Polling Stations Secure Scheme For E-Voting System in Indonesian General Election

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***Abstract*—The implementation of e-voting technology for election has been prevalent worldwide. There are 43 countries in the world implementing this technology, where some of those countries succeeded while the other found unsuccessful. The reason for the application of e-voting is mainly due to inefficient, insecure, and impractical nature of the conventional election system. It seems that technology is the only approach to solve the problem. There has been a lot of research on e-voting recently. Most studies assumed that the implementation of e-voting is not merely about the technology, but it also relates to several critical factors such as the readiness of human resources and infrastructure, public trust, and others. In this paper, we propose the technology section of the e-voting, i.e., the polling station scheme, to make the e-voting system more efficient, secure, and practical. This study uses the case of Indonesian elections, with the hope proposed scheme can be a reference for the Indonesia Election Commission or other countries wanting to implement e-voting in the future.**

Keywords—e-voting, polling station, ballot

I. INTRODUCTION

The election, such as the general election, is a regular activity in the countries that adopted a democratic system to elect state leaders, parliamentarians, or decision makers. However, the implementation of the general election requires a large budget. For example, the government of Indonesia spent 24.1 trillion rupiahs to organize the 2014 general election, which involved around 190 million voters, 545,803 polling stations (TPS) with each polling station contains nine committee members. Some countries have tried and succeeded in implementation general election using electronic devices, which is better known as electronic voting or abbreviated as e-voting. This technology does not only reduce costs but also increase data accuracy, voting process speed, and security. Some countries, such as Finland, Estonia, Norway, Switzerland, and others, have been successful in implementing e-voting on a broad scale and increasing legally [1]. It seems that technology is a solution to solving the problems in elections [2], and e-voting may replace traditional electoral schemes in the future [3].

In this paper we proposed an efficient, secure and practical polling stations scheme for implementing e-voting by taking case studies in general elections in Indonesia or for other countries which in future will implement e-voting.

II. LITERATURE

A. Ballots

Ballots in voting are the main mechanism in modern liberal democracies [4], and object that has always be special attention in the implementation of voting, guaranteeing the security of ballots will have a major impact on the validity of the votes which will also lead to the integrity of the general election. Therefore, it is crucial to make a system and procedures for ballot security to avoid the failure of the general election caused by human and procedure errors, and the threats of interference.

The implementation of e-voting certainly differs with that of the conventional election in terms of the used ballots. The traditional system uses physical ballot such as paper while the e-voting employs digital ballot. The traditional paper-based voting is highly criticized after the finding of fraud evidence, causing to the uncertainty in the electoral process. Traditional voting systems have severe problems in terms of user privacy or voting procedures [5]. In the implementation of e-voting, of course, the trust and security of ballots must be guaranteed because one of the most important aspects of electronic voting is the ballots. The Ballots must be secure from piracy and verified. The encryption method is often used to secure the data [6]. Digital ballot systems have been developed in the last twenty years and have reached a high level of maturity [7]. In implementing e-voting, ballots encrypted with cryptographic systems have been proposed in developing countries in the Middle East and Africa (MENA) [8].

B. Polling Stations

A polling stations is a place where voters vote their choice. In the 2014 Indonesian General Election, the number of involved polling stations reached 545,803, serving 300-500 voters. Each polling station is managed by a committee consisting of seven members, having the task as follows:

1) The person who recorded the incoming voters (1 person)
2) The person in charge of distributing paper ballots (3 persons)
3) The person who maintains the voting booth (1 person)
4) The person who maintains the ballot box (1 person)
5) The person who maintains ink (1 person).

The architecture of the polling stations can be shown in figure 1 as follows:

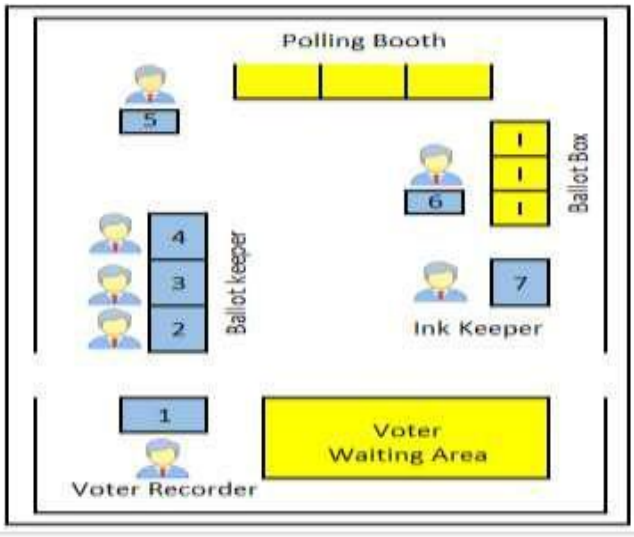

Fig 1. Indonesian polling stations architecture[9]

III. PROPOSED SYSTEM

A. *Procedure and Scheme*

The proposed system constitutes a scheme or an architecture for implementing e-voting at polling stations in Indonesia, with an assumption that Indonesia has carried out the pre-implementation research on issues such as the index of public trust in government, election organizers, and technology, as well as e-voting technology, and other critical issues [10].

Before explaining the proposed scheme, there are things that need to be explained as follows:

1) Indonesian population data has been centralized and computerized, the resident card (KTP) has used the chip so that it can be read by the system, the population data is valid so the KPU can arrange the owner of e-KTP to vote and arrange the polling station where they have to vote.
2) The proposed scheme using paper is entered into the ballot box, its function is for ballot physical audits when later in automatic calculations there are complaints or conflicts.
3) The printed ballot contains a choice of voters that have been encrypted with a display in the form of QR code.

Supporting facilities in this scheme are:

1) E-KTP reader for voters coming to vote at polling stations and connect to population data.
2) E-voting machine or computer e-voting system installed.
3) Printer for printing ballot.
4) Ballot Box.
5) The maximum number of KPPS officers is 3 people with at least 1 computer operator qualification.

The procedure for the proposed scheme is as follows

1) Voters coming to the polling stations must bring their e-KTP. At the polling station gate, they will be welcomed by the voter verification officers. The voters tap the e-KTP into the e-KTP reader to verify whether the voter is eligible to vote in the voting stations and to identify whether the voter has voted in other polling stations. Only the valid voters can enter and vote in the polling station. The verification scheme is presented in figure 2 below.

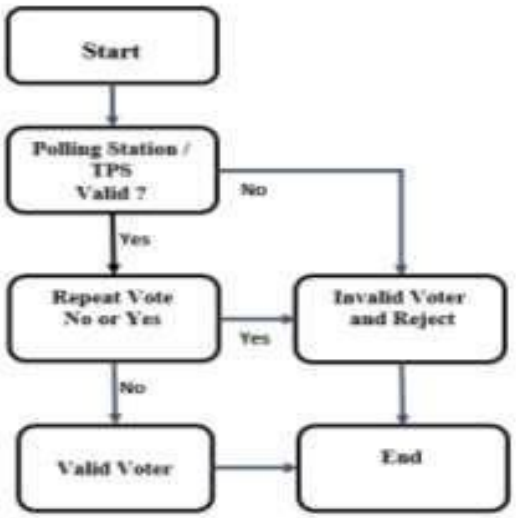

Fig 2. E-KTP verification procedure

2) Voters queue to wait for turn vote in the voting booths
3) Voters go to the voting booth to vote. In the voting booth, there is already a voting machine/computer. The voters select the candidate using touch screen monitor and then the printing machine will print the votes that have been chosen. The selection scheme can be described in Figure 3 below

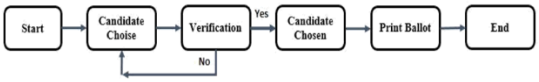

Fig 3. Vote procedure.

4) After the selection, the printed ballot is inserted into the ballot box by the voter.
5) Finish.

What happens in the e-voting system at the polling station?

1) The voters scan the e-KTP to the reader machine, which then verifies the voter data to check whether the e-KTP is registered in the polling stations and the e-KTP has been used in another polling station.
2) After e-KTP is verified, the voter selects the candidate at the polling room having e-voting machine inside. After having checked the candidate, the machine records the vote with encryption, prints the ballot and marks the e-KTP in the voter's data. The e-KTP has been used in the election.
3) After the election completed, the chairman of the KPPS can automatically count the voting result on one e-voting machines. To facilitate the committee, witnesses and the public to see the results, the KPPS can provide a large monitor/bulletin board.
4) The general polling station scheme is displayed in figure 4 as follows.

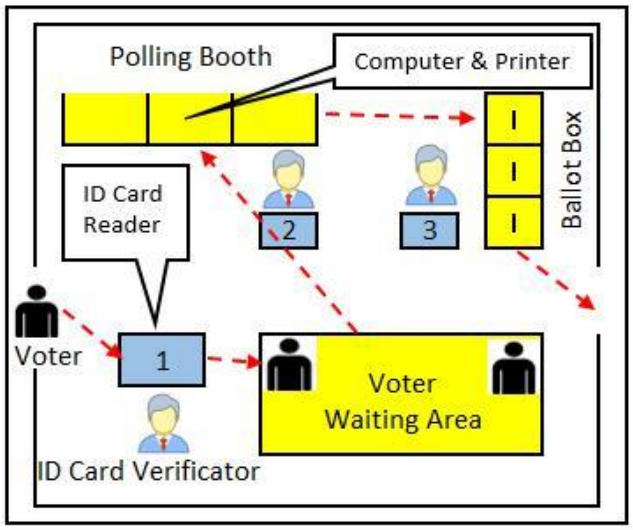

Fig 4. Proposed polling station architecture

B. Database

The e-voting main database consists of two parts:

1) Population database in the Indonesian population data center already contains polling stations code and vote status/arrival status in polling stations. This database will be the first and last reference. In the former, the database is for verification, via e-KTP, to check whether the voter is registered in the polling station and whether voters have never chosen elsewhere. While the former is to mark e-KTP voter data has already come to the polling station to vote.
2) Database in polling station contains two main tables. The first table contains the list of the voter has come and voted — this table has one encrypted attribute, namely queue code. The second table contains the list of voter's choice with all attributes encrypted.

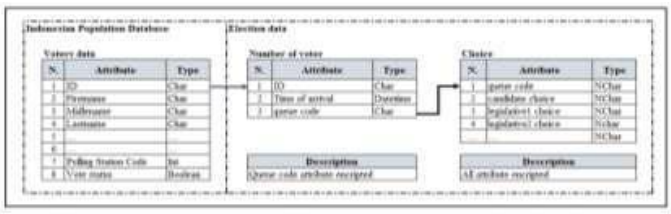

Fig 5. Proposed database architecture

IV. Evaluation

The researcher focuses on three things related to privacy, verification, and confidentiality, which are the most important elements in e-voting [11]. The e-voting scheme must meet the following rules [12]:

1) Only legitimate voters are entitled to vote. In the proposed scheme, the system verifies the voters by tapping voter's e-KTP to a reader machine connected to the national population database, so that the officers can know whether a voter is eligible in terms of age, and identify the designated polling stations for the voter.
2) No one can vote more than once. In the proposed scheme, after a voter gives the vote, the system will record the transaction in the national population database so that the voter already voted cannot vote more than once.
3) No one can track who chose for whom. In the proposed scheme, the e-voting system database is encrypted so that people who are not entitled cannot see the voters' choice.
4) No one can steal votes from other people. In the proposed scheme, the ballots cannot be stolen because of encryption.
5) No one can change choices. In the proposed scheme, ballots cannot be stolen by encryption
6) Each voter can ensure that their votes have been counted. In the proposed scheme, the election process is recorded in the database so that the votes can be calculated.

The proposed scheme fulfills six security criteria. In terms of efficiency, the e-voting scheme is very efficient, where each voting station need only three people. The paperless system will reduce the budget for printing ballot papers and cut the other expenses. Also, the electronic voting shortens the voting time so that the maximum number of voters in a polling station will increase, resulting in reducing the number of polling stations.

V. Conclusions

Efficiency, security, and practicality are the main issues in the implementation of e-voting for general elections. The proposed scheme addressing the three points mentioned above is intended to be a reference for Indonesia and other countries that will apply e-voting in the future. It is recommended to conduct further studies such as the development of e-voting software based on the proposed architecture and scheme as well as the investigation of such critical factors as human resource and infrastructure readiness, public trust, frameworks, and others [13].

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