A Framework for Adopting E-Voting in Jordan

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Abstract: Elections represent the highest level of democracy, where citizens choose their leaders and representatives. Merging technology with the election process in order to facilitate voting and solve the problem of declining turnout is already an existent reality, and several countries are using or testing different types of electronic voting systems. Jordan is one of the countries that have not yet started testing this technology. This research tries to find a suitable framework for adopting e-voting in Jordan by exploring the readiness of the Jordanian society to trust e-voting technology, including identifying the requirements that should be considered to build this trust, and investigating the social and technical issues that can play a role in accelerating or slowing down the adoption process. Based on previous research, a trust model is developed and examined. The model is comprised of two components: e-voting trust parameters and e-voting issues. The questions of the research are do the "trust" requirements (security, usability, privacy, audit, reliability and equity of access) really affect citizens' trust in e-voting? And do some e-voting issues (social and technical, authentication type, the conduit digital divide, and user expectation) influence trusting the e-voting system? For answering these questions, the quantitative method is adopted and a questionnaire was used to collect the needed data. Several statistical methods were used to analyze the data. The results show that there exists a considerable trust in technology and its ability to provide users with the needed e-voting systems. The results of the first question showed that trust in e-voting is positively affected by the fulfillment of the trust requirements, which, from the citizen's perspective, have different priorities. For the second question, the outcomes showed that these issues (authentication type, the conduit digital divide, and user expectation) also have a positive relation with creating a trust environment for e-voting.

Keywords: trust, e-voting, Jordan, framework, adopting

1. Introduction

Technology has become a foundation of the way of life in present society, and it is expected that its admission to the democratic system will happen sooner or later, but this also means that trust in democracy will be directly affected by trust in technology. E-voting means the use of computerized machines during the voting process in elections, aiming to increase participation, improve the voting process and enhance citizens' convenience. One of the most important and complicated issues related to e-voting is gaining citizens' trust; trust has different aspects that should be taken into account so that it can remain strong and will not collapse because of small problems Therefore, it is important to know the factors that drive people to trust e-voting. Fortunately, many authors set a number of parameters that directly affect trust in e-voting. This research examines these parameters and checks their priority according to Jordanian society. Other objectives are to find out if trust in the e-voting system is related to the technical characteristics of the system and whether some social issues play a role in adopting e-voting. The main findings are expected to enable a better understanding of e-voting and how to create an environment of trust in Jordanian society.

1.1 The selected environment of e-voting

E-voting has different implementations and approaches (Qadah and Taha, 2007; Qi, 2004). The first step is deciding the suitable method for e-voting. Although remote voting has attractive advantages, especially the ability to vote from home or work, it is still facing uncontrollable issues related to the security, privacy and concern surrounding the digital divide. (Oostveen and Besselaar, 2004; Fairweather and Rogerson, 2002). Using the ATM (kiosk e-voting), faces many difficulties, headed by the unwillingness of banks to insert any software to their systems (Fairweather and Rogerson, 2002). Thus, supervised polling-stations are expected to be the most appropriate method for e-voting in Jordan and the most suitable and smooth step after traditional voting (with the recommendation that both e-voting and traditional voting will be implemented at the beginning). Henceforth in this research, the concept e-voting will mean supervised polling-stations.

2. Literature review and research hypotheses

2.1 E-Voting

E-voting implies combining technology with the democratic process to make voting more efficient and convenient for voters. E-voting can play a significant role in enhancing the voting process through, firstly, increasing the low turnout among young age groups, who are not satisfied with the traditional

voting process (Xenakis and Macintoch, 2005). Secondly, e-voting can help in improving the participation of disabled people, who are usually less likely to vote than individuals who have similar demographic characteristics, according to Baker and Moon (2005). This help comes through providing conveniences, such as different text size, colours and audio voting. Thirdly, e-voting can solve the mother language problem by allowing voting in different languages. All of these benefits are in addition to the rapid and more accurate process of counting the votes that e-voting allows for (CoE, 2004). Although these benefits are attractive and can solve many problems of the paper-based voting system, the introduction of e-voting is not easy, as it faces a number of issues and challenges, such as social, technical, political, legal, economic, and behavioural aspects. These aspects should be studied thoroughly to unravel the hidden details that could affect the choice of suitable solutions and the overall success of the system. One of these critical and central issues is how to gain the people's trust in this technology. Trust obtains this significance because it is the base for supporting and adopting any technology or product.

2.2 Trust in e-voting

Randell and Ryan (2005) state that trust affects the people's acceptance of new products and services including computer-based systems. . Tassabehji and Elliman (2006) state that the concept of trust is enormously complex and includes many angles in addition to the difficulty to observe and measure trust itself directly. . Cetinkaya and Cetinkaya (2007) state that from technological view accepting e-election is not a problem as a significant part of the population are using technology in different aspects of their daily life. Therefore, the problem comes from the high sensitivity of the e-voting systems toward some subjects such as security, privacy and trusting governments or suppliers who will be involved in delivering the e-voting systems. Pieters (2006) emphasizes that the needed trust must develop from the dependability of the system, not because the people are required to rely on it; consequently the public choose to use the system even though they are aware of its potential risks and problems.

Therefore, before introducing the e-voting system as a reality to citizens, an environment of trust should be created to assure people that this system can be adopted. Fortunately, several models have been developed, which set a number of factors that should be included in any e-voting system in order to be trusted. Also a number of technical and social e-voting issues can affect the success or failure of the e-voting system.

2.3 Trust and trust parameters

Oostveen and Besselaar (2003, 2005) argue that, for a voting system to be trusted, the system should fulfill the security, privacy, accountability and economic requirements. Hoffman et al. (2006) stress that, from the user perspective, security, privacy, usability, reliability, audit and verification, and user expectation are the expected trust factors. Salem (2007) states that trust is developed in e-voting through the ease of use and simplicity of the e-voting. Avgerou et al. (2005) emphasized the simplicity of use factor for trusting any ICT-based service. In short, many authors agreed on the same “trust” factors (requirements): security, usability, privacy, audit, reliability and simplicity.

Based on the idea that e-voting should fulfill the requirements that satisfy the traditional voting system, equity of access appears as a strong “trust” requirement (Fairweather and Rogerson, 2002).. So it will be investigated if this requirement is directly related to trusting e-voting.
The following section sheds light on the trust parameters:

Security: e-voting research declares that the computer-based system which needs the best security insurance against different types of attack is e-voting (Qi, 2004; Hoffman et al., 2006). These attacks could be either from an inside or outside actor and either have deliberate or accidental motivation (Lauer, 2004). E-voting security is a multidimensional concept, and there is a set of parameters against which security should be investigated; for example, Hoffman et al. (2006) set them to be: authentication of all involved parties, data integrity, data access control, and physical security.
Privacy is defined as the inability to link a voter to a vote during or after the election (Cetinkaya and Cetinkaya, 2007), (Mitrou et al., 2002), (Sampigethaya and Radha ,2006), (Kofler et al., 2003). Hoffman et al. (2006) and Fairweather and Rogerson (2002) divide privacy into two aspects: user anonymity (the voter's choice cannot be revealed to any party) and data confidentiality or secrecy of ballot (the content of votes should not be revealed to those who are not authorized to know it). Krimmer and Volkamer (2006) argue that privacy should be secured currently as well as in the future against different parties, such as government, voters, attackers, election employees and any actor

involved in delivering the systems. In the same manner, voters should not be able to prove that they voted in a particular way, in order to prevent voter coercion and ballot buying.
Usability: a quality attribute that evaluates the ease of using the user interfaces from the first interaction. It also refers to methods of improving ease-of-use during the design process (Nielsen, 2003). Gritzalis (2002) argues that usability deals with the consistency in the user interface, the existence of context-sensitive help, the quality of user documentation and the availability of training materials. The e-voting system must provide different interfaces to cover up the different needs and types of voters (e.g. different languages, disabilities, etc).

Reliability: The IPI (2001) states that while security is concerned with the system's resistance to intentional attacks, reliability concentrates on the system's ability to function as planned, despite any failures in the hardware or software. Cetinkaya and Cetinkaya (2007), Mitrou et al. (2002), Sampigethaya and Radha (2006) and Kofler et al. (2003) see that reliability implies that the entire voting system should work robustly so that no votes are lost even if failures occur, in addition to ensuring that the votes are counted correctly. In the same direction, Gritzalis (2002) and Mitrou et al. (2002) argue that, in a reliable system, the votes received by the counting server should be the original ones and not modified. A valid vote is not allowed to be rejected, nor is a non-valid one allowed to be accepted.

Audit: concerns the transparency and reproducibility of the whole voting process and also the process of collecting information about attempts to access particular resources and use particular privileges (Mitrou et al. 2002). Cetinkaya and Cetinkaya (2007) see that physical recounting and auditing is a fundamental requirement for e-voting systems, where electronic and physical means should be used to store the election data and results and where recounting and auditing could be carried on off-line when needed, without compromising the integrity of an election or the privacy of the voter.

Simplicity of Voting Process Requirements: Fairweather and Rogerson (2002) concentrate on the idea that the whole voting process should be simple. The duration of the voting process should not be long. The likelihood of making mistakes should be minimized. Cost savings should be encouraged. The e-voting process should not require extra skills or mental effort form voters.

Equity of access: Fairweather and Rogerson (2002) state that equity of access implies that all voters are equal, and there should not be any organized discrimination that will make the voting more difficult for one segment of the voters than for others. Therefore, the authors stress that e-voting systems should not increase inequalities in access between voters. For instance, technologies that are more equally distributed among citizens should be preferred over technologies that are only used by a small part of the population. All eligible citizens should be able to use and access e-voting systems, including low-skilled, elderly and/or disabled citizens.

2.4 Trust and trust issues (technical and social factors)

There are some technical and social issues that were claimed to play a great role in trusting e-voting systems. Technical issues concern the different technical applications for e-voting and how to choose the most acceptable alternative suitable to a specific society. Alternatively, it is not enough to have a working, error-free system. The social issues and the characteristics of each society should also be considered. Oostveen and Besselaar (2003) stress that neglecting social and behavioral matters will affect the success of introducing new voting technologies, while analyzing them will help in realizing the level of users' confidence and trust in this new tool.

Two social issues will be discussed:
Digital Divide is the gap between those who use and have access to digital technologies and those who do not (Bozinis, 2007; Reddick et al. 2000; Oostveen and Besselaar, 2003). Reddick et al. (2000) stress that the previous definition is not complete, as non-users are not homogenous. They are divided into two groups. The first are those who have different levels of awareness to the advantages of using computers and accessing the Internet, but are not capable of doing so because of challenges, such as economic circumstances, availability of service, cost, lack of skill, literacy, etc. The second group consists of people who believe that the technology can add nothing to their lives and their needs for different reasons, such as actual disinterest, lack of observing value, lack of the needed skills to use technology, lack of understanding the available services and information, and lack of trust. DiMaggio and Hargittai (2001) expand the definition of the "digital divide" to "digital inequality" between people who are already on-line and those who are not. This inequality comes

from inequality in technical means, inequality in skill or inequality in the availability of a social support network. These inequalities affect the quality of knowledge the user receives in the IT world.
User Expectation: Hoffman et al. (2006) state that user expectation can play a considerable role in gaining citizens' trust in the e-voting system, where the term trust can be identified as the users' expectation that a service will be supplied or an obligation will be accomplished. Users' expectations may be based on citizens' familiarity with computer-based technology, citizens' understanding of the used technology, the reputation of the supplier who will deliver the service or product and also the reputation of the e-voting products and technology.

From the technical perspective (and since the polling station e-voting method is selected), two issues will be studied: the authentication type and the conduit. There are different options for each that should be considered with respect to each country's circumstances.

Authentication Type is the technical means by which one entity verifies that another entity is who it claims to be (Turban, 2004). There are different means by which the identity of the voter can be verified, ranging from the simple and weak methods, such as passwords, through smart cards, to the most significant authentication method, which is biometrics. These different types of authentication can be measured against familiarity and usage, preferences, usefulness, acceptability, security perceptions, and privacy perceptions (Jones et al. 2007).
Conduit consists of the means by which the votes are transferred to the central processor. Fairweather and Rogerson (2002) discussed different available means: physical transfer, telephone cables or Internet based solutions, with their different advantages and risks.

2.5 Research model

Based on previous research, building trust in e-voting is expected to depend on two factors. The first factor is the fulfillment of a number of "trust" requirements. The second factor is related to some social and technical aspects that affect the trust in e-voting systems. This study will examine these issues according to the Jordanian society. Figure 1 represents the research model.

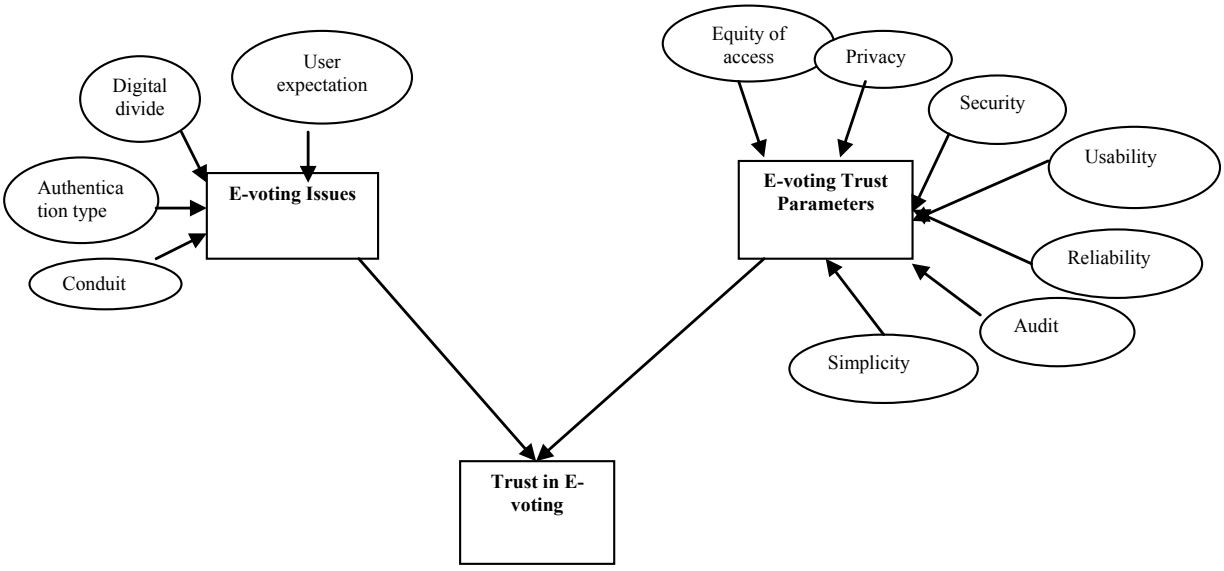

Figure 1: The research model

2.6 Research hypotheses

H1: There is a positive relation between e-voting trust parameters and their determinates (security, privacy, usability, reliability, audit, simplicity, and equity of access).

H2: There is a positive relation between e-voting issues and their determinates (user expectation, digital divide, authentication type and conduit).

H3 (the main hypotheses): There is a positive relation between trust in e-voting and its determinates (e-voting trust parameters and e-voting issues).

3. Research methodology

3.1 Sampling and data collection

The present research is quantitative, where the main objective is to develop and employ mathematical models, theories and hypotheses related to e-voting and its technical and social issues. Selecting the appropriate sample was not an easy task for a number of reasons. First, there is a high level of variation in the Jordanian society (as in other societies), including variation in age, culture, education, and relation with technology. Second, the subject of this research is a new and even ambiguous concept for Jordanian citizens. **The Strategy of Selecting the Population:** when a new technology is introduced to people in any country, it is not expected that the whole population will adopt it and start using it right away. On the contrary, this process will pass through stages, starting with a small group within the population, and, if their experiment succeeds, they will encourage others to participate. So the research strategy is to select groups of the society who are expected to use technology or who are currently using a technology similar in some way to e-voting or the groups who play an essential part in affecting the public opinion. Therefore, the sample was selected from many segments of the population. The first is the young, educated generation (university students) to assess whether they are ready to trust and adopt e-voting. This group is expected to be closer to and more familiar with technology and to have the curiosity to use new technologies. The second group is IT and related area experts in order to assess whether they expect that e-voting can be trusted and implemented. The third group consists of leaders in the government and nongovernmental organizations in order to assess how much they know about and trust e-voting. The fourth group is journalists. In addition to assessing how much they know and trust e-voting, they can support or destroy the e-election by their opinions, which often influence people. The fifth group contains professionals who use and trust technology, such as engineers, doctors and university professors. The final group is school teachers, who can affect the younger generation's views on e-voting. The point of this selection is that these groups could affect the public opinion and could be the starting point for support of e-voting.

3.2 Instrumentation and Procedures

The Resources

The primary resource of data for this study is a questionnaire that is prepared to provide data about the following aspects: data measures the variables and data that measure the relations between variables.

The secondary resource that this research used was content analysis methodology; it examined published articles from refereed scientific journals, consulting firms, recognized IT specialists and conference proceedings that were published after 1997.

The Instrument

The instrument used in this research is the questionnaire. The questionnaire passed through a number of stages to reach a convenient one, according to the suggestion of Lanthier (2002) and Walonick (2004). Stage 1: **determining the questionnaire's contents:** the questionnaire of this study did not benefit from any previous questionnaires, and it was developed specifically for this research by its author, depending only on the related literature. The variables related to e-voting trust that should be investigated were identified, then the operational definitions of each variable were declared, and, from them, the statements of the questionnaire were written. Stage 2: **preparation of the questions** by checking that each question was clear, simple, specific, and measures one item at a time to avoid ambiguity, word leading, or question-coverage errors, in addition to taking care with the sequence and arrangement of the questions. The questionnaire was also double checked by an English professor to avoid any language misleading errors. Stage 3: **the enhancement of the questionnaire through a panel of experts:** the questionnaire was handed to a number of referees to validate it. These experts were six university professors, three computer engineers, and two IT specialists; depending on their notes, the questionnaire has been refined. Stage 4: **carefully translating the questionnaire** into Arabic to overcome any language hurdle that may face some respondents. This was done by getting help from a university professor who is a specialist in both Arabic and English. Stage 5: **A pilot test** of the questionnaire was carried out in which 30 questionnaires were distributed and collected (with a returning percent of 100 percent), the respondents were asked to state their notes on the questionnaire; the results of the questionnaire

were analyzed and accepted, then the final version of the questionnaire was created taking into consideration the useful comments provided by some respondents (which were few).

3.2.1 The Questionnaire's Final Structure and Content

The final version of the questionnaire structure was as follows:

1. **Covering Page and Introduction**: this section includes the title of the study, the purpose of the questionnaire, emphasis on the confidentially of the responses, the intended participants who have been selected to receive the questionnaire, the contact person accompanied with the e-mail address and cell phone number of the contact person.
2. **Glossary**: the terms used in the questionnaire are defined.
3. **Demographic Questions**: this section includes questions about the respondent's age, gender, and level of education. Information is also collected about the organization the respondent works for and his or her current position.
4. **Instructions**: clear instructions on answering the questions are given.
5. **The Questions**: The questions are discussed below.
6. **Other Comments**: there is a space in the questionnaire to allow respondents to share any other comments.
7. **A thank you note**.

The Questions

The final version of the questionnaire consists of 44 statements with close-ended questions. The likert scale was used to measure the study variables; it ranges from 1= Strongly Agree, 2= Agree, 3= Neutral, 4= Disagree, 5= Strongly Disagree.

The questionnaire's questions cover all variables that are related to the subject of the study. The table below shows the studied variables and the questions representing them in the questionnaire

Table 1: the trust variables and The Questions representing them

Security is represented by questions1 to 4:
1. **U**sing unique authentication methods for each voter, to avoid mixing up between voters improves the security of the election process
2. An e-voting system lacks data confidentiality, thus it would be easy to tamper with.
3. Only authorized individuals can access e-voting services and data.
4. Before ending the casting process, the system must confirm the data entered by the voter.
Privacy is represented by questions 5 to 7:
5. By using e-voting system the votes' contents can't be revealed by unauthorized parties.
6. Using powerful encryption method can protect the privacy of voters.
7. By using an e-voting system, the anonymity of voters can't be disclosed by electoral officials or the government.
Usability is represented by questions 8 to 12:
8. E-voting interface can be used easily by voters from the first interaction.
9. E-voting system can provide instant help to voters in case any problem occurs during the e-voting procedures.
10. I think that the e-voting system can be simple and easy to use.
11. E-voting system can utilize the voter's natural dialogue.
12. The e-voting system must provide different interfaces to cover up the different needs and types of voters (e.g. different languages, disabilities, etc).

Reliability is represented by questions 13 to 17:
13. The e-voting system tends to lose votes during the voting process.
14. In using e-voting system, errors such as rejecting valid votes or accepting non-valid ones are unexpected to occur.
15. The e-voting system is able to acquire votes correctly.
16. Through e-voting system, some procedures can be used to ensure that the votes are counted correctly.
17. By using the e-voting systems it is not allowed to lose information even if failures occur.
Audit is represented by questions 18 to 21:
18. The use of audit trail that assures voters their votes were recorded correctly is an important component of the e-voting system.
19. Recounting and auditing votes without compromising the integrity of election is a possibility using e-voting systems.
20. E-voting system can record information about actions that can violate the election process.
21. The entire e-voting process provides a high level of transparency.
Simplicity is represented by questions 22 to 25:
22. There is time saving using the e-voting.
23. The e-voting system is expected to be easy that encourages voters to use it.
24. Low level of mistakes is an integral attribute of the e-voting system.
25. The ease of the e-voting procedures encourages voters not to abandon the e-voting process once they started the voting procedure.
Equity of access is represented by questions 26 to 29:
26. All eligible citizens can use e-voting.
27. Disabled and old citizens can be provided with suitable facilities to use the e-voting system easily.
28. E-voting will not be more difficult to low skilled people.
29. In e-voting familiar technology (such as GUI, touch screen technology, etc) is the most appropriate technology to be used.
User Expectation is represented by questions 30 to 33:
30. Users' computer literacy will play significant role in their expectations of the e-voting system.
31. Users' understanding of the e-voting technology will affect their expectations of the e-voting system.
32. The reputation of the system's supplier will not affect on users' expectations of the e-voting system.
33. Providing detailed information about e-voting impact its popularity.
Digital Divide is represented by questions 34 to 38:
34. The citizens' technical skills in technology will play a significant role in their acceptance to e-voting.
35. The ability to use the e-voting system is influenced by the economic capability of citizens to own the needed skills.
36. Older people have less interest in participating in e-voting than younger people.
37. Gender (male or female) is an important factor to engage in e-voting.

38. The availability of family members or friends who use and encourage using technology affects the individual willing to use the e-voting system.
Authentication Type is represented by questions 39 to 41:
39. The familiarity of the authentication method (password, smartcard, or biometrics) affects adopting e-voting.
40. The simplicity of the authentication method affects adopting e-voting
41. Each authentication method affects protecting the privacy of users differently.
Conduit is represented by questions 42 to 44:
42. The mechanism used to transfer the votes to the central servers affect the voters decision to adopt e-voting.
43. Transferring votes physically to the central servers (e.g. using memory storages) is more secure than using the internet.
44. Using the internet to transfer votes to the central servers is accepted even with all the internet threats.

There is also a section in the questionnaire which asks respondents to rank the types of the authentication methods to be used in e-voting system as follows:

Please rank your favourite type of authentication methods to be used in e-voting system (1 for the most favourite type, 3 the least favorite one)

☐ ***Password*** ☐ ***Smartcard*** ☐ ***Biometrics***

3.3 Questionnaire distribution and collection

300 copies of the questionnaire in both Arabic and English were distributed by hand, and a softcopy was published on a website, "The Knowledge Stations Website," related to IT trainers located across Jordan. 207 copies were returned (69%); 200 of the 207 copies were accepted and used in data analysis (67% of the original distributed copies). The discarded copies were mostly not answered.

The respondents in the sample were predominately male (67.5%). The age of most respondents was between 25 and 35 years (46%), followed by those younger than 25 years (31%). This indicates that most respondents were young people. From the education perspective, the majority of respondents had earned B.A or B.Sc. degrees (70.5%), followed by those with Master's degrees (17.5%).

4. Data analysis and results

4.1 Operationalisation and measurement of model variables

In order to validate the research model, all variables in the model should be operationalised which, leads to a better-developed model. The first step was Theoretical Operationalisation, which is done through the review of related literature. The second step was Statistical Operationalisation, using explanatory factor analysis (EFA). Using SPSS software, EFA was carried out to analyze the questionnaire's responses for each item of the e-voting trust. The purpose is to measure the multiple items that had been set to represent each variable and to check if they are loading together on the same factor. This was aided by the work of Hair et al. (1998), who declared that, when the item value loads on only one dimension (factor) with a value larger than or equal to 0.5, then it is accepted. Table 2 shows the number of items loaded on each related factors with the value ranges, which is noticed to be >0.05.

After that, the summated scale technique was used to combine all the variables loading significantly on a factor, and the average score of the variables was used as a replacement variable (Hair et al., 1998). This approach is a valid approach and has strong support among researchers

Table 2: Major indicators of the factor analysis

Constructs	No. of items	Loadings
Security (SEC)	3	0.61- 0.77
Privacy (PRI)	2	0.82- 0.82
Usability (USA)	5	0.56- 0.77
Reliability (REL)	3	0.72- 0.74
Audit (AUD)	4	0.65- 0.76
Simplicity (SIM)	4	0.67- 0.81
Equity of access (EQU)	4	0.57- 0.78
User Expectation (EXP)	3	0.74- 0.77
Digital Divide (DIG)	4	0.57- 0.73
Authentication (AUT)	3	0.68- 0.81
Conduit (CON)	2	0.79

4.2 Measurement model

Confirmatory factor analysis (CFA) is commonly known as the measurement model in the structural equation modeling (SEM). It is a multivariate technique used to confirm a hypothesized relationship structure between the items and the factors (Coughlin and William, 2007). CFA permits for a statistical test of the goodness of the fit for the anticipated model. The confirmatory modeling approach was carried out to examine the significant of the research model using EQS 6.1 software. The results are shown below in Table 3, which shows the model fit indicators and their benchmark values; it also shows the values derived from the research model. As shown in table 3, Chi-square value is significant at 0.05 significance level, (X^2 (.05) = 55.06, P = 0.05), and all other fit measures indicate that the hypothesized model is accepted as GFI = 0.95, RMSEA = 0.05, LTI = 0.97, IFI = 0.98, CFI = 0.98, and X^2/df = 1.41. Therefore, the hypothesized model was accepted and adopted for testing the hypothesis of this study.

Table 3: Model fit indicators

Goodness of Fit Measurement (GFM)			
The Measurements	Abbreviation	Best Range	Model Reported Values
Absolute Fit Measurement (AFM)			
Chi-Square	X^2 (p)	P >= 0.05	55.06 (.05)
Goodness-of-Fit Index	GFI	> 0.9	0.95
Root Mean Squared Error of Approximation	RMSEA	< 0.08	0.05
Incremental Fit Measures (IFM)			
Comparative Fit Index	CFI	> 0.9	0.98
Incremental Fit Index	IFI	> 0.9	0.98
Tucker-Lewis Fit Index	TLI	> 0.9	0.97
Parsimonious Fit Measures (PFM)			
Normed Chi-Square	X^2/df	2-5 good, < 2 fair	1.41

4.3 Reliability test

A reliability test was carried out using Cronbach's alpha, which measures the internal consistency of a construct; its values should be greater than or equal to 0.6. In some cases, some items' values may be below the benchmark value; nevertheless, various statistics can be examined instead, such as the fit indices in confirmatory factor analysis (CFA), which should be above the cutoff (usually .9) levels according to Garson (2008). Another statistical value that could be referenced is the total variance.

The results of the reliability test are shown in table 4 in which the α-values are greater than 0.6 for all variables except for security, privacy, digital divide and conduit; this is not considered a problem for a number of reasons.

First, the total variance, which specifies the percentage of explanation for each clarifying factor, can be used as a supportive indicator and as indicated in table 4. This ratio is a good one. Second, theoretically, there is evidence that the existence of these factors is essential when studying trust in e-voting. Third, this study is an explanatory one where its subject is new for respondents.

Table 4: Major indicators of the factor analysis

Constructs	α-value	TVE (%)	Standard Division
Security (SEC)	0.43	47.50	0.62
Privacy (PRI)	0.51	67.68	0.85
Usability (USA)	0.69	45.76	0.60
Reliability (REL)	0.66	39.68	0.77
Audit (AUD)	0.66	49.83	0.66
Simplicity (SIM)	0.69	52.34	0.69
Equity of access (EQU)	0.65	48.59	0.73
User Expectation (EXP)	0.63	57.30	0.78
Digital Divide (DIG)	0.56	43.68	0.73
Authentication (AUT)	0.63	57.45	0.72
Conduit (CON)	0.38	61.83	0.91

4.4 Normality

According to Hair et al. (1998) normality is the assumption about the degree to which the distributions of the sample data correspond to a normal distribution. Normality of the variable's data could be read from the standard division. When the standard division is less than one, it indicates normality. From Table 4, it is obvious that the standard division for all variables is less than one, which indicates normality in data.

4.5 Hypotheses analysis

In order to assess the hypotheses of the model, a number of means of evaluation were used. First, the overall coefficient of determination (R^2), which is a measure of the entire structural equation, as $R^{2,}$ can provide a relative measure of fit for each structural equation. Second, the standardized estimation coefficients (beta) can closely approximate the magnitude of the effect. A beta close to zero has little, if any, substantive effect, while an increase in value corresponds to increased importance in the causal relationships.

Table 5: Path analysis: analysis of the hypothesized regression path

Regression Path	Test statistics		
	Standardized Beta	t-test	R^2
Measurement Model1			
Security→ EVTP	0.50*	6.32	0.25
Privacy → EVTP	0.48*	6.12	0.23
Usability→ EVTP	0.72*	8.93	0.53
Reliability→ EVTP	0.68	N/A	0.46
Audit→ EVTP	0.79*	9.54	0.62
Simplicity→ EVTP	0.82*	9.85	0.67
Equity of access→ EVTP	0.68*	8.47	0.46
Measurement Model2			
User Expectation→ EVI	0.82*	4.88	0.67
Digital Divide→ EVI	0.66*	4.72	0.44
Authentication→ EVI	0.47*	4.15	0.23
Conduit→ EVI	0.39	N/A	0.15
Measurement Model3			
EVI → TEV	0.84	N/A	0.71
EVTP → TEV	0.79*	3.46	0.63

EVI: E-voting issues; EVTP: E-voting trust parameters; TEV: Trust in e-voting;

Significant at .01 levels

N/A (Not Applicable): in order to perform CFA, some values should be fixed, which a model building requirement is.

Measurement model1 represents the first question in the research, which involves the existence of a significant relation between e-voting trust parameters and their determinates (security, usability, privacy, reliability, audit, simplicity and equity of access), with seven hypotheses that were created to investigate these relations.

Measurement model2 represents the second question, which states that there is a significant relation between e-voting issues and their determinates (user expectation, digital divide, authentication type and conduits), with four hypotheses that were created to investigate these relations.

Measurement model3 represents the third question, which says there is a significant relation between trust in e-voting and its determinates (e-voting trust parameters and e-voting issues), with two hypotheses that were created to investigate these relations.

For testing the direct significant relationships between the four parameters and EVI, the Standardized Beta was used as an indicator for this relationship. Looking at table 5, it is clear that a positive significant relationship between EVI and each parameter does exist. This denotes that the four parameters (user expectation, digital divide, authentication type and conduits) are parts of the e-voting issues and have significant relationships with EVI.

For testing hypothesis and analysis of the structural model, the value of the t-test is investigated. When looking at table 5, the t-value of the regression paths between each parameter and EVI is significant. Also, the coefficient of determination (R^2) of each parameter was investigated, as it represents the percentage of total variance in the specific parameter, which is accounted for by the EVI. For example, the R^2 for user expectation equals 0.67, which indicated that 67% of the total variance in user expectation was accounted for by the EVI.

The SEM and the t-test of beta significance were exploited to test research hypotheses; the t-test exhibited statistical significance, hence all hypotheses of this study were accepted. Also, the coefficient of determination (R^2) of each parameter was shown, which represents the percentage of total variance in the specific parameter that is accounted for by its dependent variable.

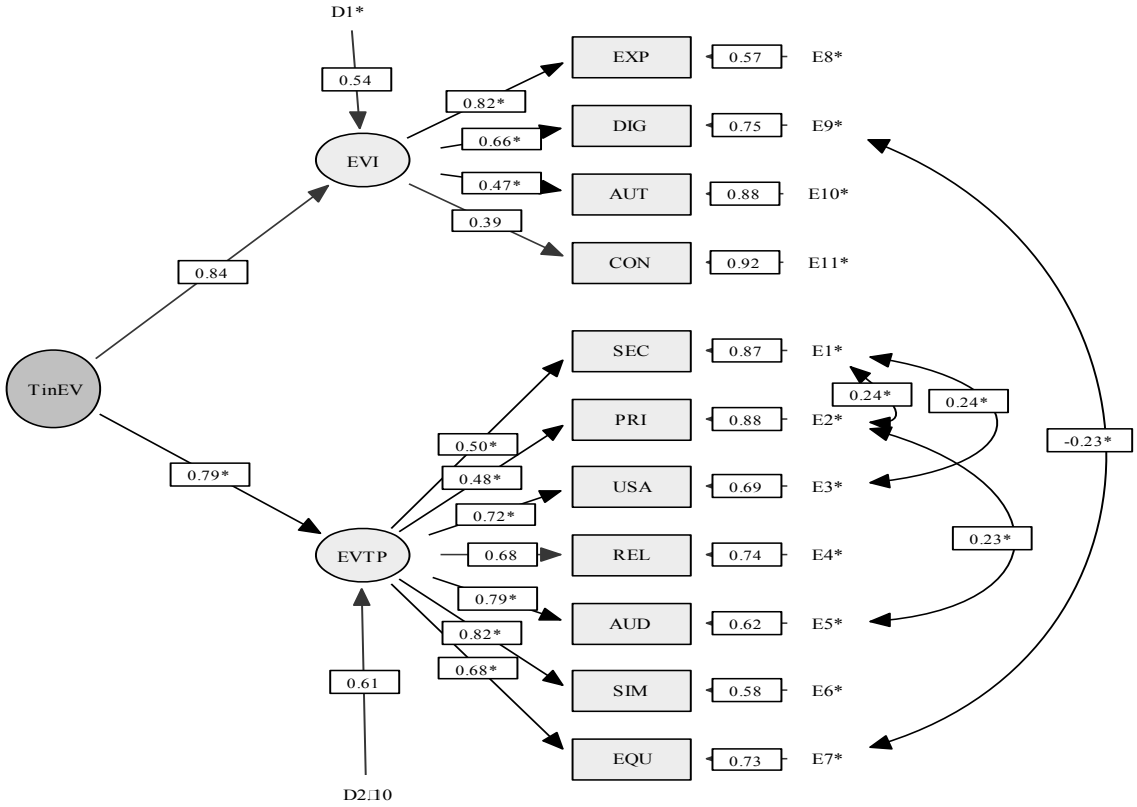

Figure 2: Trust in e-voting construct (TEV)

5. Discussion

This research was dedicated to build a framework to adopt e-voting through exploring the trust requirements and the social and technical issues related to trusting e-voting in Jordan through studying eleven parameters. It was found that the eleven studied parameters have positive relations with trust in e-voting, but with different priorities.

- User expectation was given the highest priority, indicating a logical fact that, when a system meets the users' needs and expectations, it is bound to gain their trust.
- Simplicity, the parameter that is directly related to user interaction with the system was also placed in the highest position, indicating that citizens will build their trust in e-voting on its ability to make the voting process easier.
- Audit, usability and reliability were placed in the following positions, which indicate that the government should take these parameters and their characteristics into consideration when developing an e-voting system.
- Equity of access and digital divide were placed afterward, which indicates that people will trust a system when it does not exclude segments of the population. Also, it emphasizes that the needs of the different types of citizens, including the disabled, elderly and low-skilled people, should be taken into consideration.
- Security and privacy were placed in the fifth and sixth places, even though they are usually set in the first places, which may indicate that citizens are not well informed about e-voting and the risk surrounding it.
- The technical issues were given the least priority in the process of trusting e-voting, but they still have a role to play, keeping in mind that the proposed method has limited the number of threats on the system. So the proposed authentication method, with its familiarity and ease of use, is part of the trusting process. One reason for this is that trust is related more to people trusting themselves to use the system without facing problems in the process of authenticating themselves to the system. The conduit was found to play a small role in trusting e-voting, as people are concerned more with the security of the conduit than its manner.

In summary, the first research question was do the “trust” requirements really affect citizens' trust in e-voting? The results showed that trust in e-voting is positively affected by the fulfillment of these requirements. The second question was do some e-voting issues (authentication type, the conduit digital divide, and user expectation) influence trusting the e-voting system? The outcomes showed that these issues also have a positive relation to creating a trust environment of e-voting and will help in smoothing the adoption of e-voting.

On the other hand, the study revealed that there is a need to educate people about e-voting so that they can differentiate between actual and false news and threats. Another issue that the people are concerned about is the possibility of manipulating the technology to control the results of elections. Therefore, governments should show citizens how e-voting is implemented to facilitate the means of voting.

From the implementation perspective, the initial implementation of e-voting should be conducted as pilot e-voting tests on different elections, such as those at universities or unions, and, afterwards, tests in some cities or at the Jordanian embassies around the world for parliamentary elections. These pilot tests should be prepared carefully to guarantee their success, so as to strengthen the citizens’ trust.

6. Conclusion

This research has provided a number of contributions to the literature on trusting e-voting. Firstly, it is the first comprehensive research that draw an outline for the suitable framework of e-voting that suit the Jordanian circumstances; It discusses the concept of e-voting in Jordan through checking what is needed for citizens to trust and what some of the social and technical issues related to e-voting are. . Secondly, the research joins the trust requirements of a number of models into one model with both social and technical issues related to trusting e-voting. Thus, this research provided a better and wider picture that represents the whole trust environment that should be created. Thirdly, this researcher expected that equity of access would be a vital parameter in trusting e-voting. After analyzing the result, it was found that this factor is actually a significant part of the e-voting trust

parameters as it was in fourth place among other trust parameters. Fourthly, even though Hoffman et al. (2006) set user expectations as part of the trust parameters, in this research it was found that user expectation is part of e-voting issues.

Finally, introducing this technology successfully is not easy as it requires the acceptance of a wide range of people and is related to the sensitive issue of the election, in addition to the different related topics that affect it, including legal, technical, and social, concerns. However, e-voting in Jordan is not impossible since it has already been implemented successfully in several countries. Additionally, e-voting can contribute to advancing the whole country to a higher level of development that can affect other aspects of citizens' lives. For Jordan, with its available capabilities, it is essential not to be just a spectator of on-going advancement, only adopting technology as a reflex action, but to be a catalyst for the future and a leading country in the region.

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