



Mapping Publication of E-Voting, Bibliometric Analysis, and How About Opportunities Indonesia for That?

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Abstract. This study aims to find out the development of research on e voting from data based scopus and how opportunities are in Indonesia. To find out, the author reviewed an article with the theme of e-voting from the 2009-2022 edition and compiled between data based scopus and e-voting studies that have been carried out in Indonesia. This research uses qualitative research methods by reviewing previous research on e-voting. The data source is a selection article of e-voting studies from data based scopus as many as 347 documents and e-voting studies in Indonesia with 97 documents edition 2009-2022. The results of this study were then analyzed and visualized using VOSviewer. The results showed that e-voting studies in the international scope have studied the design of e-voting using blockchain methods and protecting the privacy security of voters. Then in Indonesia, the study of e-voting is still being studied in the scope of the election of the BEM chairman on campus and the Election of Village Heads. The study of e-voting in Indonesia also still tells various problems such as the absence of an integrated e-voting system (e-voting innovation is only based on the needs of a certain region only), e-voting infrastructure, legal protection, and the pros and cons of various elements. The significance of this research is that the future opportunity for Indonesia is the development of e-voting with blockchain methods or designs that are integrated into unity between regional-level e-voting up to national and the development of privacy standards or security protections for voters in voting.

Keywords: E-voting; Bibliometric; Blockchain; Elections

1 Introduction

Voting is an integral part of the process inherent in a democratic society. Electronic Voting (e-voting) is a digital voting platform in carrying out the rights and obligations of a citizen. However, in practice, the implementation of e-voting found several cases in countries such as North Carolina 2019 (vote controversy) and Georgia in 2018 (server deletion) [1]. As a result, the voting process using an e-voting system can lower public confidence in the organizers of voting [2].

In reality, many countries such as the Netherlands, Germany, Paraguay, Ireland, the United Kingdom, and the United States have failed to implement the e-voting system [3] [4]. The factor that influenced him came from his legislator on e-voting in the

Netherlands. In the United States itself, the failure of e-voting was triggered by controversy between supporters and opponents of technology.

In addition to departing from the failures experienced by these developed countries, several countries already have a good track record on their realization. Here are the countries that are successful in realizing e-voting

Table 1: List of Countries Implementing E-voting and Their Status

Status	Country
Countries that have implemented e-voting completely	Estonia, Norway, Switzerland, India, Brazil and Philippines
Countries that have implemented e-voting partially	Argentina, United States, Belgium, Canada, Japan. Mexico, France and Peru
Countries that cancelled the implementation after conducting try outs of e-voting	Australia, Costa Rica, Finland, Guatemala, United Kingdom, Ireland, Italy, Kazakhstan, and Norway
Countries that did not continue the implementation of e-voting	Netherland, Germany and Paraguay
Countries that are in the process of Testing e-voting	Bangladesh, Bhutan, Ecuador, Mongolia, Nepal and Indonesia

Source: [6]

To realize the e-voting system there are at least nine components or criteria in it as explained by [7] :

- a. **Ballot Privacy:** Ballots that are unknown to others and voters can't know other people's choices
- b. **Individual Verifiability:** voters can verify the vote counting process
- c. **Eligibility:** legitimate voters who can exercise voting rights
- d. **Fairness:** the electoral system cannot be manipulated by anyone
- e. **Uniqueness:** voters can only cast one vote
- f. **Robustness:** No one is to manipulate the vote until the final result
- g. **Universal Verifiability:** anyone can verify clarity with election organizers
- h. **Receipt Freeness:** no receipt can be obtained to prove how a voter casts his or her or her vote
- i. **Coercion Resistance:** no cooperation between voters and coercion to prove the form of the vote

In Indonesia, e-voting was first conducted in Jembrana Regency, Bali, in 2009 to elect the Head of Hamlet using the e-KTP system [8]. The reason behind this is the acceleration of counting, community access, transparency, and saving costs [9]. However, in the overall national context, the realization of e-voting still leaves several problems including: 1) the absence of a valid citizen identity, 2) political culture and democracy, 3) digital misery, 3) participation, 4) technology, 5) organization [10]. Apart from technical and infrastructure aspects, the design of e-voting itself also does not have an accumulated ternology system [11]. Therefore, the opportunity or design of e-voting in Indonesia is still wide open in future development.

Then, to find about this study, bibliometric can analyze what is the problem and design

about that. Using Bibliometric method was then adopted as one of the Science Mapping Analysis (SMA) in research with the aim of knowing the development of research and seeing the gaps of previous research [12]. The research mapping process classifies article publications according to the theme that has been determined in the scopus data base. Then, visualization analysis through VOSviewer is used to analyze the results, networks, and trends of information production in NPS [13] Thus, the mapping process of bibliometric analysis can produce concepts or theories that are widely adopted by researchers and open up new concept spaces for further research.

Research on the study of e-voting in the direction of e-democracy raises an ever-growing interest and perspective for researchers. Various researchers intensely publish their work in scientific articles and can be judged their academic novelty. Therefore, the author will explain the mapping and trend of research publications with the theme of E-voting through bibliometric analysis. Therefore, this study aims to see the extent to which research with this theme presents authors and all articles that show significance in journal articles in articles indexed by scopus and how opportunities Indonesia for that?

2 Methodology

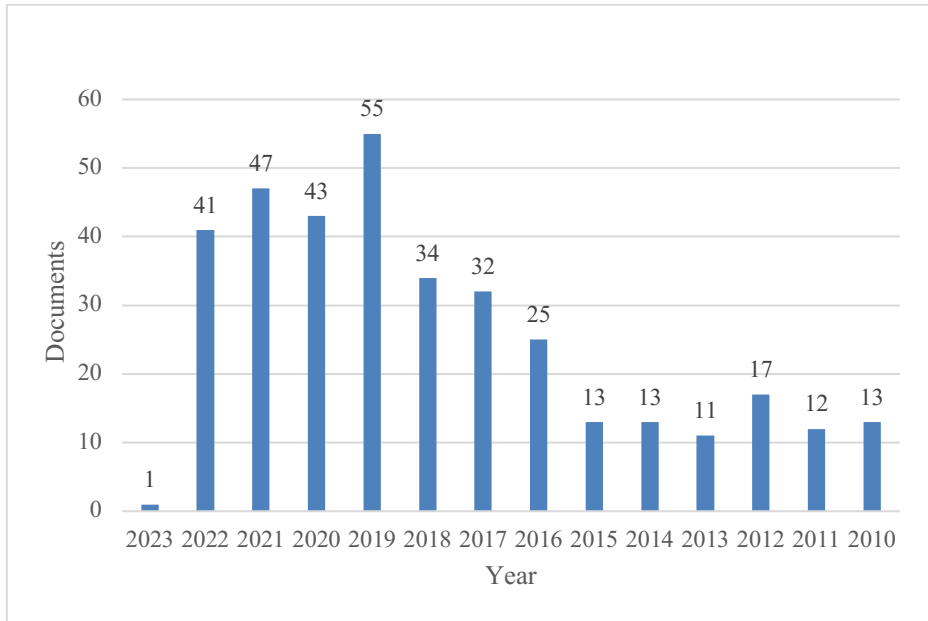
The research method used is qualitative by analyzing articles with the theme of E-voting. Research data obtained from the scopus data base for e-voting research within the scope of the world. The scopus databased platform uses the platform by capturing E-voting articles with a total of 347 documents international and in Indonesia using using platform Google Scholar to find articles then the result is 97 documents. The analysis used the scopus search engine and Google Scholar with the period 2009-2022 to identify literature regarding E-voting. The subcategories used to identify the study were: TITLE-ABS-KEY(e-voting) AND PUBYEAR > 2009 AND (LIMIT-TO (OA,"all")). Data sourced from scopus is categorized into several top citation variables, journals, citation matrices, countries or regions, and research regions. In addition, to visualize bibliometric boxing data using VOS Viewer to identify literature on the theme of articles about E-voting

3 Results And Discussion

Results of the analysis of 347 scientific articles obtained from the scopus database produced results with different variations. Scientific articles on e-voting from 2009-2022 have a variety of varied perspectives. Therefore, the author classifies data starting from the year of publication of the document, the author with the largest contribution, the country that has a high intensity of publication, and the author

3.1 Year of publication of the article

Research on e-voting and has increased in the early period of e-voting. This rapid development is due to the rapid development of ICT.



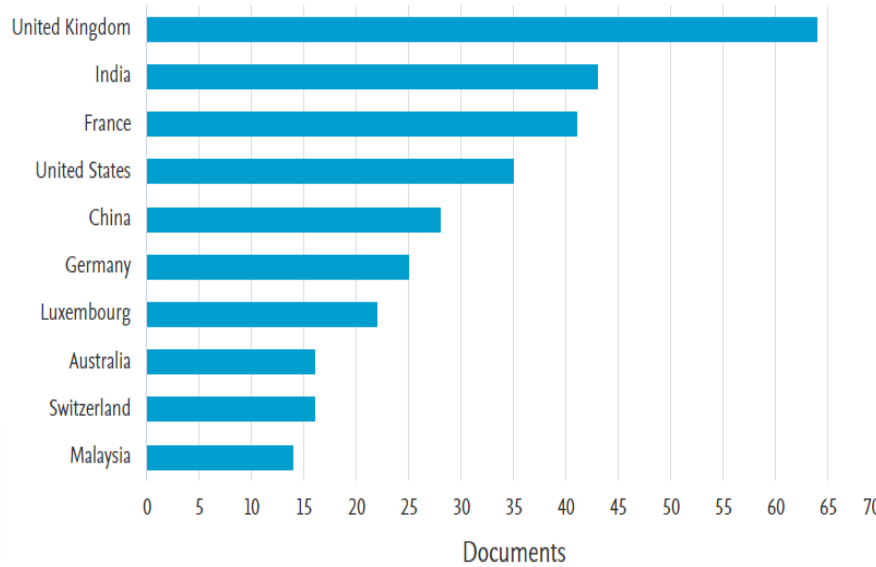
Source: Analysis Research on www.scopus.com

Fig 1. Documents by Year

Figure 1 shows the results of publications themed with e-voting from 2010-2023. In 2010 there were 13 article documents indexed by scopus, then increased in 2011 by 12 documents and in 2012 by 17 documents. This intensity then decreased slightly in 2013-2015, namely 11 documents and 13 documents. Then it experienced an increase again in 2016-2019, namely as many as 25, 32, 34, and 55 scientific articles. The increase was motivated by the design of e-voting using the blockchain method [14] E-voting using blockchain was also adopted by public sector organizations in the technical development of government [15] later, in the following year it decreased by 43 scientific articles in 2020. Then it experienced a hike back in 2021 with 47 scientific articles. Lastly in 2022 there were 41 scientific articles.

3.2 State Contributions

There are 10 countries that have contributed to the publication of global scientific articles with keywords



Source: Analysis Research on www.scopus.com

Fig 2. Documents by state

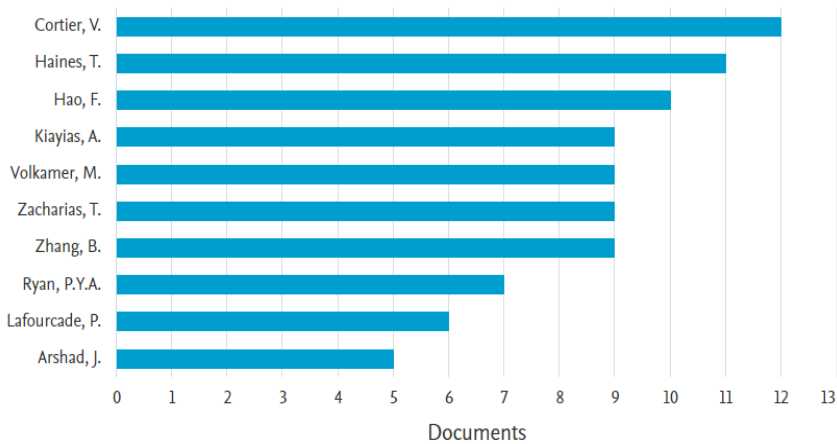
Figure 2 shows that the United Kingdom is the country that contributes the most to scientific research indexed by scopus with a total of 68 documents. The theme of the study conducted in the study in the United Kingdom was e-voting through the blockchain method [16] [17]. Assement of e-voting security in election [19] the effectiveness of e-voting in the implementation of elections [20] [21][22], 2022), and the impact of e-voting on the development of democracy. This was then followed by India with a contribution of 45 articles. The studies conducted were: the security of e-voting through blockchain [24] [25] [26] and the implementation of e-voting protocols in voters [27].

Furthermore, France with the contribution of 42 scientific articles indexed by scopus with a research study on the use of blockchain in e-voting and the identification protocol on voters [29][30] [31][32][33]. United Stated with the contribution of 35 scientific articles indexed by scopus with the study of the use of web applications in e-voting [34] and the development of e-voting infrastructure [35] [36].

The contribution of the publication of further scopus indexed articles by the State of China with a contribution of 23 articles. Then Germany contributed 25 documents to e-voting articles, Luxembourg also contributed 22 documents, Australia 16 documents, Switzerland 16 documents, and Malaysia 19 documents.

3.3 Authors Contributions

In the results of the publication of scientific articles indexed by scopus as many as 347 documents produced the top 10 contributing authors. Here are the 10 authors with the most contributions in the 2009-2022 period with e-voting research topics.



Source: Analysis Research on www.scopus.com

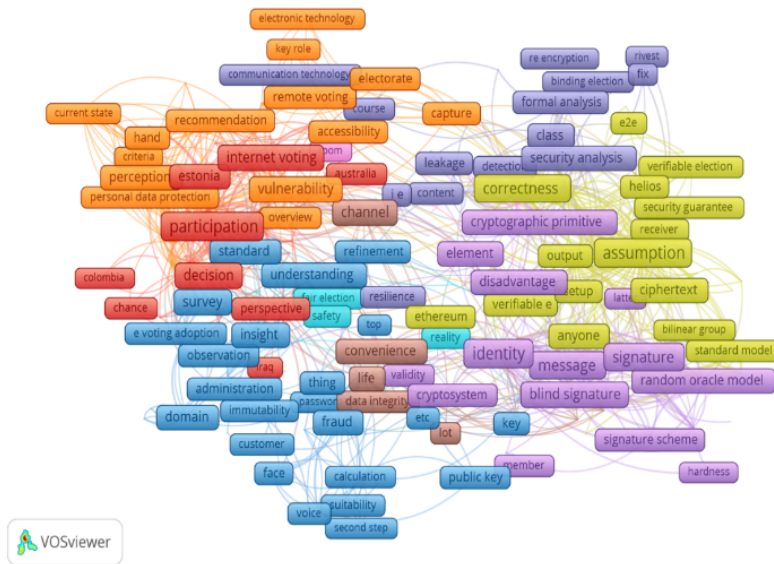
Fig 3. Author Contributions

Cortier, V. is the author with the most article contributions in 2009-2022 with 12 scientific articles indexed by scopus with study topics including Applications on E-voting [37] and Verification on voters [38]. Then followed by Haines, T. with 11 articles examining the Optimization of political parties in electronic electoral systems [40]. The contribution of author Hao, F, by contributing 10 scopus indexed scientific articles containing studies including e-voting design or scheme [41] and e-voting security through blockchain methods [43].

Next followed by Kiaylas, A [44] with each contributing 9 scientific articles talking about e-voting. Furthermore Ryan, P.Y.A. had a contribution with 7 later scientific articles, followed by Lafourcade, P. with 6 articles and Arshad, J. with 5 scientific articles indexed by scopus.

3.4 Mapping Network Visualization and Overlay Visualization VOSviewer Scopus Database

In this study, the authors used a minimum of keyword occurrences in all research publications analyzed using VOSviewer. The figure below shows the results on 9 clusters.



Source: by Author use VOSviewer

Fig 4. Vizualization density from 97 documents about e-voting in Indonesia 2009-2022

The gray cluster became the main domain in the e-voting research topic in Indonesia and was then followed by the pink cluster. In the cluster occurrences VOSViewer shows that the main domain of e-voting research in Indonesia is campuses, namely students. Then, the next topic is on the side of the e-voting approach used and the correlation of e-voting with the development of e-government. Here are the results of the occurrences that appear. In the orange cluster, the highest e-voting keywords are remote voting and recommendation. In the red cluster, participation and internet voting are the highest keywords. In the light blue color, the highest is e-voting adaptation, while in purple, the highest is identity. Then in gray, the highest is binding election, while in yellow, it is assumption.

Table 2. List Occurrences from VOSviewer

Keywords	Occurrences	Relevance
E-voting of student governors	1	1.76
Rivest shamir Adleman algorithm	1	1.76
Rsa	1	1.76
e-government	1	1.54

Source: by Author use VOSviewer

Based on the occurrences and mapping of VOSViewer research topics above, the largest object in the e-voting research topic in Indonesia is the selection of campus organizations and village heads, and the rest only examines the e-voting perspective of

infrastructure readiness. In the context of e-voting in the election of the head of campus organizations, the study of [46] states that e-voting was adopted as a suggestion for the election of the Chairman of the Student Executive Board (BEM) by utilizing gadgets and internet connections. explained that e-voting used by students uses a fairly simple method, namely the MySQL database and PHP language. Thus, it will make it easier for students to vote and prove to be efficient in time and cost [46] [47] [48] [49] [50] [51] [52].

The study of e-voting in Indonesia was then widely studied in the realm of Village Head Elections (Pilkades). It was recorded in the 2013-2020 period that there were 1,572 villages from 23 districts that held e-voting. The methods used are the Unified Model of Electronic Government Adoption (UMEGA), SMS Gate Way and e-voting, and touch screen technology [53] [54] [55] [56]. The system implemented has differences in each region depending on the innovation and needs of the area. The e-voting implemented has also had an impact on the accuracy of accurate, efficient, and accountable calculations [57] and provided opportunities for voting reform from paper to electronic systems [58].

In addition to providing opportunities and benefits, some notes on e-voting studies point to shortcomings in terms of regulations and systems used. On the regulatory side, the implementation of e-voting does not yet have a legal protection and technical standards for implementation by the General Election Commission (KPU) [59]. From a technical point of view, the implementation of e-voting has not been able to infrastructure [60] and weak cyber data security that needs to be improved again [61][62][60][63][64][65].

The study of e-voting in Indonesia in addition to providing guidance and opportunities also still occurs many pros and cons in some circles. [66] Dian Eka Rahmawati (2022) explained that the pros and cons of implementing e-voting can be seen from the response of academics and politicians who consider that the e-voting budget in Indonesia issues a fee of 90 trillion and the high digital divide in various regions. Election organizers such as Bawaslu and KPU also highlighted the inadequate e-voting infrastructure and legal protection. Then for the pros is the government by giving a positive response regarding the development of e-voting and entrepreneurs who think that the implementation of e-voting will have its own impact.

4 Conclusion

Based on the results of bibliometric analysis, it can be found that the highest author contribution is Cortier, V., with 12 articles. Then the contribution of the state with the most article publications is 68 articles. The 2009-2022 publication with a total of 357 scopus indexed article documents had the highest number in 2019 with 55 documents.

Then the VOSviewer analysis in the scopus data base has shown that the research topics that are often studied in the 2009-2022 period are about the theme of e-voting with blockchain methods and protection of privacy or data security. Then in Indonesia, the topics that are widely studied are e-voting in the selection room for student leaders on campus and e-voting in village head elections.

The evolution of e-voting has garnered significant attention globally, with international studies emphasizing blockchain-based designs and robust privacy security for voters. These advancements ensure transparency, security, and efficiency in electoral processes. However, in Indonesia, the implementation of e-voting remains relatively limited, primarily observed in campus elections for student body (BEM) leaders and village head elections. While these localized applications demonstrate the feasibility of e-voting, they also highlight several unresolved issues that hinder broader adoption.

One of the primary challenges is the absence of a unified e-voting system. Currently, e-voting initiatives in Indonesia are developed based on specific regional needs rather than a standardized, nationwide framework. This fragmentation leads to inconsistencies in technology, security protocols, and legal protections. Additionally, concerns over e-voting infrastructure, regulatory clarity, and varying stakeholder opinions further complicate its widespread implementation. Addressing these challenges presents an opportunity for Indonesia to develop an integrated e-voting system that leverages blockchain technology, ensuring transparency, security, and interoperability between regional and national elections. Future research should focus on developing a standardized, blockchain-based e-voting system that ensures interoperability between regional and national elections while addressing privacy, security, and legal challenge

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