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E-Voting: A Novel of Generic Conceptual Framework

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ABSTRACT

The aim of this research is to analyze and identify factors that influence the success of e-Voting, develop an e-Voting framework, and to examine the proposed e-Voting framework for utilization based on countries, organizations, or institutions that will be introduce e-Voting for elections. Based on research conducted, the analysis and identification results show that there are three aspects that influence the success of e-Voting: readiness, public perception, and technology. The quantitative research was conducted, and the number of respondents were 403 that covered West Java, Indonesia. Based on results, is shows that the factors that influence the success of e-Voting are technology readiness, human resources readiness, trust in the technology, trust in the government, trust in the election commission, constitution readiness, and technological. Whereas the proposed generic e-Voting framework were consisting of the technology readiness index, human resources readiness, trust in the technology, trust in the government, and trust in the election commission, issue laws and policies, e-Voting technology development by conducting socio-technical research, e-Voting technology design and development, and technology acceptance model research that need to be assess. Hopefully, the proposed e-Voting framework will contribute to the new era of digital technology, especially to overcome the issues of traditional vote.

1. INTRODUCTION

General election is an election generally held at regular intervals in which candidates are elected in all or most communities. It is a way or means to find out what the people want for the future in their country or organization. Basically, there are three kinds of general election objectives: enabling the transition of government in a safe and orderly manner, exercising people's sovereignty, and exercising the rights of citizens. General election is a democratic process that is held periodically to produce representatives of the people or leaders who can voice the interests of the people, maintain national stability, and create a legitimate and democratic government [1].

Progressive nations are undoubtedly driven to investigate electronic voting technologies to elevate the standard of their national elections [2]. Voting procedures can be made more accessible, transparent, auditable, and safe with the use of e-Voting. Many predict that in the future, electronic voting will take the place of the conventional general election system. Electronic voting, often known as e-Voting, is a political action that uses technology. Voters use machines rather than punching holes in paper to cast their ballots, which are digitally saved [3], electronic voting is a type of voting where electronic media is used for both the recording and counting of votes [4], the purpose of e-Voting equipment was to decrease errors and expedite the counting process [5].

Indicate that during the past 30 years, e-Voting has been developed through study and implementation [6]; nevertheless, many countries have failed to implement e-Voting [7, 8]. including the United States of America, Paraguay, Germany, the United Kingdom, and the Netherlands, technology plays a significant role in e-Voting implementation [9], it is not the only aspect that affects its success. There are several elements [10, 11].

Widespread opposition from citizens and lawmakers was a major obstacle to the implementation of e-Voting in the Netherlands [12]. Furthermore, the public's trust in e-Voting proved difficult to rebuild even if the system was designed to be superior, a group advocating for digital rights tested an electronic voting device in the United Kingdom. Their observations indicate that they oppose the implementation of e-Voting because they don't think it can be trusted [13]. Furthermore, Germany conducted and tested e-Voting [14], During the testing environment, there are several issues with the e-Voting machines that are being used in the testing environment. As a result, the idea to use electronic voting in Germany's general election was not carried out, Ireland also invested thousands of euros on e-Voting, albeit only in tiny trial projects. Although the deployment of electronic voting systems in the United States caused controversy and sparked intense discussions between proponents and opponents, the creation of a framework for the effective use of e-Voting should be the focus of future research [15]. For a successful e-

Voting deployment, Ehin et al. advised developing an e-Voting framework [16]. Abdallah advised determining the required components and creating an e-Voting framework [17].

The aim of this research is to analyze and identify factors that influence the success of e-Voting, develop an e-Voting framework, and test the proposed e-Voting framework for utilization by countries, organizations, or institutions that will e-Voting for elections. It is hoped that proposed e-Voting framework will contribute to the e-Voting technology, development and implementation of e-Voting and countries, organizations, or institutions that will implement e-Voting successfully.

2. METHODOLOGY

In conducted this research, the research process was divided into five phases to achieve the research objectives, the overview of the research phase is shown in Figure 1.

(1) The first phase of this research has been conducted using the literature review method by accessing international, reputable databases of journals and proceedings related to e-Voting. Several filters have been implemented to search for publications about countries that are involved in general elections. This is to map the implementation status and success rate of e-Voting implementation. This process produced a list of e-Voting implementations for general elections and issues related to the implementation of e-Voting, e-Voting success factors, e-Voting readiness, e-Voting technology used, e-Voting frameworks, and results.

(2) The second phase, the aim of this phase of this research was conducted e-Voting success factors mapping, from social aspect and technological aspect, literature review related to e-Voting success factor from related study used in this phase.

(3) The third phase, the aim of this phase is to conduct experiments on e-Voting success factor mapping from social and technological aspects using quantitative research and literature review methods. Experiments using quantitative research methods have been conducted, including generating hypotheses, question design, determining the number of samples, data collection, and data analysis. At this phase, validation was also conducted by experts for a valid result. The Public Perception Success Factor Model for these stages was explained in a separate section. In addition, the experiments used the method of literature review, and previous research data collection has been conducted from international reputable journals and proceedings that focused on information system management and system development to produce e-Voting success factor models from the technological aspect.

(4) The fourth phase, the aim of the last phase is to conduct framework development, the last phase, framework development is conducted, combining e-Voting success factors from the social aspect and e-Voting success factors from the technological aspect, the result of this phase is a proposed generic e-Voting framework.

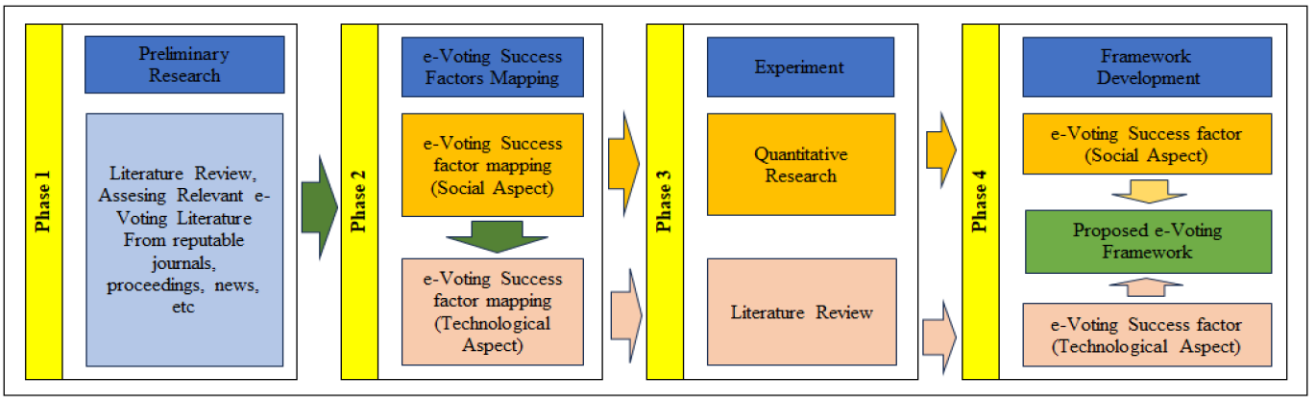

Figure 1. Research method

3. RESULTS

Activity of preliminary research, studying the literature on the implementation of e-Voting technology by looking for related news from trusted sources, and research reports, including reputable international proceedings and reputable journal papers, countries that are involved in general elections. This is to map the implementation status and success rate of e-Voting described in Table 1 [18].

Based on this process, 12 e-Voting articles have been found that mention the factors that influence the success of e-Voting. These findings are summarized in Table 2 [19].

Activity of e-Voting success factor mapping from the social aspect based on the grouping that is provided in Table 1 into two main factors is provided in Table 3.

Based on Table 3, the results of success factor mapping from the social aspect are 8 factors; three factors are included in public perception, and five factors are included in the readiness factor. There are two improvements in this mapping, namely:

(1) Trust in e-Voting expanded become trust in technology because in several past studies trust in technology is one of the factors that influence e-Voting.

(2) Environmental factors and policy and law factors are the same groups because both are external factors that influence e-Voting, decided policy and law are included to the readiness factor the last result of e-Voting success factor mapping from social aspect provided in Figure 2.

Table 1. E-Voting implementation results

No.	E-Voting Results	Number of Countries
1	completely and sustainably	5 countries
2	partially	8 countries
3	canceled after tryouts	9 countries
4	discontinued	3 countries
5	testing process	7 countries

Table 2. E-Voting success factor summary

Factors	Previous Research											
	1	2	3	4	5	6	7	8	9	10	11	12
Trust in the government	√			√			√	√	√		√	
Trust on the e-Voting	√					√	√	√	√		√	√
Trust toward election organizer								√	√	√	√	
Compatibility	√											
Relative advantage	√		√									
Perceived usefulness	√											
Perceived ease of use	√	√										
Complexity												
Availability		√			√							
Security		√			√					√	√	
Privacy		√			√							
Reliability		√			√							
Technological readiness			√	√		√			√	√	√	√
Organizational readiness			√	√		√			√			
Environmental factors			√									
Human resources readiness							√	√				
Policy and law				√								√

Table 3. Public perception and readiness mapping

No.	Success Factors	Success Factor Grouping
1	Trust in the government	Public perception
2	Trust on the e-Voting	Public perception
3	Trust toward election organizer	Public perception
4	Technological readiness	Readiness
5	Organizational readiness	Readiness
6	Environmental factors	Readiness
7	Human resources readiness	Readiness
8	Policy and law	Readiness

Table 4. Technological success factor mapping

No.	Success Factors	Success Factor Grouping
1	Compatibility	Technological
2	Relative advantage	Technological
3	Perceived usefulness	Technological
4	Perceived ease of use	Technological
5	Complexity	Technological
6	Availability	Technological
7	Security	Technological
8	Privacy	Technological
9	Reliability	Technological

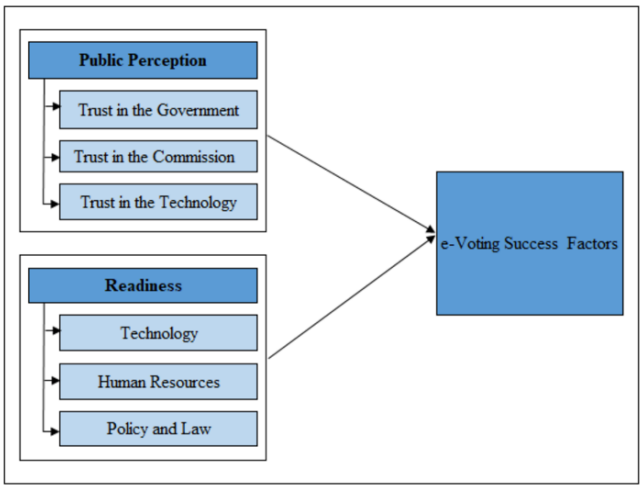

Figure 2. E-Voting success factor mapping from social aspect

E-Voting success factor mapping from a technological aspect based on the group in Table 1 by technological eliminated, provided in Table 4.

The last result of e-Voting success factor mapping from technological aspect is provided in Figure 3 [20, 21].

Experimental activity conducted quantitative research found that based on the e-Voting success factor from social aspect, 7 hypotheses are formulated as the basis for making questions (questionnaires) [19], the number of samples is determined using 4 formulas from the population of voters in the province of West Java, Indonesia of which the data is obtained from the Indonesian General Elections Commission (KPU) in 2020, as many as 11,632,816 voters with a margin of error calculation of 5% with the formula presented in Table 5.

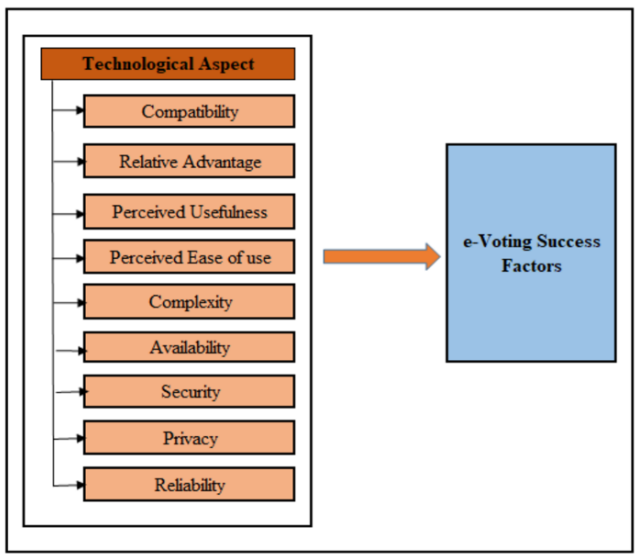

Figure 3. E-Voting success factor from technological aspect

Table 5. Minimum of sample

Formulas/Table	Minimum of Sample
Taro Yamane	399,98
Slovin	399,98
Issac Table	349
Krejcie and Morgan Table	384

The data collection of respondents was conducted from November 19, 2021, to December 4, 2021, using a Google form and generated 403 feedback, the number of samples exceeded the minimum number recommended by the formulas in Table 4 and declared sufficient to represent the population, the data from the questionnaire was converted using a Microsoft Excel formulation to be processed using SEM-PLS method.

Figure 4 exhibit the results derived from data analysis and measurements, quantitative research findings indicate the existence of a novel phenomenon that reinforces the elements influencing e-Voting success [19].

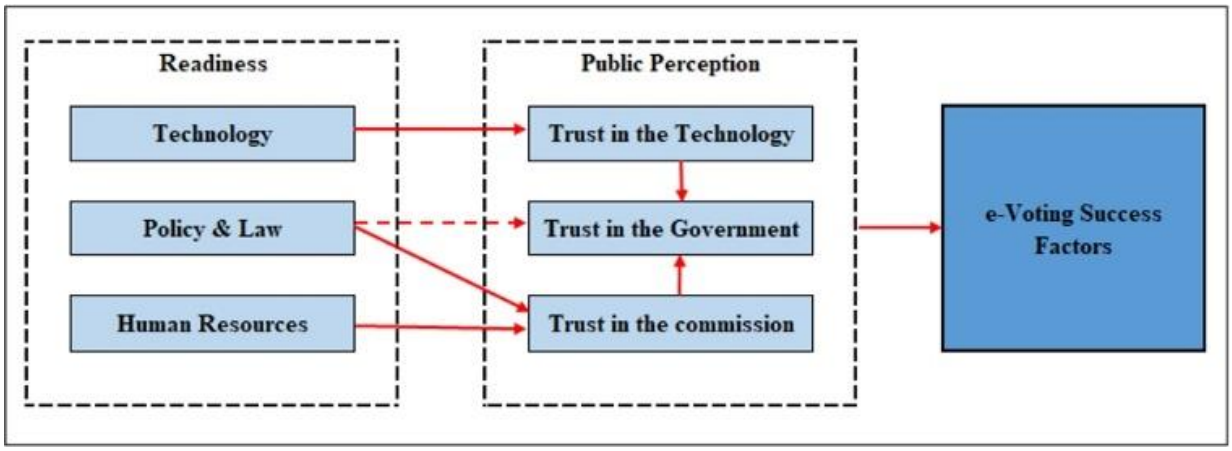

Figure 4. Public perception success factor model

Table 6. Technology acceptance literature review

Authors	Descriptions
[22]	There is a need for research to test user prediction and acceptance of information systems and technology.
[23]	The Technology Acceptance Model (TAM) available to explore how and when individuals will accept and use technology.
[24]	The Technology Acceptance Model (TAM) is specifically designed to model user acceptance of information systems and determine the rate of technology adoption.
[25]	Trust in the internet, trust in government, attitudes, beliefs, trust in the internet and computer skills, website design, relative advantage, compatibility, complexity, perceived usefulness, and perceived ease of use. This research is the first step in examining the implementation of the e-Voting technology adoption model.
[26]	The Technology Acceptance Model (TAM) aims to evaluate the designed e-Voting technology and then propose an actual e-Voting system.
[27]	The Technology Acceptance Model (TAM) has two constructs: perceived usefulness and perceived ease of use, and this construction determines the user's attitude toward technology.

Table 7. Socio-technical literature review

Authors	Descriptions
[28]	Socio-technical research aims to determine the level of human adaptiveness towards existing technology.
[29]	Socio-technical research identify and classify threats and variables related to human dependency due to technological and organizational changes and provide recommendations for the development and change of technology being built.
[30]	Socio-technical research supports designing technologies to be implemented to address knowledge gaps, and the public can use and accept the technological products.
[31]	Using a socio-technical approach integrating culture and technology, and the technology design be accepted by the public.
[9]	Socio-technical research pays more attention to society, culture, and politics shaping the electoral process and, vice versa, the reciprocal relationship between social construction and technology related to the implementation of e-Voting technology.
[32]	Socio-technical research focuses on the impact of technology on humans and considers ways in which technology can be designed more effectively and accepted by humans.

Table 8. Objectives and outcomes from social aspect component

No.	Objectives	Outcomes
1	Assessment on technology readiness	Index of the e-Voting technology readiness
2	Assessment on human resources readiness	Index of the voters and the e-Voting committee's readiness
3	Assessment on public perception toward the government	Index of public perception toward the government
4	Assessment on public perception toward the General Election Commission	Index of public perception toward the General Election Commission
5	Assessment on public perception toward technology	Index of public perception toward technology
6	The Constitution, the state, and the parliament provide a legal protection for the implementation of e-Voting	Laws, policies, and regulations for the e-Voting

The process of quantitative research to test the e-Voting success factor from a social aspect has been conducted according to the quantitative research method phase, The phases of hypothesis determination, questionnaire determination, sample size determination, validity and reliability test, normality test, and data processing have been conducted according to the theory of quantitative research.

Validation of the entire quantitative research process has conducted by expert in their fields using the questionnaire method. Based on score calculations and comments in the questionnaire, it has been stated that the quantitative research process is declared high valid, and the results can be used.

Experimental activity conducted literature review approach found on Table 6, it was concluded that testing was required on the acceptance of e-Voting technology used in society for the next e-Voting technology to be developed in accordance with requests, and it was recommended to use the Technology Acceptance Model (TAM) in the research process.

Based on Table 7, it is concluded that it is important to conduct socio-technical research that aims to measure the extent to which e-Voting technology can adapt to the society, culture, and politics where the e-Voting technology will be implemented and have a significant positive impact on the implementation of e-Voting.

Based on experiments conducted using a literature review approach to find technological aspect components, it was concluded that technology is an important component in the implementation of e-Voting. There are three components that need to be considered, as follows:

(1) Socio-technical research, according to previous studies, socio-technical research needs to be conducted to understand the social, cultural, and environmental conditions and the resulting recommendations for e-Voting technology that will be implemented, socio-technical research implemented in e-Voting must prioritize the principles of joint optimization for e-Voting to perform optimally, which can only be achieved if the social and technical dimensions are designed to complement each other. If e-Voting only optimizes the technical dimension or only the social dimension, then there is a reduction in the ability of to implement e-Voting. Socio-technical research must pay more attention to how society, culture, and politics shape the election process and vice versa. Therefore, this must include the reciprocal relationship between social construction and technology related to the application of the technology; the results of socio-technical research must become the basis for the design and development of e-Voting systems that are culturally and socially appropriate to the place where e-Voting is implemented.

(2) Developing e-Voting technology requires strategic planning of e-Voting technology and considering the results of socio-technical research conducted by adopting all aspects inherent in e-Voting technology, such as relative advantage, compatibility, complexity, perceived usefulness, perceived ease of use, privacy, verification, authentication, availability, integrity, accuracy, uniqueness, and reliability. Based on technology requirements mapping, the main activities for implementing e-Voting are preparation/preregistration, registration, voting, and counting, many other activities are required, including managing voters, candidates, parties, committees, reports, and others. Other infrastructure, such as database technology and data communications, needs careful design, and the implementation of maximum-level security is required.

(3) Technology Acceptance Model (TAM), this research was conducted to measure the public's perception of e-Voting technology that has been created, the results of this research are recommendations for developing e-Voting technology by considering the findings from Technology Acceptance Model (TAM) research. The implementation of the Technology Acceptance Model (TAM) in e-Voting is to assess public acceptance of the e-Voting technology that has been designed. This measurement aims to evaluate the design of the e-Voting technology for the results of its implementation will not be a failure. All aspects of the Technology Implementation Acceptance Model (TAM), such as perceived usefulness, perceived ease of use, behavioural intention to use, and perceived usage, must be assessed. Negative results from the implementation of the Technology Acceptance Model (TAM) must be used as evaluation material in designing the e-Voting technology, cycle between the Technology Acceptance Model (TAM) and the design of e-Voting technology must continue before all aspects are assessed as positive.

Based on the three components above, Figure 5 describes the proposed technological success factor model, important things to e-Voting technology development.

Activity of the framework development phase, two experiments have been combined, namely, the results of the quantitative research and the results of the literature review approach. The proposed social aspect component and proposed technological aspect component have been combined into a systematic sequence. The sequence of these components is the basis for the e-Voting framework development.

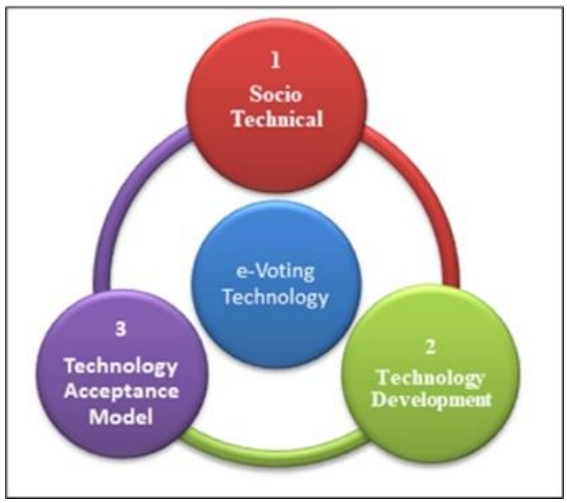

Figure 5. Technological success factor model

Based on Figure 4, the proposed social aspect component is the result of a quantitative research approach that produces six objectives and outcomes, with details provided in Table 8.

Based on Figure 5, the proposed technological aspect component, results of a literature review approach that produces three objectives and outcomes with details provided in Table 9.

Based on Table 8, Objectives and Outcomes from the social aspect component, and Table 9, Objectives and Outcomes from the technological aspect component, are the forerunner components of the e-Voting framework. The proposed e-Voting framework consists of 4 stages; each stage has components that must be implemented, and the design of the proposed e-Voting framework has been conducted from the

combination of the components previously designed for the successful implementation of e-Voting, as presented in Figure 6.

The proposed e-Voting framework consists of 4 stages, each stage has components that must be implemented, with outcomes according to Tables 8 and 9. Details of the stages in the framework are described in Table 10.

Validation of the entire process of proposed generic e-Voting framework has been conducted by two experts using the questionnaire method, the results of the expert validation score by obtaining an average score of 5.0, and the instrument is declared very high valid.

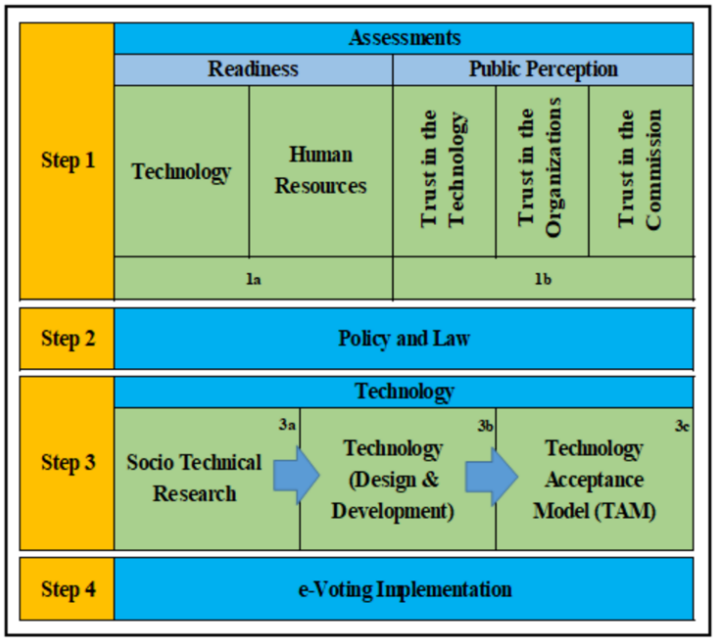

Figure 6. Proposed generic e-Voting framework

Table 9. Objectives and outcomes from technological aspect component

No.	Objectives	Outcomes
1	Socio-technical research	Report on public social behavior towards technology and e-Voting technology model design
2	Technology design and development	Design and development of software, hardware, database, network, security, and all the supporting technology of e-Voting implementation
3	Technology Acceptance Model (TAM)	Perceived usefulness and ease-to-use index to e-Voting technology

Table 10. Steps of proposed e-Voting framework

No.	Steps	Phases	Description
1	1	1	Assessment of technology readiness is a measurement of the maturity condition or readiness to implement e-Voting technology that is measured systematically with the aim of being adopted by users (voter and e-Voting committee). Technology, or technology readiness, determines the success of e-Voting. The more ready the e-Voting technology is at the start of the planning, the greater the chances of success in implementation.
2	1	2	Assessment of human resources readiness is an assessment measuring the condition of readiness of users (voters, committees, and the public) towards e-Voting technology. The implementation of new technology in the general election certainly affects users; the more ready users are to use e-Voting technology, the greater the chance of success in implementation.
3	1	3	Assessment of public perception toward the government is an assessment measuring public perceptions of the government. This is important because the higher the trust in the government, the greater the opportunity for public participation in e-Voting.
4	1	4	Assessment of public perception toward the General Election Commission is an assessment measuring public perception of the election commission. The higher the level of public trust in the general election commission, the greater the opportunity for the public to vote in elections using e-Voting.
5	1	5	Assessment of public perception toward technology is an assessment measuring public perception of e-Voting technology. The higher the level of public trust in e-Voting, the greater the opportunity for people to vote in elections using e-Voting.
6	2	1	The institution, organization, state, or parliament provide a legal protection for the implementation of e-Voting produced laws, policies, and regulations for the e-Voting.
7	3	1	Socio-technical research. This research is about social behaviour and habits. In e-Voting technology, it is very important to study social and cultural habits and behaviours so that e-Voting technology can be accepted by the community and increase the number of voters and public trust in technology. Socio-technical research is a social study of the relationship between the social and cultural behaviour of the

No.	Steps	Phases	Description
			community with technology to create a proposed technology model as the basis for e-Voting technology development that will be implemented. The state must conduct its own socio-technical research for e-Voting. The results of socio-technical research from other countries cannot be used as a basis for e-Voting technology development because each country certainly has its own social and cultural characteristics. The results of socio-technical research must be used as a reference in the design and development of e-Voting technology.
8	3	2	Technology (design and development) is to do physical design and development. The design and development must be in accordance result of socio-technical research and findings of technology requirement mapping [20], described in Figure 7.
9	3	3	The Technology Acceptance Model (TAM) is an e-Voting technology assessment activity for users such as the public, voters, committees, and general election commissions. This activity is to assess the public's perception of the e-Voting technology that has been created and to serve as a benchmark for its implementation, TAM assessment must follow the principles described in the list below: (1) Perceived Ease of Use (PEOU) (2) Perceived Usefulness (PU) (3) Attitude Toward Using (ATU) (4) Behavioural Intention to Use (ITU) (5) Actual System Usage (ASU)
10	4		All stages of pre-implementation of e-Voting implementation have been conducted, and the countries, organizations, or institutions are ready for e-Voting.

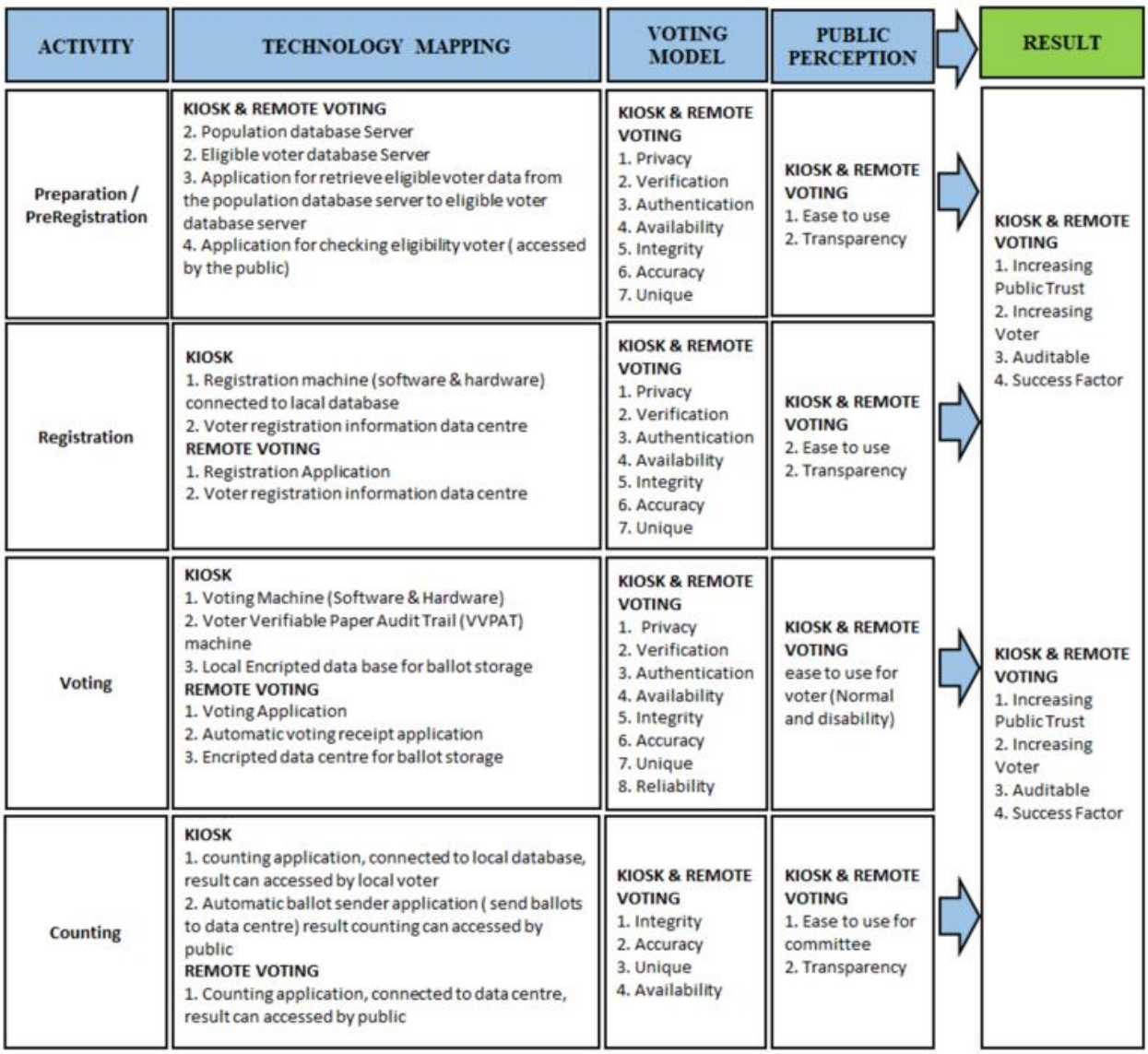

Figure 7. Technology requirement mapping

4. DISCUSSION AND CONCLUSION

All research findings certainly have positive implications, namely:

(1) The findings of the e-Voting success factor in this study have updated the findings of previous research and complement the literacy of researchers and the public related to e-Voting implementation. These findings have a significant

impact on the success of e-Voting if used as a reference.

(2) There has been a lot of international e-Voting literacy, and most of it focuses on e-Voting technology such as systems, networks, and security, even though technology is not the only factor that influences the successful implementation of e-Voting. Meanwhile, e-Voting implementation management, such as frameworks, is not widely found. The proposed e-Voting framework is hoped will complement scientific literacy, especially the management of e-Voting information systems through the e-Voting framework and strategic management of e-Voting implementation.

(3) In the previous e-Voting framework studies, most of them reviewed the technology used partially for certain countries, organizations, or institutions. It is hoped that this proposed framework can be used in any country, organization, or institution and can be used as a general framework to prepare e-Voting.

(4) Many countries have implemented e-Voting for general elections, but not many have been successful and sustainable. Most of these countries succeeded but did not continue, just trial, or fail. With the establishment of this e-Voting framework, it is hoped that it will increase the number of countries, organizations, and institutions that conduct elections using e-Voting technology successfully and sustainably.

All research findings certainly have significance and positive contributions, namely:

(1) For researchers, especially e-Voting researchers, the results of this study can be used as references and can be developed, including e-Voting research methodology, validation methodologies and procedures, e-Voting implementation models, e-Voting implementation frameworks, building e-Voting technology, and building readiness in the implementation of e-Voting.

(2) For countries, organizations, and institutions that will change their general election method from conventional to e-Voting technology, this framework can be used for planning or reference for e-Voting implementation, so that its implementation result will be successful and sustainable.

(3) For the development of science, especially the management of framework development, management of e-Voting implementation, e-Voting technology, and e-Voting framework.

This research resulted in a proposed e-Voting framework that is open to further research and development. Some recommendations and suggestions for further research are:

(1) Social research aims to create a framework for implementing an assessment of the e-Voting success factor. With a special framework for assessing e-Voting implementation, countries, organizations, or institutions that will implement e-Voting have a measurable picture.

(2) Research frameworks produced derivatives of this proposed framework, such as the e-Voting security framework, the e-Voting network framework, and the e-Voting system framework. With a comprehensive framework, it is hoped that countries, organizations, and institutions will have a reference framework for the implementation of e-Voting.

(3) Technical research on e-Voting technology, such as network, security, and systems which are derivatives of the proposed framework because of this research. Technology is a significant aspect in the implementation of e-Voting and the slightest error in technical terms can reduce public trust, making the implementation fail and unsustainable.

(4) The development of socio-technical research and technology acceptance model research, especially for the implementation of e-Voting, this is important because the system built for e-Voting is certainly different from other systems, and the two studies above greatly affect the success and sustainability of e-Voting implementation.

Almost all academic researchers have limitations. In addition to the possibility of human error that may affect the results, including in this study, the limitations of this study, in the quantitative research phase, the number of sample respondents from the total population. Although determined by statistical theory and formulas, due to limitations, sampling was not carried out worldwide but only in Indonesia. However, the data received is original, with a balanced and even distribution of data.

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