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DEVELOPMENT OF ELECTRONIC VOTING AROUND THE WORLD AND ITS POTENTIAL APPLICATION IN INDONESIA

NURYAHMAN[1], NAEK TUA PASARIBU[1],
DIKY ZAKARIA[2], WILDAN ARASID[3]*

[1]Sekolah Tinggi Intelijen Negara, Bogor, Indonesia
[2]Universitas Pendidikan Indonesia, Bandung, Indonesia
[3]Politeknik Negeri Bandung, Bandung, Indonesia
*Corresponding Author: wildanarrasyid55@gmail.com

Abstract

This research aims to examine the development of e-voting throughout the world and its potential application in Indonesia. The method used in this research is a literature review from the Scopus database to examine the development of e-voting throughout the world and interviews with stakeholders regarding the potential for implementing e-voting in Indonesia. The results of this research show that countries in the world such as Estonia, Switzerland, India, and Brazil have implemented e-voting in general elections. The technology used in e-voting is Direct Recording Electronic (DRE) and internet voting with the tools used, namely Electronic Voting Machines and Blockchain Technology. The implementation of e-voting in Indonesia has enormous potential. However, there are still many aspects that need to be prepared, starting from technological readiness, internet networks, organizer readiness and citizen readiness. It is hoped that the results of this research will provide a general overview regarding the application of e-voting throughout the world and its potential application in Indonesia.

Keywords: Development, Electronic voting, Potential application in Indonesia.

1. Introduction

General elections are an important aspect of democratic systems throughout the world. The voting system in general elections is a tough task for the election commission to hold free and fair elections [1]. Traditional electoral systems have been widely used and proven in elections in various countries. The success and reliability of this system over the years has built public trust in the electoral process [1]. However, traditional election systems that use manual methods with paper and ballot boxes have a number of shortcomings that need to be considered [2]. The manual vote counting process takes quite a long time and requires a lot of election officials, so it costs a lot of money. In addition, the risk of vote counting errors is also higher in this method, both due to human error and manipulation that can occur during the counting process. Furthermore, the use of large amounts of paper and ballot boxes also has the potential to produce waste that has a negative impact on the environment. In light of these shortcomings, the development of electronic voting (e-voting) has emerged as a promising alternative to traditional voting methods over the past few decades. In the last few decades, the development of electronic voting (e-voting) has become an alternative to overcome various problems that occur in traditional general election systems [3].

E-voting is an election method that uses digital technology to facilitate voters in voting electronically such as electronic voting machines or online voting platforms [4-6]. E-voting has become an attractive alternative in the general election process in many countries. This system offers a number of advantages, including increased efficiency, accuracy and speed in vote counting [1, 7, 8]. Apart from that, e-voting can also increase voter participation by providing easier access, especially for voters who are outside the electoral area or have limited mobility.

The development of e-voting has occurred in various countries with the aim of improving efficiency, participation, and transparency in the election process. Some of the countries that have adopted e-voting include Estonia, Switzerland, India, and Brazil, each using different e-voting technologies. In Estonia, e-voting has been an integral part of the electoral system since 2005, with significant participation rates and high voter trust [7, 9]. Switzerland has conducted several e-voting experiments at both local and national levels, with the goal of reducing costs and increasing voter participation. India has adopted e-voting in parliamentary and certain state elections to address issues of fraud and enhance the efficiency of vote counting. In India, biometric fingerprint scanning systems are used in general elections to ensure security and prevent fraudulent and duplicate voting. In Brazil, e-voting has been widely used since 1996, with the integration of electronic voting machines and biometric systems [10]. Although many countries have adopted e-voting, it does not mean that this voting method is without its challenges and obstacles.

Problems related to e-voting have occurred in various countries that implement this system. Several examples of problems related to the use of e-voting have occurred in various countries. One example is the security issue of the e-voting system. The use of e-voting in the Netherlands faces a number of challenges and even hacking which has an impact on rejection and decreased trust in the e-voting system in the country [11]. Another problem is vulnerability to cyber-attacks. In the United States, in 2016, there were indications of attempts to influence foreign parties on the e-voting system through cyber attacks [12]. In addition, there are still challenges in terms of technological security, privacy protection, and the digital

divide that need to be considered in implementing e-voting [13]. All of these issues emphasize the importance of protecting the security, integrity and reliability of e-voting systems in the election context.

In Indonesia, in order to improve the quality and efficiency of the general election process, implementing e-voting is an option that needs to be considered. As a country with a large population and vast territory, implementing e-voting in Indonesia has the potential to increase voter participation, reduce costs, and speed up vote counting [14-16]. However, the implementation of e-voting in Indonesia also faces a number of challenges. One of the main challenges is technological infrastructure which is still limited in some areas, especially in rural areas. Apart from that, the security and privacy aspects of voter data are also an important concern. Serious efforts are needed to protect e-voting systems from cyber attacks, vote manipulation and misuse of voters' personal data. In addition, it is important to involve relevant stakeholders, such as the General Election Commission (KPU) and authorities, in designing and implementing a reliable and trustworthy e-voting system.

Based on this background, This research aims to explore the development of e-voting in various countries around the world, analyse the potential benefits and challenges of implementing e-voting in Indonesia and propose suitable e-voting technologies for its application in the Indonesian electoral system.

2. Methods

The method of the research is depicted in Fig. 1.

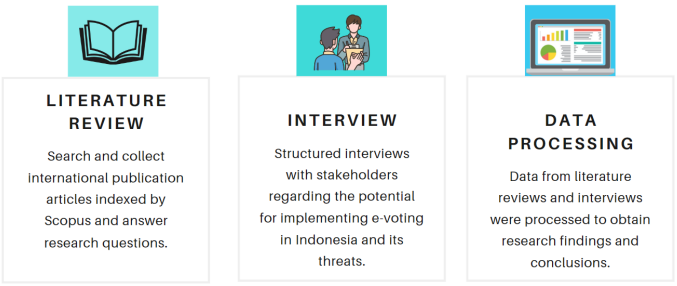

Fig. 1. Research method.

This research uses a literature review method by searching for related published documents regarding e-voting developments and technology throughout the world in the Scopus database using the keyword *"electronic voting" OR "e-voting" AND "election"*. The data search was carried out on May 15, 2023. Apart from literature studies from reputable international journals, this research also took data from the International Institute for Democracy and Electoral Assistance (International IDEA) [17]. International IDEA is an intergovernmental organization consisting of countries from all continents which has a mandate to spread the continuity of democracy throughout the world. Apart from that, we also used the interview method with representatives of the election supervisory committee in Indonesia (Bawaslu) and academics in the informatics field to gain information regarding the potential of e-voting implementation in Indonesia. All data obtained is then analysed and concluded to answer the research objectives.

3. Results and Discussion

3.1. Development of e-voting in around the globe

The development of e-voting has become an important concern in many countries around the globe, with efforts to modernize and improve the electoral process. According to data provided by International IDEA, there are many countries that use e-voting in their general election system as can be seen in Fig. 2.

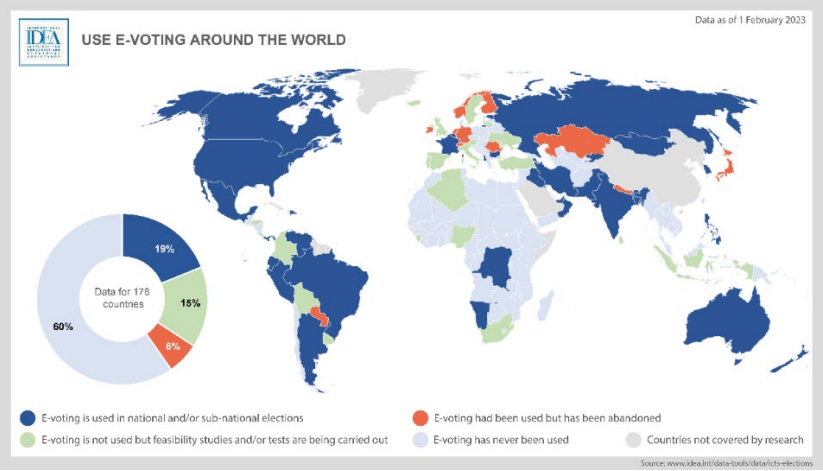

Fig. 2. Data on countries using e-voting based on International IDEA.

The development of e-voting is a key focus globally, with efforts to modernize electoral processes. Figure 2 shows that 19% of 178 countries have adopted e-voting at national or sub-national levels, reflecting a trend towards using technology to improve election efficiency and accuracy. Additionally, 15% of countries are conducting studies or feasibility tests on e-voting, indicating that many governments are seriously considering it to address complex electoral challenges [18].

Several countries have faced significant concerns leading to the abandonment or re-evaluation of e-voting systems, primarily due to security and trust issues. In Brazil, the elimination of Voter Verified Paper Audit Trail (VVPAT) requirements in 2003 and 2009 raised doubts about the auditability of votes. Argentina's trials since 2003, especially in Salta, highlighted challenges like geographic complexity and legislative hurdles, impacting trust. The United States adopted new e-voting technologies under the Help America Vote Act of 2002, yet persistent issues with verifiable voting records underscore ongoing security concerns. India's early adoption of Direct Recording Electronic (DRE) machines, starting in 1982, faced reliability questions due to the lack of a comprehensive legal framework initially. Estonia's successful internet voting since 2005, bolstered by secure voter identification and transparency, stands out as an exception, demonstrating high public trust. Conversely, the Philippines' introduction of e-voting in 2010 aimed to reduce counting times and fraud but faced legislative and logistical challenges, underscoring the complexity of ensuring secure and credible elections.

3.2. E-voting technology in various countries

According to International IDEA, e-voting systems are classified into four main categories. Figure 3 shows the distribution of e-voting technology use worldwide.

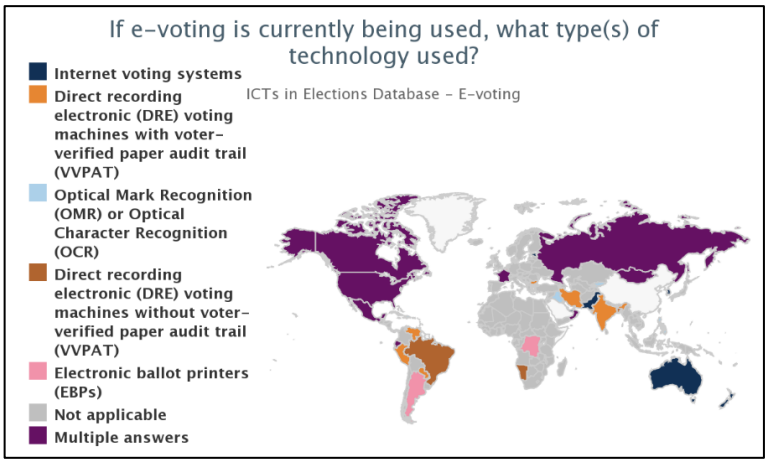

Fig. 3. Distribution of use of e-voting technology used throughout the world.

3.2.1. Direct recording electronic (DRE)

Figure 4 highlights that 50% of the 34 countries using e-voting have adopted DRE technology. Countries like Albania, India, and Venezuela use DRE with a voter-verified paper audit trail (VVPAT) to enhance transparency. In contrast, countries like Brazil and Bangladesh use DRE without VVPAT, which speeds up the process but raises transparency concerns.

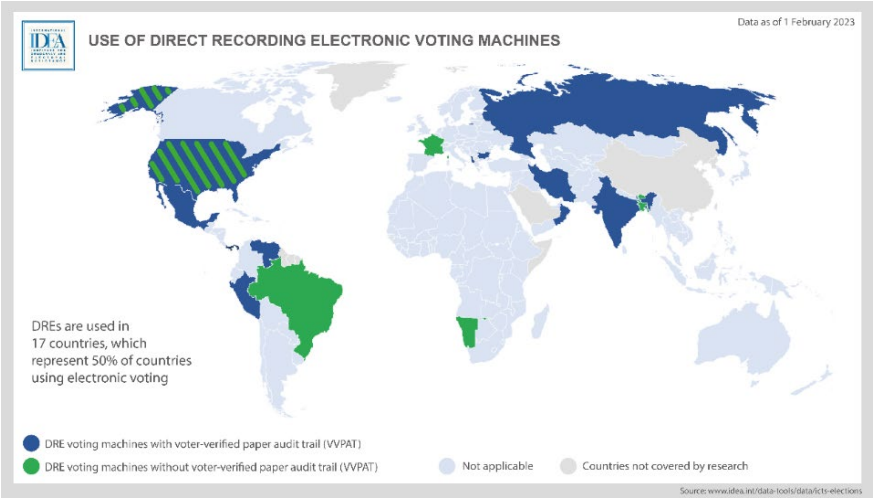

Fig. 4. Map of the distribution of DRE technology users throughout the world.

3.2.2. Optical mark recognition (OMR) or optical character recognition (OCR)

As shown in Fig. 5, 24% of the countries use OMR or OCR technologies, which scan and recognize marks on paper ballots. This technology is mainly used in the Northern Hemisphere, in countries like Canada and the United States, offering a more efficient voting process while maintaining the paper voting method. However, security and integrity remain key concerns.

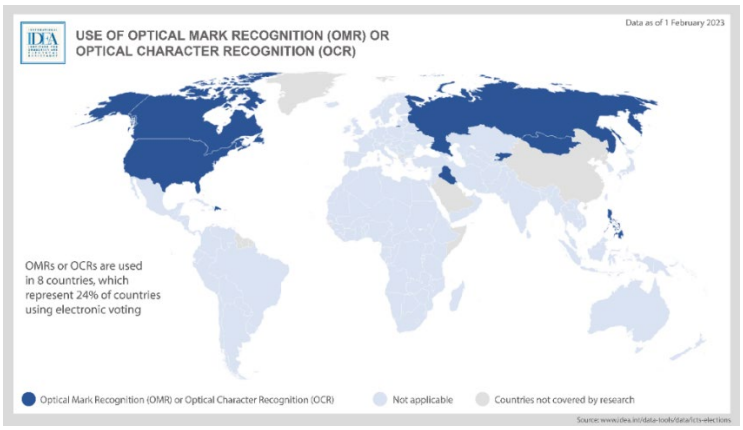

Fig. 5. Distribution map of countries using OMR or OCR.

3.2.3. Internet voting

Figure 6 shows that 41% of the 34 countries have adopted internet voting. Estonia and the UAE offer internet voting for all domestic voters, while countries like Australia and Canada limit it to specific groups. Internet voting is also used for overseas voters in countries like France and New Zealand. While this method increases accessibility, it is primarily used for voting abroad or limited domestic applications due to security concerns.

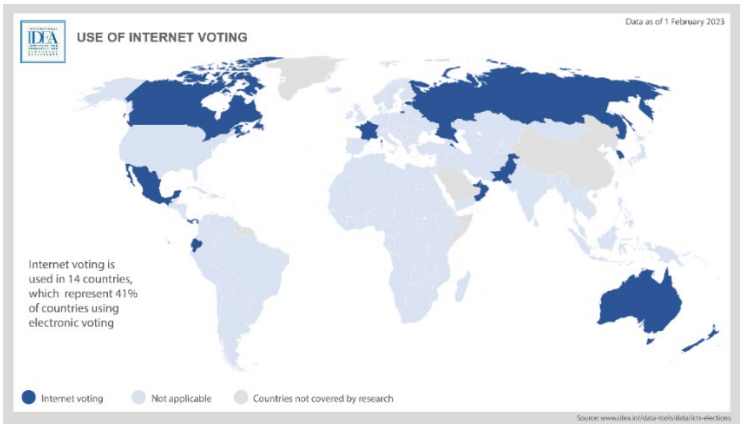

Fig. 6. Distribution map of countries using internet voting technology.

3.3. Electronic voting machines (EVMs) and blockchain technology

Based on the data presented, Direct Recording Electronic (DRE) systems and internet voting are the most widely used e-voting technologies globally. This study examines the use of Electronic Voting Machines (EVMs) and blockchain technology to understand their technical aspects and implementation in various countries.

EVMs: Electronic Voting Machines are designed to replace manual voting in elections, playing a crucial role in modernizing electoral processes. EVMs, which fall under the DRE category, typically consist of an electronic voting unit with a touch screen or buttons, allowing voters to select their preferred candidates. The EVM records votes electronically in a secure internal memory, with multiple layers of security, including voter authentication and data encryption, to ensure vote integrity. Countries such as India, the U.S., and Brazil have widely adopted EVMs. In India, EVMs have been used since 2004, significantly increasing the efficiency and accuracy of voting and vote counting [19]. However, the use of EVMs has sparked debates over security concerns and the potential for electronic manipulation or cyberattacks, necessitating stringent security measures to protect election integrity.

Blockchain Technology: Blockchain technology has emerged as a promising solution to many challenges in e-voting systems. In the context of e-voting, blockchain functions as a decentralized digital ledger where every transaction or vote is stored in interconnected, immutable blocks [20-22]. Countries like Russia and Estonia have adopted blockchain technology for e-voting, leveraging its security and transparency benefits [23]. Blockchain-based e-voting allows voters to cast their votes through a secure online platform, with each vote encrypted and authenticated using private keys, ensuring that only authorized voters can cast votes [24]. Additionally, blockchain enhances transparency, as all transactions are visible to stakeholders, including voters, election administrators, and third parties, facilitating effective monitoring. This technology also addresses voting integrity issues by making it nearly impossible to alter or fake votes, thereby increasing confidence in election results. Furthermore, blockchain can reduce administrative costs by automating vote verification and processing, saving time and resources. However, challenges such as voter accessibility to digital technology and privacy protection must be addressed [24].

Overall, both EVMs and blockchain technology offer significant innovations to the e-voting process, improving efficiency, accuracy, and transparency. Nonetheless, careful consideration of security measures and implementation challenges is essential to ensure that these technologies effectively protect voters' rights and maintain the integrity of the election process.

3.4. Potential application of E-voting in Indonesia

We have conducted interviews with election supervisory committees in Indonesia and academics who are competent in the field of informatics regarding the potential for implementing e-voting in Indonesia. The main points discussed were the opinions of the speakers regarding the implementation of e-voting in Indonesia, the benefits of implementing e-voting, Indonesia's readiness in terms of technology and the steps taken to implement e-voting in Indonesia.

In the interview results, views regarding the implementation of the e-voting system in Indonesia gave rise to differences of opinion. Although the implementation of e-voting has been implemented in small-scale elections, there are concerns that implementing it in national elections will eliminate an important element in the electoral process that is considered a "People's Party." However, overall, the Election Supervisory Committee (Bawaslu) expressed its support for the implementation of e-voting in Indonesia, although with notes.

In looking at the potential benefits of using e-voting in general elections, Bawaslu focuses more on the supervision aspect. They argue that e-voting has potential disadvantages because supervision can only be carried out after the election has taken place, while supervision in conventional elections starts from the start, aiming to prevent violations. However, on the other hand, there are several advantages that can be seen in implementing e-voting, such as time and cost efficiency, data accuracy, real-time monitoring capabilities, and ease of conducting elections.

The question of e-voting technology that can be implemented in Indonesia underscores the need for standardization, certification, and selection of trustworthy vendors. The main obstacles in implementing e-voting include infrastructure constraints such as Base Transceiver Stations (BTS), electricity, and signals in remote areas, which have the potential to create dependency on provider vendors. To face these obstacles, efforts are needed such as outreach in various regions, ensuring the readiness of e-voting facilities and infrastructure, increasing training through simulations, and preparing IT resources. Transparency and accountability in all stages of e-voting are a concern, with accountability currently lying with the General Election Commission and clear rules and regulations required before implementation. A gradual approach to planning and implementing e-voting is emphasized as a way to face challenges, with the need for consistent rules and synergy across aspects to ensure readiness and overcome obstacles. Finally, evaluating the impact and success of implementing e-voting requires in-depth study, clear regulations, as well as an understanding of conventional election processes and transparent data recapitulation to the public. With these various views and considerations, wise and mature steps are needed in deciding to implement e-voting in Indonesia.

4. Conclusion

This research aims to examine the development of e-voting throughout the world and its potential application in Indonesia. From the results of the literature review that has been carried out, it can be concluded that many countries in the world have implemented e-voting in the general election process, namely Brazil, Argentina, USA, India, Estonia, Philippines, Estonia and UAE.

Furthermore, the most commonly used e-voting technologies are Direct Recording Electronic (DRE) and internet voting with the tools used, namely Electronic Voting Machines and Blockchain Technology.

From the results of the interview, Indonesia has great potential to implement e-voting in general elections, although there are many things that must be prepared, such as: technological readiness, internet networks, organizer readiness and citizen readiness.

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