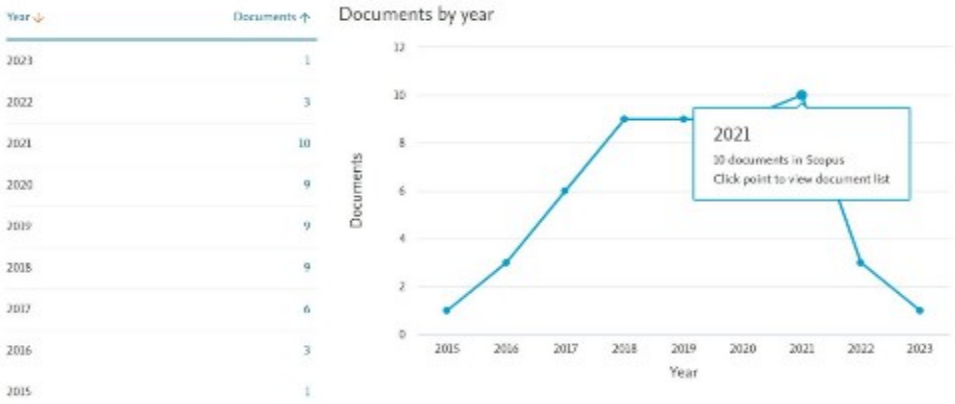

Figure 1. Document by years

Figure 1 shows the data of research publications on e-voting every year from 2013-2023 indexed by Scopus. This study found that 2021 was the year with the highest number of e-voting publications with 10 documents. This shows that in a complex way, the dynamics of elections around the world have a significant impact on research publications on e-voting. Then, overall, it can be mentioned that research publications on e-voting in 2015 had 1 document, in 2016 there were 3 documents. In 2017 the publication increased to 6 documents, and consecutively in 2018-2020 there were 9 publication documents each. Whereas in 2022 it dropped by only having 3 documents, and at the beginning of 2023 it only had 1 document.

Figure 2 shows the authors or academics who are experts in the discussion of evoting. The data in figure 2 explains that Alguliyev, R. has 2 documents, Hao, F. has 2 documents, Mehrnezhad, M. has 2 documents. Then, Muller-Torok, R. also has 2 documents, Shahandashti, S.F. has 2 documents. Furthermore, Toreini, E. also has 2 publication documents on e-voting, as well as Yusifov, F. who has 2 documents. while Abdurrohman, A. only has 1 publication document on e-voting indexed by Scopus.

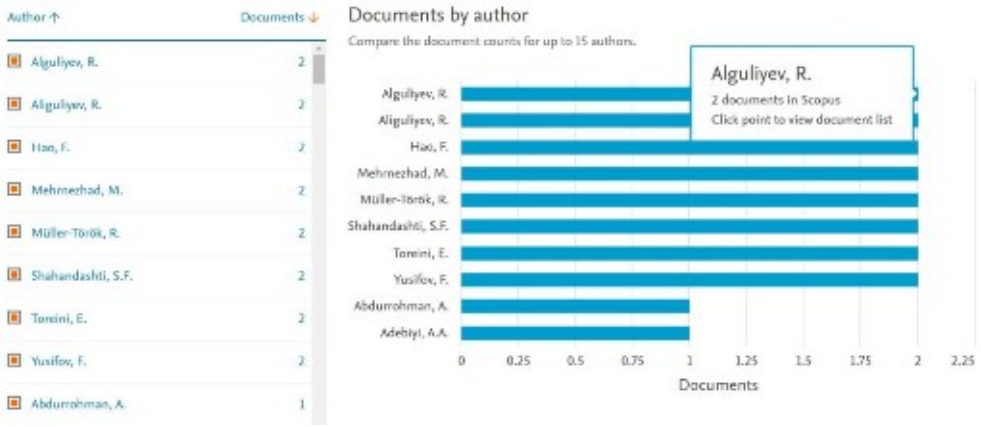

Figure 2. Document by author

Figure 3 shows the data of the top 7 affiliates that contribute to research publications on the topic of e-voting indexed by Scopus. The University of Applied Science- Public Administration and Finance Ludwigsburg has 2 publications, Newcastle University has 2 publications, the University of York has 2 publications, the University of Warwick has 2 publications. The University of Edinburg has 2 publications on evoting, the Azerbaijan National Academy has 2 publications and the Institute of Information Technology of the Azerbaijan National Academy of Sciences has 2 publications.

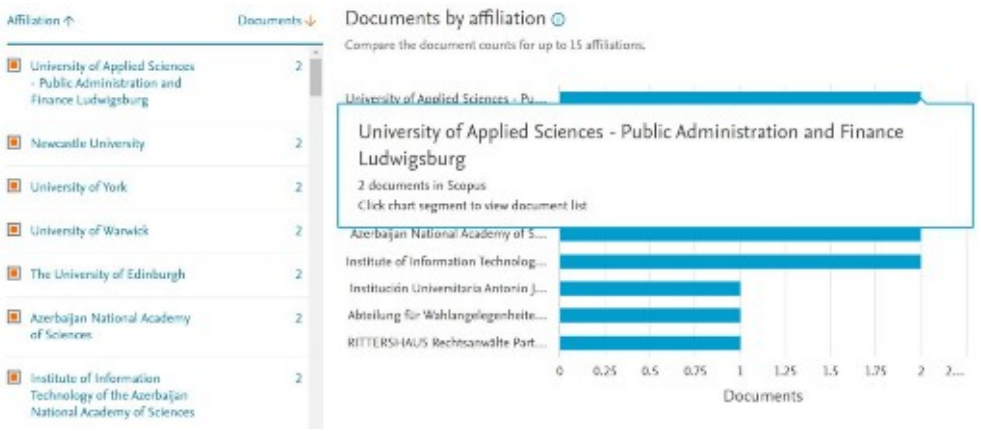

Figure 3. Document by affiliations

Figure 4 shows the top 7 publication sources that contribute the most to the research topic on e-voting. The findings in this study show that Electronic Government and Jusletter IT are the most highly contributed publication sources with 4 publication documents. This illustrates that for authors or academics who are interested in the topic of e-voting, these two publication sources can be an open choice. IEE Security and Privacy has 3 publication documents, Computers and Security has only 2 documents. Furthermore, Government Information Quarterly, International Journal Of Electronic Governance and International Journal Of Electronic Government Research have 2 documents each. Based on this data, it can be understood that the topic of e-voting is inseparable from issues of government, politics and ICT. Therefore, the sources of publications that contribute to research on e-voting are more likely to have this scope.

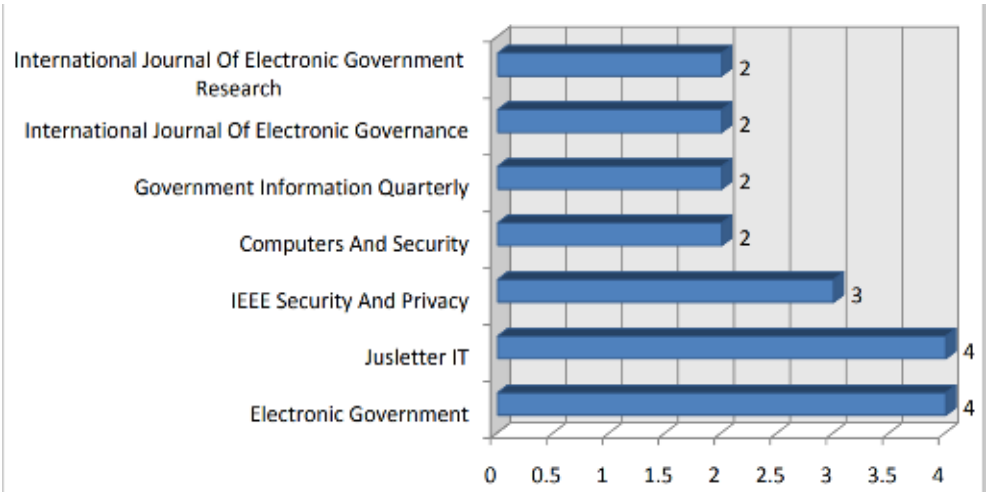

Figure 4. Document by source

Figure 5 shows the 5 most dominant countries in Scopus-indexed e-voting research publications. This study found that the United Kingdom (UK) is the most contributing country in research publications on e-voting with 8 documents. This indicates that academics in the UK are still very interested in discussing the use of e-voting, both in their country and comparing with other countries. Many of countries that failed in the implementation of e-voting such as In the UK, the implementation of e-voting was limited only to testing, a group of digital right advocacy who observed the testing of e-voting showed that the implementation of cannot be trusted.

Indonesia is the second most contributing country in Scopus-indexed research publications on e-voting with 5 documents. This is an interesting finding, because the issue of e-voting has been very vocal in Indonesia's elections. However, it is still widely debated in many circles, with the most fundamental question being related to the readiness of the implementation of the system in Indonesia both in terms of infrastructure and human resources. General Indonesian people are prepared to use the e-voting system, only trust factors are a concern. The using e-voting systems does not directly increase public trust towards the government. Thus, that the e-voting system developed must take into account factors such as system security, data security, communication network security, and applicable standards with best practices so that the e-voting system built will be able to increase public trust as its users(Risnanto, Rahim, & Herman, 2019).

Table 1 shows the top 10 most cited documents on e-voting. Research publication with the title ”Fraud, convenience, and e-voting: how voting experience shapes opinions about voting technology” became the most influential and often referred to by many authors, as evidenced by the number of citations that totaled 5 times. The study's findings demonstrate that people prefer the systems they have previously used and that they favour less sophisticated alternatives to touch-screen voting devices when they are primed with concerns about voting fraud. especially among voters who have had prior experience utilizing e-voting technology. Policymakers would be well-served to pay close attention to how the case for new voting technology is portrayed when they consider implementing new voting systems in their states and counties (Alvarez et al., 2018). Then, the publication of an article entitled “On Secure E-Voting over Blockchain” became the second most influential with 4 citations. This research explains examines three different voting scenarios— decentralized voting, centralized distant voting, and centralized voting at polling places—and secure ways to execute electronic voting over a blockchain in each.

Almost all voting scenarios that happen in real life are covered by these parameters. The blockchain of Ethereum hosts a proof-of-concept implementation for decentralized voting (Mccorry et al., 2021).

Table 1. Identification of Document Publication

No	Title	Author	Source	Cited
1	Fraud, convenience, and e-voting: how voting experience shapes opinions about voting technology	(Alvarez et al., 2018)	Journal of Information Technology and Politics, 15(2), pp. 94–105	5
2	On Secure E-Voting over Blockchain	(Mccorry et al., 2021)	Digital Threats: Research and Practice, 2(4), 33	4
3	MCDM for candidate selection in e-voting	(Alguliyev et al., 2019b)	International Journal of Public Administration in the Digital Age, 6(2), pp. 35–48	4
4	Designing an E-Voting Framework Using Blockchain Technology: A Case Study of Oman	(AlAbri et al., 2022)	International Journal of Electronic Government Research, 18(2)	3
5	End-to-End Verifiable E-Voting Trial for Polling Station Voting	(Hao et al., 2020)	IEEE Security and Privacy, 18(6), pp. 6–13, 9152966	3
6	MCDM approach for weighted ranking of candidates in e-voting	(Alguliyev et al., 2019a)	Informacijos Mokslai, 86, pp. 8–22	3
7	The challenges of e-voting	(Cserny & Nemeslaki, 2018)	Public Policy and Administration, 17(4), pp. 497–509	3
8	Cheating the Machine: E-voting Practices in Kyrgyzstan's Local Elections	(Sheranova, 2020)	European Review, 28(5), pp. 793-809	2
9	E-Voting systems to prevent conflicts caused by false results in Elections in Indonesia	(Chotim & Pramanti, 2020)	International Journal of Innovation, Creativity and Change, 12(3), pp. 508–517	2
10	Turnout, preferential voting and vote flows in the E.U. election1	(Pritoni & Vignati, 2019)	Journal of Modern Italian Studies, 24(5), pp. 691–715	2

Mapping of Network and Density: Electronic Voting Topic

This study displays the network, and density of research publications on evoting

from 2013-2023 which are indexed by Scopus. The analysis to display the network aims to find out what keywords have a strong relationship with the topic of e voting. This will help understand the theories used in scientific research publications on this topic. Moreover, this analysis will also help to understand which keywords are relevant to e-voting studies. Furthermore, the visualization of overlays aims to see the trend of e-voting research based on the keywords used. Then, the density analysis aims to find out what keywords have a large enough opportunity to be investigated further by researchers with the topic of study on e-voting. Density analysis is used to see which keywords have been discussed a lot or which have not been widely discussed related to this topic.

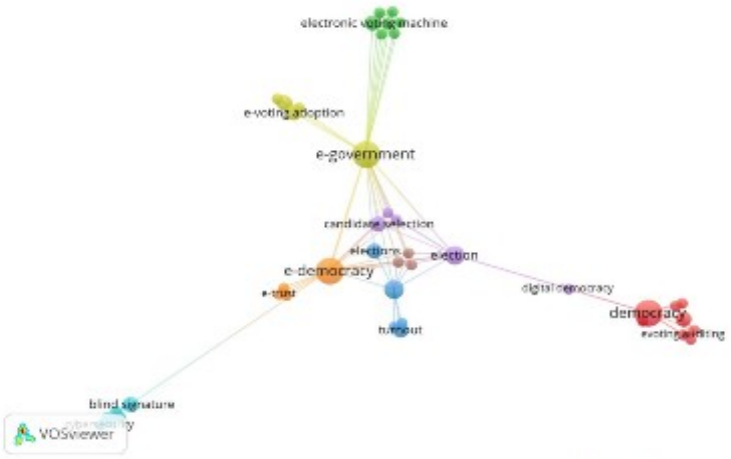

Figure 6. Network Of Electronic Voting Topic based on keywords

Figure 6 shows a network of e-voting topics based on keywords. The analysis in Figure 6 was generated using Vosviwers software. The results of the analysis resulted in 8 clusters marked with different colors. Cluster 1 marked in red consists of keywords: democracy, anynomous votes, e-voting system, e-voting auditing, information society, political election, transparency, and trust in government. Then, cluster 2 is marked in green which consists of the keywords: electronic voting machine, i-voting, independent national election, k-voting, and m-voting. Cluster 3 is marked in dark blue with keywords: direct democracy, election, internet voting, participation and turnout. Cluster 4 is marked in yellow with keywords: developing countries, e-government, e-voting adoption, and trust of technology. Cluster 5 is highlighted in purple with keywords: candidate selection, digital democracy, e-government maturity, elections, and governance. Cluster 6 is marked in light blue with keywords: blind signature, cybersecurity, mobility, security. Cluster 7 with orange color consists of keywords: digital election, e-democracy, e-trust, e-voting technology. Cluster 8 marked in brown consists of keywords: electoral process, electronic democracy, and electronic government.

Table 2 displays keyword network data related to the topic of study on e-voting. Based on these data, it shows that e-democracy is the most powerful keyword in the network with the topic of e-voting with 40 total link strengths. Followed by the e-government keyword which has a power of 18. Then, the election keyword also has a power of 12.

Table 2. Keyword and Occurrences

No	Keywords	Occurrences	Total Link Strenght
1	E-Democracy	29	40
2	E-Government	6	18
3	Election	3	12
4	Internet Voting	3	9
5	Candidate Selection	2	8
6	Democracy	6	6
77	Blind Signature	2	4
88	E-Voting Adoption	2	4
99	Online Voting	2	4
110	Political Election	2	3

Figure 7 visualizes the density of research publications on e-voting from 2013-2023 indexed by Scopus. Vosviewers Software incorporates the primary colors red, green, and blue (RGB) into each visualization it creates. The density visualization is used to see the density level or the amount of a studied issue. The more a node is reddish, the more research has been done on that issue. On the other hand, the greener a node, the less research on that topic will be done(van Eck & Waltman, 2010). The research findings show that electronic voting machine is a topic that has a great opportunity to be researched in relation to the topic of e-voting. This is because there are still not many keywords that take this point of view, as evidenced by the green color around it.

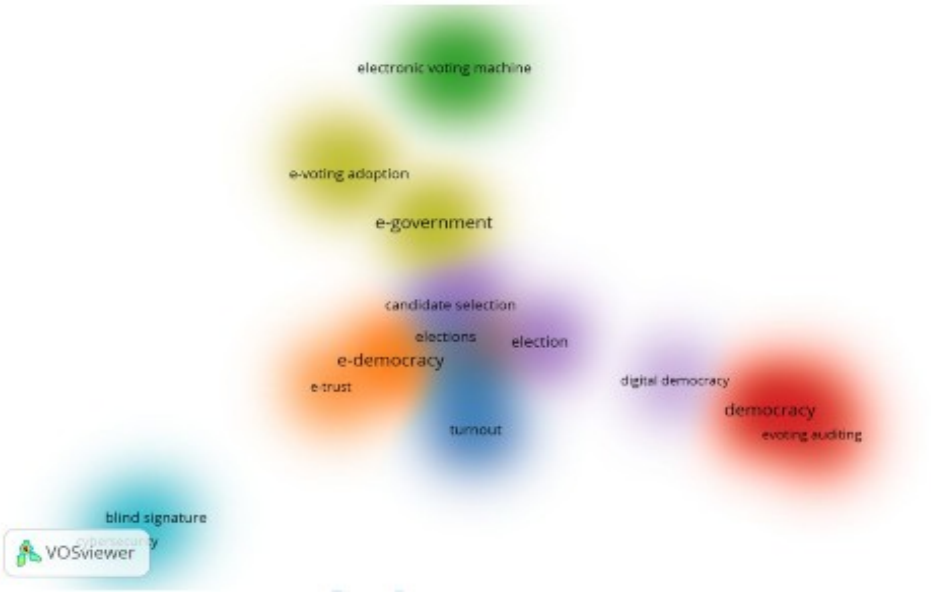

Figure 7. Density of Electronic Voting topic

Discussion

The participation of the populace in the fair and free election of their representatives to represent them is the most potent representation of a democracy. Voting is considered to be the act that currently defines the interactions between citizens, government, and democracy, even while a lack of other forms of engagement may be the reason for declining turnout or certainly cause for concern. E-voting thus assumes a significant symbolic function in e-democracy. Modernizing the voting process, whether through electronic counting procedures or remote voting over the Internet, seems to be necessary for a modern e-enabled system of democratic governance (Shat & Pimenidis, 2017; Smith & Macintosh, 2003). In line with this, the findings of this study explain that the topic of e-voting has an important relationship with the theories of e-democracy and e-government. This illustrates that e-voting is a tangible form of implementing e-democracy principles. Moreover, e-democracy is part of the concept of e-government. According to Alcaide–Muñoz et al., (2017) E-government frequently includes claims of greater advantages and expectations that the use of ICTs will change how governments operate. The e-Government period represents a new paradigm in which the complete spectrum of democratic and institutional values are now applicable(Sundberg, 2019).

Then, electronic government is the change of government via the use of information and communication technology, with a focus on increasing responsibility, effectiveness, and accessibility. It is founded on the establishment of information policies and the dissemination of information. Electronic government resources for boosting citizen engagement and the growth of engaged citizens that affect democratic processes. Electronic democracy, or e-democracy, refers to technology advancements that enable democratic institutions to be strengthened and empowered with the use of the internet (Spirakis & Spiraki, 2010). E-democracy aims the production of functional democratic processes like communication, information providing and decision-making after electronic public dialogue and voting. E-democracy is the cornerstone in a social system as citizens can have an active participation in the public issues (Dalmau, 2016; Musiał-Karg & Kapsa, 2020).

This research found that internet voting is a keyword that is also directly related to the discussion on this topic. This is in line with research findings from Vassil et al., (2016) that E-voting has the potential to lower participation thresholds and increase turnout, but its technical complexity may produce other barriers to participation. There was a lack of conclusive evidence regarding whether the new voting technology had diffused homogeneously among the voting population or had remained a channel for the resourceful and privileged due to the aggregate share of e-voters increasing with each election, with one third of voters now casting their vote remotely over the internet. Diffusion has occurred, according to our data, but it wasn't until after the first three e-enabled elections. Internet voting thus has the ability to appeal to many different sorts of voters, heal societal gaps, and establish itself as an innovative, inclusive voting system. Throughout the past few decades, turnout rates have fallen in many advanced democracies. Many nations are moving forward with convenience voting measures, such Election Day registration and postal voting, that seek to streamline the voting process and hence enhance political participation, in an effort to buck this trend(Mendez & Serdült, 2017).

This topic is being debated more and more in relation to internet voting (i-voting), a voting technology that enables voters to vote remotely over the Internet. I-voting has a contentious past despite being less than two decades old. Around the turn of the 2000, i-

voting was widely hailed as the "magic ballot" that would persuade many more individuals to cast ballots (Germann & Serdült, 2017). Furthermore, this research found that the United Kingdom as a country in Europe is the country that contributes most to the discussion about e-voting. The motives and driving forces of e-democracy are manifold. However, at the centre of all the efforts of (not only but in particular) the European Union (EU) to apply e-democracy and e-participation tools is the particular problem that the EU (and other transnational political bodies) has to directly refer and relate to a specific constituency, causing problems of legitimising its policy (Lindner et al., 2016). In order to stimulate the further formation of a European public sphere via (e-) participation and reaping the benefits of participatory potentials with the aim of strengthening democracy at the European level. Based on the analyses of electronic, Internet-based remote voting, concerning cost-benefit considerations, technical feasibility and, most importantly, political legitimacy. On balance, the large-scale and mandatory introduction of e-voting systems in binding elections for public office cannot be recommended at present (Kneuer, 2016; Sorice & De Blasio, 2019).

Furthermore, this study found that the topic that has a great opportunity to be researched is from the point of view of e-voting machines. This finding can be seen from the data in figure 7 which shows that keywords about e-voting machines in density are not marked in green. Electronic Voting Machine (EVM) is a simple electronic device used to record votes in place of ballot papers and boxes which were used earlier in conventional voting system (D. A. Kumar & Begum, 2012). Election officials are developing a variety of technologies to address a wide range of voting difficulties, including: System adaptability and acceptance by common and preferred stockholders Individuals who live in isolated communities, some of them possibly illiterate as well. System functioning should be as similar to a traditional paper ballot system as possible. Cost-effectiveness and simplicity of system deployment and maintenance. System security and dependability with regard to tamper resistance, error-free operation, etc., Voting process efficiency and results announcement speed (Djanali et al., 2018; Shin-Yan & Jiun-Ming, 2018).

Research from Prasad et al., (2016) explain that the e-voting machine system has to be further studied and innovated to reach all level of community, so that the voter confidence will increase and election officials will make more involvement in purchasing the innovated e-voting machine for conduct smooth, secure, tamper- resistant Elections. Meanwhile, research findings from Marcacini & Barreto, (2019) that e-voting systems have shown to be very quick to deliver results, but serious concerns have been raised about their security and transparency. There is no possibility to run an election that satisfies all three of these conditions at once. Votes must be anonymous, publicly auditable, and entirely digital. The use of 100% electronic voting systems must be abandoned in favor of software-independent voting machines and a paper audit trail in order to ensure security, confidentiality, and transparency.

Conclusion

The conclusion of this study explains that the development of research on e-voting has a significant impact on the dynamics of various countries that hold elections. This is because e-voting research serves as the basis for studies related to countries that are just starting to implement e-voting and also as evaluation material for countries that have implemented it first. Theoretically, the mapping of research on e-voting is inseparable from the concepts of e-democracy and e-government. This illustrates that the

implementation of e-voting is a consequence of technological developments in politics that require countries to modernize the democratic system as an effort to form and run the government legally. Furthermore, practically speaking, the discussion on the topic of e-voting can be viewed from many angles. However, for future research on this topic, taking the point of view of e-voting machines is a huge opportunity and can greatly contribute to the development of this method of implementation in all countries that follow the democratic system.

Moreover, the limitations of this research only take data from one source, namely the Scopus database. Therefore, recommendations for future research can use data sources from other databases such as web of science and others. This is useful to get more comprehensive data and get a broader perspective on e-voting research.

Acknowledgement

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