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Kuwaiti people. E-voting at a polling station provides an intermediate stage to employ electronic voting without moving completely to internet voting. Such a system would build confidence in the technology to allow internet voting at a later stage.

For future work, a series of pilot experiments should be implemented for each stage of the development of e-voting and internet voting systems until a system similar to the Estonian system is eventually developed.

digital signatures and a public key infrastructure should be used, similar to the system used in Estonia. Also more security features should be enforced in order to prevent hacking or virus attacks.

6. If the Internet voting system is successful it could be rolled out to the whole country.

At each stage, surveys should be conducted after each election to determine if the Kuwaiti people are happy that the electronic voting system is working adequately before moving to the next stage. The surveys should also check to see if coercion and illegal primary elections are still a problem, to see if the e-voting system is succeeding in improving the democratic process, and to check to see if the voters are more satisfied and confident in the new system than they were for the current voting system.

Conclusions:

In this paper, we first gave an overview of the paper ballot system that has been used for many years in the state of Kuwait. Then we identified some of the drawbacks of the current voting system which the new suggested system should resolve.

For Kuwaiti people to trust the e-voting system, it has to be secure, reliable and satisfy all voting requirements of a modern democracy. Thus, we have identified the e-voting principles and secure steps that should be followed when implementing the e-voting system in Kuwaiti with emphasis on the social issues that can have an effect on the Kuwaiti election environment. A survey was conducted to check the acceptance of e-voting for parliament elections and to replace the paper voting system currently used in Kuwait. The result shows the following:

- The majority of participants have little trust on the current paper voting system.
- Most of the participants would like to change to an e-voting system
- Most of the participants would prefer to vote at polling station rather than at home as they believe it would be more secure
- Most of the participants would like to have the chance to confirm their vote electronically and also have a printed paper confirmation which can be counted.

From the survey it was found that although there was a willingness to move to a more electronic system, a lack of confidence would be a major issue if an internet voting system was introduced. This paper has therefore suggested a new e-voting system that incorporates many features and principles of the old paper system to help the Kuwaiti citizens to accept the new system and feel acquainted with it.

An analysis of the voting system in Estonia was carried out to see if this working system would be suitable for Kuwait. However, it was concluded, based on the result of the survey, that a more cautious, step by step move towards full internet voting would be necessary to build confidence in the system by the

system. Experts would need to review the e-voting system under the supervision of the election officials to determine the causes of any discrepancy.

Step 9. Recounting the Votes

Due to the fact that the physical paper copies exist this ensures that a recount can be made as many times as desired.

Future Work

The survey shows the majority of the participants (65%) who prefer e-voting at a polling station, think it is good idea to consider the voting at the polling station as a preliminary stage for implementing the full I-voting system in the future [figure-10].

A pilot trial can be suggested for future work or implementation to the proposed e-voting system with a number of suggested steps to introduce the e-voting and I-voting systems to a population that is not yet ready for it.

Thus, the suggested steps are as follows:

1. The e-voting system at a polling station is tried in a single district. Manual identification on entry to the polling station would be used as well as electronic identification with the Swipe reader at the polling booth. A paper version of each vote should be printed and put in a ballot box and then both the paper and electronic votes could be counted to see if they match. The electronic votes would also be transported to the central location by two means, the Internet, and a physical transportation of the vote storing media. Again the results from the two methods would be compared to check that they match.

2. On the next parliament election, the e-voting system is again tried, but this time in more areas and this time only the electronic version is counted unless the vote is challenged by one of the candidates, in which case the paper vote is used for the recount. The two transportation methods should be continued at this stage to demonstrate the Internet can be trusted when appropriate security software is used. The manual identification of voters at the polling station should continue.

3. The e-voting system should then be used throughout the country. Manual identification of voters should continue until all areas had used the double checking system proposed at least once.

4. Once the trust of the e-voting system has been gained, it may be possible to drop the printing of the votes when people realize the electronic count is just as reliable as the paper count. This would be a big step forward as it would make the system much faster to process and more reliable if it does not depend on printer equipment. Similarly, the manual checking of voter identity could be dropped in favor of the cryptographic identification methods.

5. Also, once the trust had been gained in e-voting, an internet voting system could be trialed in one area. If the user interface on the Internet system is similar to that on the voting machine it will be better trusted by the people. When the I-voting system is implemented, the strongest cryptographic methods based on

a system with the ability to request vote confirmation such as a printed paper (figure-10). These two features should enhance the user trust and confidence of the system. In order to comply with the system requirements of democracy, the system must ensure the voter has to vote only once, and the paper ballot is only printed if the voting process is done.

Uncoercibility and prevention of vote buying and extortion can be improved by the proposed e-voting system but it also requires the help of the government officials to ensure that no one takes the original printed paper or a copy of it outside the polling station. As some people argue, coercion cannot be totally prevented by technology alone (Gritzalis & Katsikas, 2002).

Step 8. Tallying the Votes

This process is performed to validate votes and determine the number of votes each candidate has received, along with any canceled votes. This process should take place at the end of the election day, in every main polling station, and finishes when all votes have been directly validated and tallied electronically by e-voting machines. In the first elections using this system it will also be necessary to count the votes manually by the election officials using the paper copies. Although this will be time consuming, it will build confidence in the electronic system so that in later elections the votes can be counted by only the electronic system, with the paper votes being counted only if the losing candidates challenge the result.

In the case of the e-voting machine, the voting information could clearly be transported to the central location more quickly and more reliably using an electronic network. However, confidence in the system must be maintained, so in the first elections using the system, once voting has closed, the officials should transport the vote storage devices from each machine to centralized locations for vote counting, much like they would do with paper-based systems. The electronic votes transmitted via the network would not be officially recognized until verified by tabulating the results which are stored on the storage devices from the e-voting machines.

The paper copies of votes can be handled in the traditional way, with all boxes brought to the main polling station, the boxes are opened under the supervision of the election officials and the candidates' representatives to validate each vote. Valid votes from all parts of the same district are then added together. At the end of this process the results of the network transmission of votes and the manually transported electronic votes can be compared to the result of the paper votes for verification purposes. If the results are the same, the supervisor of the main polling station can announce the result to the public through the available media. The electronic vote storing devices and the paper copies of votes should then be kept safe for as long as the state law designates.

If there is no match between the two system results then the result of paper system should be approved as this is similar to the existing, traditional voting

Police and military employees are eliminated from voting by the Kuwaiti state law.

Step 3. Setting-up Election Centers:

This process is performed after elections districts have been defined and before the voting time period is announced. Its goal is to provide the infrastructure, which allows for the election process. During this process the authorized election centre staff, along with individuals authorized to supervise the election process for each election centre, are identified. This process, again, already exists, but the staff authorized to supervise the centre will need additional training to cover the electronic systems provided.

Step 4. Setting-up the Polling Stations:

The aim of this process is to setup the polling stations for each district. Each polling station should be equipped with many e-voting touch screen machines, based on the room size and number of voters in the district. These e-voting machines should employ a card swipe system for use with the voter's ID card.

Step 5. Identification and authentication of the voter

On the election day, to ensure that the voter votes him or herself, the voter should show their identification card to the officials in order to enter the polling station. The officials would check and verify the picture and district of the voter before directing them to an available e-voting machine.

Step 6. Verifying the voter electronically before they cast their vote

Going to the polling booth alone to use the voting machine to cast their vote, enables the voter to cast their vote freely and anonymously without any coercion. At the polling booth the voter must swipe their digital ID card to give a second, electronic identification of the voter's name, district and eligibility to vote, matched to the government registration list. The screen will then show the candidate list for that district only.

Step 7. Casting the Vote:

Once the voter chooses their candidates, they must submit their votes with a press of a button which takes them to another screen which shows confirmation of the chosen candidates. The voter then has to choose one of the two options, either to confirm the selection and exit the system, or to modify their choices by going back to the previous screen to modify their selection. This confirmation process is proposed to comply with survey result that shows 57% of participant said it is essential and 30% said it is nice to have a screen to confirm their candidate selection before it was made final (figure-9).

Votes are then stored in the system. Once the voter confirms their selection, a paper ballot is printed to confirm their voting selection. The voter has to take the paper ballot, check his/her selected candidates and then insert it in the ballot-glass box in front of the adjudicator as in the traditional paper voting system. The printed paper is also added as feature to comply with survey result that shows 74% of participants said it is essential and 20% said it is nice to have

different social issues to those of Estonia. These different issues do not support the use of the same system as was used in Estonia, these issues are:

- tribal families
- family-oriented culture

These two issues could have a significant effect on the Estonian I-voting system if it was to be implemented in Kuwait society. Tribal families often hold primaries in order to coordinate their votes (against the Kuwaiti Law) so that they can win a seat in the parliament (Abubakar, 2013). Also Kuwait is a family-oriented country where family values are very high and sometimes this might affect a family member's decision, for example, one family member can sometimes decide or influence the voting choice of other family members.

Therefore, because of the Kuwaiti social issues, the risk of using an internet voting system in an uncontrolled environment, and the result of the survey conducted, we suggest a new proposed system.

A proposed E-voting system for Kuwait.

Based on the survey result discussed before, we have suggested introducing a new e-voting system which can meet the Kuwaiti population's requirements. The new system proposed is an e-voting system at a polling station with the use of a paper trail feature combined with some features and procedures of the paper based system that has been used for many years in Kuwait. The purpose of this combination is twofold, one is to enhance the confidence and trust of the new system by giving voters the ability to check that their printed copy matches their electronic vote before inserting the paper into the ballot box, and the other is to use the paper copies for a manual recount if any candidate files a complaint over the vote counting. In addition, people will also find the system easy to deal with because most of the old paper-based system procedures and principles will exist in the new system.

Although e-voting may seem the perfect application for technology, in reality, it is difficult to achieve (Daimi, Snyder & James. 2006). In any electronic voting system, security and reliability are important attributes (Spycher, Volkamer & Koenig, 2011). The steps to achieve this reliable and secure proposed e-voting system for Kuwaiti elections are as follows:

Step 1. Definition of Election Districts:

This process already exists and is carried out by the government officials before the election campaign, to define the district boundaries and the number of candidates to represent each district.

Step 2. Determining the Voters:

This process also already exists and is also carried out by the government to determine all the eligible voters for the state of Kuwait. In general, all adult persons at the age of 21 years and above have the right/obligation to participate.

Summary of the Estonia I-voting System

The survey suggests that I-voting system would not be appropriate for Kuwait at this stage. Yet Internet voting has been implemented elsewhere, and in particular Estonia's experience of I-voting is well reported (Maaten, 2004)

The Estonian e-voting system uses the internet voting as well as the traditional paper-based voting system. A voter has three options to cast their ballots :

1. Voting through the internet in an advance period before the election day.

2. Casting a paper ballot during the advance voting period, or

3. Voting on the election day with the paper ballot

Internet voting is only available for a certain period, usually from four to six days prior to advance voting days, and therefore not on election day. Electors are able to change their vote as many times as they like as long as the on-line polls are open and can still vote by paper ballot on election day, although this would disqualify their electronic ballot. The last voting cast is the only one that is counted, which replaces all the previously cast votes.

The main components of the Estonian e-voting system are a smart card reader, a voter application run on windows, MacOS or Linux operating system, and an Internet connection. When voting, the voter inserts their valid ID card into the card reader and opens the webpage for voting. After the voter is verified using the PIN1 of their ID-card, the voter is shown a candidate list appropriate to their electoral district and the voter can only make one choice. The voting system uses a "double envelope" schema (Skagestein et al., 2006) the vote is put into an inner envelope which itself is wrapped by an outer envelope that contains the digital signature of the voter. This process is designed to ensure voter privacy and security. Once the voter makes their voting decision, which is encrypted by the voting application, the voter confirms their choice with a digital signature (by entering the PIN2-code) and receives confirmation that the vote has been counted (Estonian National Electoral Committee (2007a and 2007b). At the vote count the voter's digital signature (outer envelope) is removed and the anonymous encrypted vote (inner envelope) is placed in the ballot box.

Reasons for choosing the e-voting system at a polling station.

It can be seen that there are some similarities between Estonia and Kuwait, such as:

- both are small countries in size and population
- both have ID cards for all citizens
- most of the people have access to the internet

These similarities give an indication that Kuwait could adopt the Estonian I-voting system rather than create their own. However, Kuwait has
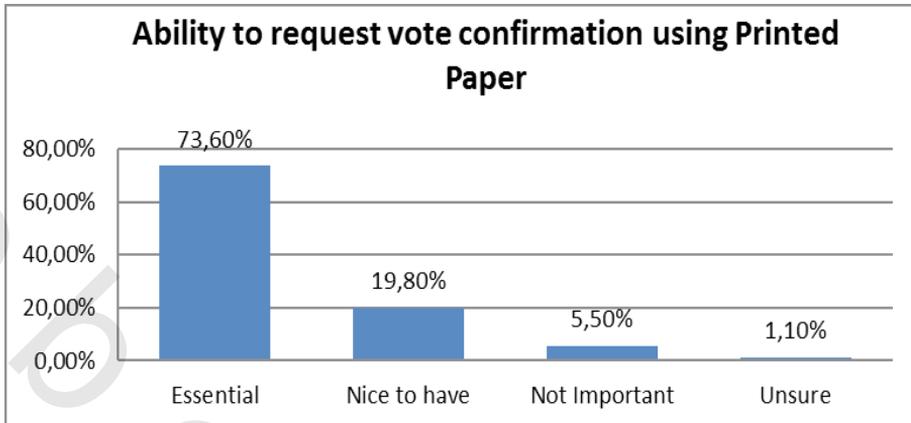
Figure 12: Ability to verify votes with a printed paper copy
Survey Results Overview
The survey result shows that more than half of the participants don't trust the way the current paper-based system is managed and not even the way the tallying process is done. A significant number of participants (64%) said they would prefer to use e-voting over paper-based voting and most of them would prefer voting at a polling station because they think it is more reliable than voting via the internet at home. However, almost the same number of participants who prefer to use e-voting at the polling station also wanted to consider it as a preliminary stage for a complete I-voting project at a later stage.
It is also interesting to note the following:

- Figures [2-4] shows slightly more of the participants said they would prefer e-voting than those who were comfortable to use it. This means that they are willing to use the e-voting system even if they don't know how to use it. This shows that they are willing to learn and take the necessary training in order to be able to use the e-voting system.

- The large majority of the participants (74%) who wanted the feature of printed paper as a means for vote verification and to make sure that their vote is counted shows that while they are willing to move towards electronic voting, they are still not 100% in favor of a purely electronic system.

- In general, responses indicate a willingness to change the current paper-based voting system to an e-voting system at a polling station, but this is as far as their confidence in such a system would permit at this stage. Such a system could be seen as a preliminary stage or as trial experiment until the Kuwaiti people are ready to implement a full internet voting system.
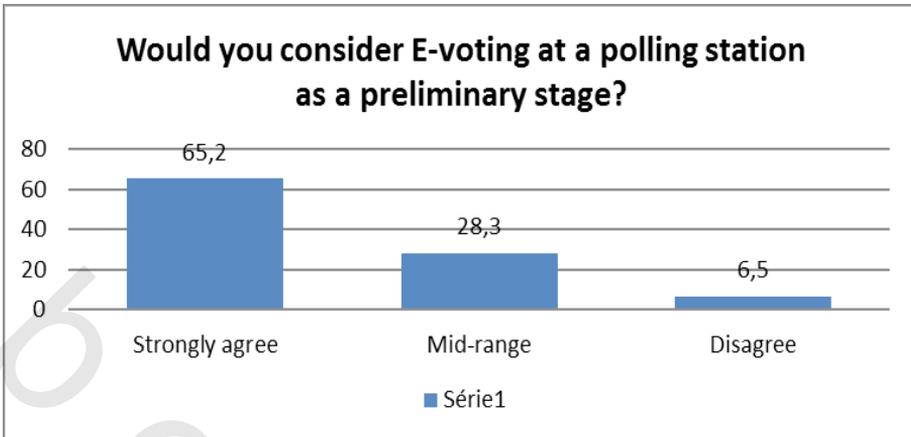
Figure 10: Considering E-voting at a polling station as preliminary stage
Additional E-Voting Features

There may be addition features that could be added to an e-voting system in order to enhance the acceptance process of the e-voting system. Two features that the survey investigated are:

- Confirmation of the candidate selection before the vote is recorded

- The ability to verify votes through printed paper

Participants were asked if they thought either of these features would be desirable.

In general, over half of the participants responded that these e-voting features were essential, especially the printed paper confirmation which nearly three quarters thought essential. Most of the remainder thought these features would be nice to have and only about 8% thought the features were unimportant. This result reflects the need for confirmation and verification through different channels to ensure the vote casting is correct.
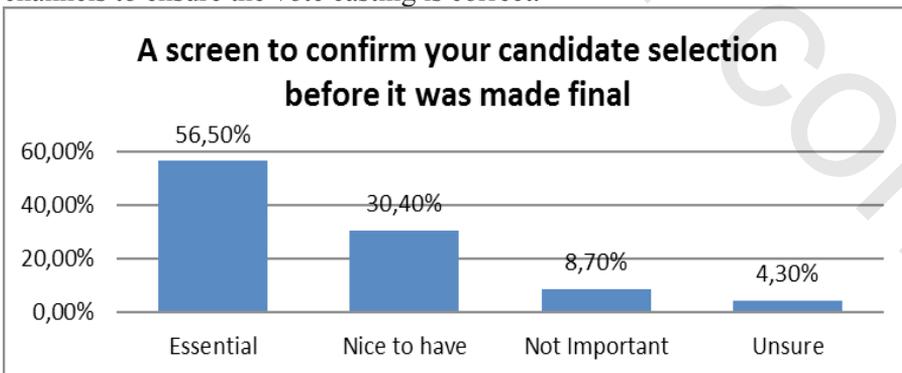

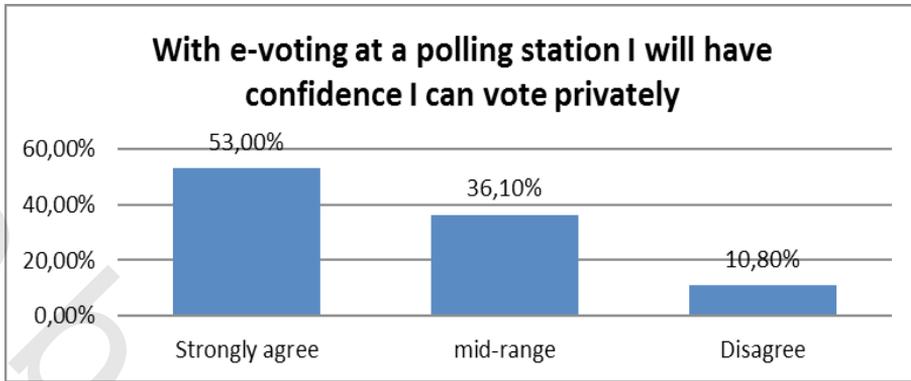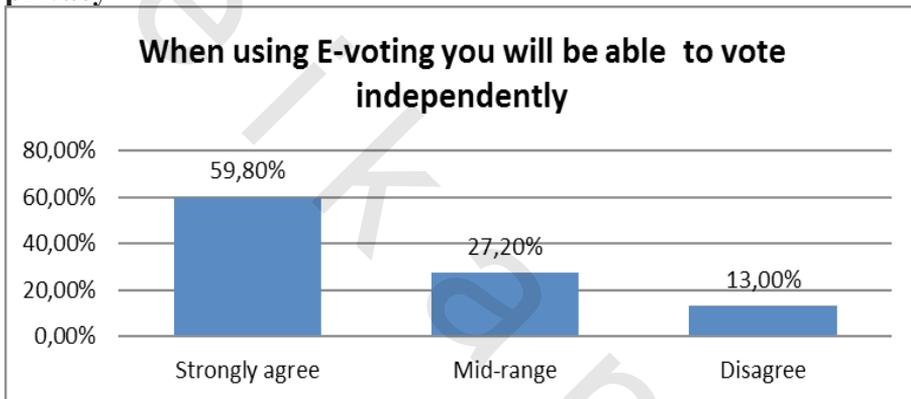**Figure 11: Confirmation of candidate selected before the vote is recorded**

Figure08: Confidence in e-voting at a polling station providing privacy

Electronic voting at a polling station is also likely to affect the incidence of coercion by family members. Figure-9 shows that 60% of participant thought that, when they vote electronically at a polling station, they can vote independently. Only 13% disagreed.

Figure٠٩: Confidence that e-voting can ensure independent voting

Figure 10 shows that 65% of the participant would like to consider the implementation of the e-voting at a polling station as preliminary stage.

E-voting at a Polling Station would help stop Primaries
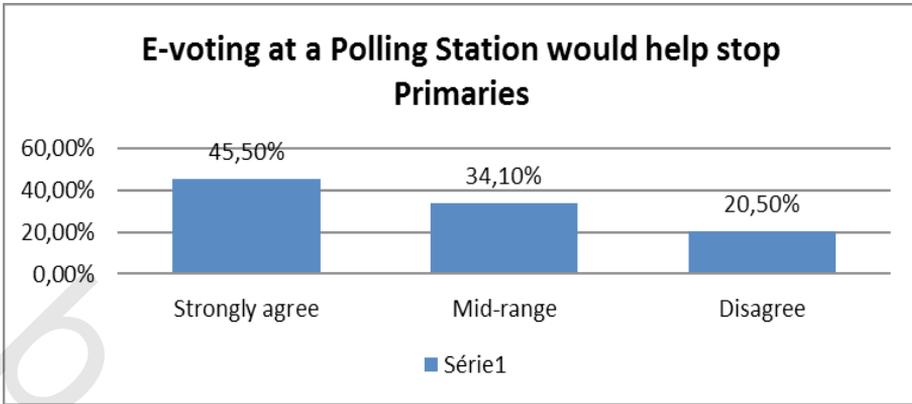
Figure 06: Belief in the effect on illegal primaries

Another potential benefit of voting at a polling station is that help can be available when needed. When participants were asked if voting at a polling station would give an advantage in providing help and assistance when problems arise, Figure 7 shows that 52% strongly support the idea.
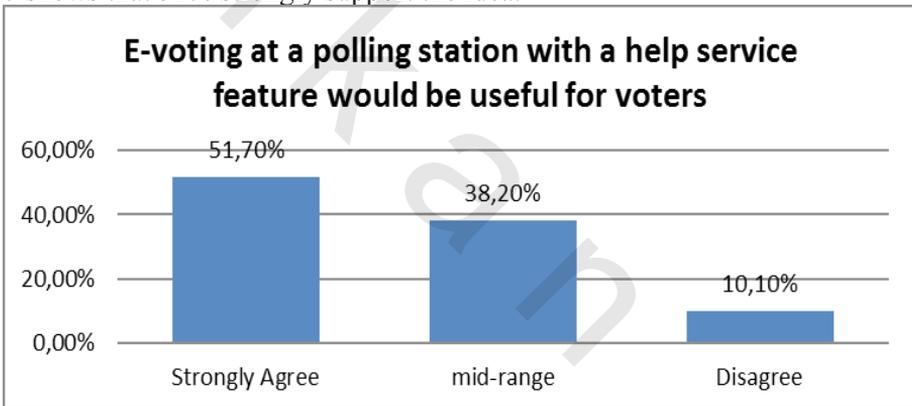

E-voting at a polling station with a help service feature would be useful for voters

Figure 07: Respondents belief that available help at polling stations would be an advantage.

When participants were asked if anonymity can be provided at a polling station, 53% were confident that an e-voting system would provide the necessary anonymity and privacy with only 11% disagreeing (see Figure 8).
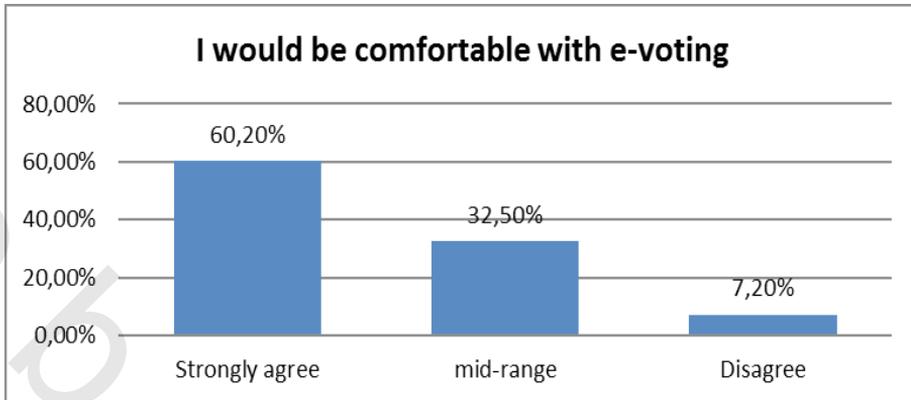
Figure 04: Comfortable with e-voting:

3- Reasons for Preferring Electronic Voting at a Polling Station:

Over half (52%) of participants strongly believed using e-voting at a polling station rather than using the internet at home would be more reliable as is shown in Figure 5.
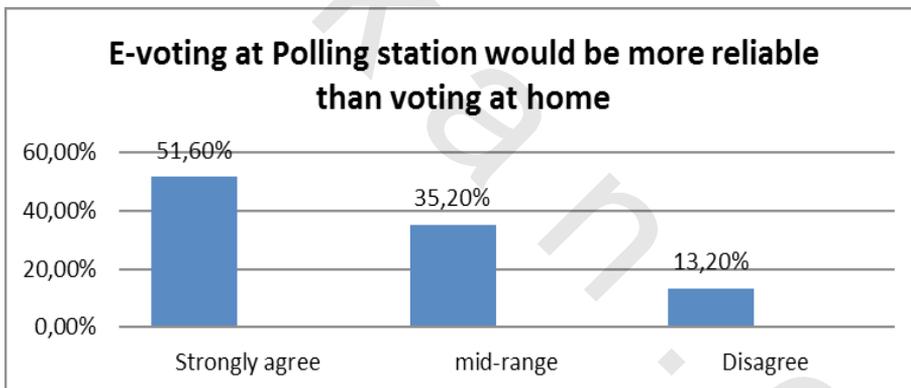

Figure 05: Belief in the reliability of e-voting at a polling station

One of the other potential advantages of voting at a polling station is that it could help to stop the illegal use of primaries. The illegal nature of these primaries means that all candidates remain on the ballot paper and the primaries rely on voters acting on the primary outcome. The primary elections are not subject to any official scrutiny so coercion and family pressures can affect the outcome. However, any improved anonymity in the voting system means a voter could break their commitment to the group and vote freely, ignoring the primary outcome, arguably rendering the primaries ineffective. When participant were asked if they agree that e-voting could help prevent primaries, Figure 6 shows 45% of respondents indicated they strongly agree, 34% thought it might help prevent primaries, and 21% didn't think it would.
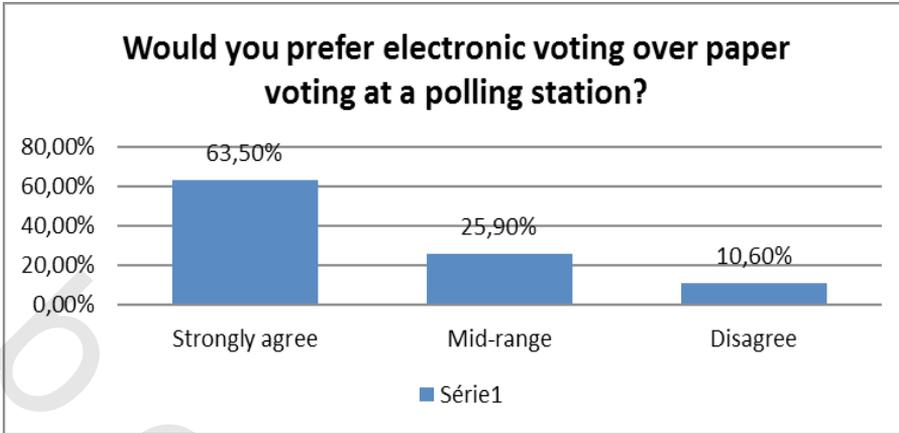
Figure 02: Preference of e-voting system at a polling station over paper voting

The next question was asked to find out from those people who are not satisfied with the current system, whether they would prefer to vote online rather than using the paper voting system. Figure 2 shows that the majority of the participants (64%) indicated they would prefer using an e-voting system rather than using the paper voting system.

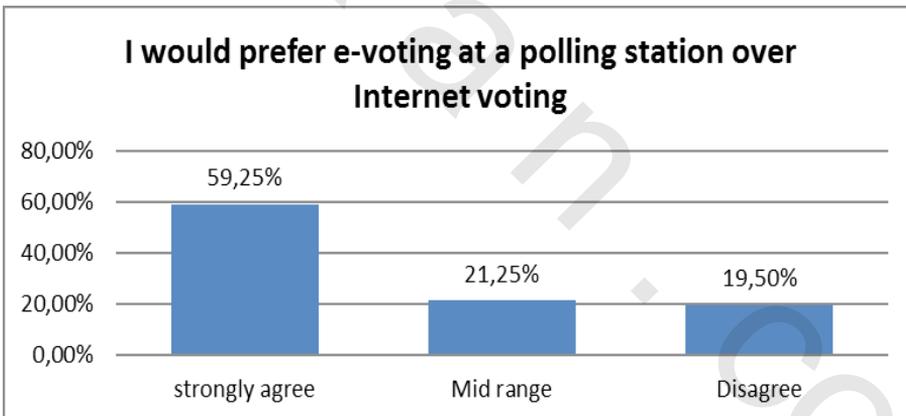
Figure 03: Preference for I-voting at a polling station.

Figure 3 shows, however, that 59% of the participants would prefer e-voting to be conducted at the polling station rather than using internet voting (I-voting) in an uncontrolled computer environment. Figure 4 shows 60% of the participants indicated they would feel comfortable with the idea of electronic voting at a polling station.

Frequency	118	13	2	4	137
percentage	86.1	9.5	1.5	2.9	100

Table 4 shows that 86% of participants use the internet and the e-services daily. This question was again asked to predict whether the population would be likely to know how to use an e-voting system.

2- Preferences Towards Voting Methods:

The participants who have taken part in the Kuwaiti election system were asked to rate how confident they are in "the current Kuwaiti Election system based on how voting is managed and the votes counted". This question covers both the way the election process is carried out and the way vote counting is managed. Figure 1 shows that just over half of the respondents have no confidence in the current election system in Kuwait. Only 14% of participants have confidence in the Kuwaiti Election process. This is a strong indication that a change in the voting system is needed to maintain confidence in the democratic process.
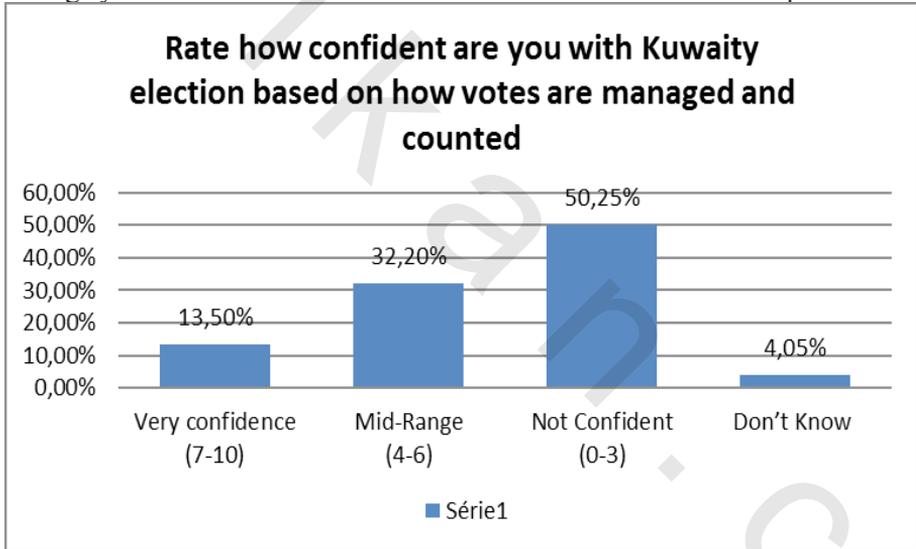

Figure 01: Confidence in the current election process in Kuwait

21 – 40 years old, the reason most of the participant were selected from this age category, was because these people are most likely to use the internet and may already have an understanding about the e-voting concept.

Table 01: Age of respondents

Age	21-30	31-40	41-60	61-65	+65	Total
Frequency	53	41	39	3	1	137
Percent	38.7	29.9	28.5	2.2	0.7	100

Table 02: Education Level of respondents

	High School	Diploma	Bachelor	Post graduate	Others	Total
Frequency	9	21	78	26	2	136
Percent	6.6	15.3	56.9	19.0	1.5	100

Table-2 shows that the largest group of participants (57%) were in or had completed education to bachelor degree level and a further 19% had completed post-graduate education. Less than 7% only had high school qualifications and 15% had a diploma educational level. These results reflect the fact that the majority had already completed their education and probably have used the internet before.

Table 03: Computer Knowledge of Respondents

	Novice	Average	Above Average	Excellent	Total
Frequency	9	39	56	33	137
Percent	6.6	28.5	40.9	24.1	100

Table-3 shows that, in their own self-assessment, 65% of the participants have computer knowledge ranging from being above average to expert, and about 29% had some or average knowledge level. Less than 7% considered themselves to be absolute beginners. The reason for asking this question was to have an indication of whether the population has the knowledge and vision to appreciate E-voting.

Table 04: E-service use rate

	Daily	Once a week	2-4 a month	Don't use	total

260

has attended the election station. The voter is then given a paper ballot with all the candidates name listed for that district only. The voter then has to go to the polling-booth alone to cast their vote securely where nobody can see or coerce him or her. The paper ballot is then inserted in a glass ballot-box in front of the adjudicator. The anonymity is achieved by using the polling booth and the glass ballot box.

At the end of the voting period, the election officials for each polling station within the same district will take the voting ballot-boxes to the main polling station for counting all votes for that district. The counting of the votes is run by government officials and judges. Vote collecting, counting and tabulating are done in front of observers (candidates representatives) and is broadcasted on television and radio stations simultaneously so that all citizens can watch the result live.

A paper ballot is considered cancelled if a voter chooses more than four candidates or writes their name or puts any suspicious mark on the ballot paper.

A Survey to Determine Attitudes Towards E-Voting in Kuwait

A survey was carried out to investigate the voter trust and satisfaction with the paper-based voting system that have been used in Kuwait for many years and the willingness to change this system to an electronic voting system. The survey was distributed using a hard copy paper to participant in two categories:

1- Young educated adults (age 21 or more) who can represent the current and future election process in Kuwait and who are mostly familiar with using the internet. These participant were chosen randomly from young employees who work in government ministries and the private sector. For each ministry and company visited, the department's manager was asked if he could give a permission for the survey representative to distribute the survey to his employees at the end of the working day.

2- Older, generally less educated people who have used the paper-based system before and rarely use the internet. These participant were chosen from the Kuwaiti families that agreed to participate in the survey.

Approximately 200 people were sampled from the Kuwaiti eligible voters of which 130 responded, this represents a 65% response rate.

All questions were asked in Arabic, but are translated into English for this paper. The information gathered from the survey was analyzed qualitatively and quantitatively. The results are given in the next sections.

Demography and Internet Knowledge of Respondents

Table 1 shows that the majority of participants (70%) were young adults aged

cautious about electronic voting systems and are not ready for a full internet enabled voting system.

This paper proposes a step by step approach to introducing electronic voting, starting with an e-voting system at polling stations that can adapt to the generic and specific requirements for Kuwaiti elections.

Key words : voting system, electronic voting system, paper ballot voting.

Introduction:

While the voting system in Kuwait has helped establish a lead in democraticracy amongst the nations of the area, the system is clearly far from perfect. This motivated this research to examine electronic voting systems in the hope that election campaigns would connect more directly with the voter, deterring any corrupt practices and enabling campaigns based on ideologies rather than family and tribes loyalties.

The literature shows (Phillips & Von Spakovsky, 2001; Voting News, 2011; Slovak & Pettai, 2008) some countries have cancelled their e-voting system before implementation because people didn't trust the system. This indicates that not all e-voting projects have succeeded in delivering a good result. For example, mistrust towards the Irish voting machine culminated in the cancelation of the respective project shortly before going live and, for the same reason, Germany and the Netherlands have persistently banned their voting machine from use at political elections (Phillips & Von Spakovsky, 2001). Estonia is currently the only nation using E-voting successfully for national elections (VotingNews, 2011).

In this paper, we propose an e-voting system for Kuwait which involves electronic voting at a polling station, rather than through the Internet.

1- The Current Voting Procedure in Kuwait

Citizens are only eligible to vote within their own district, each district will have one or more polling station depending on the size and number of towns and cities it covers. One of these polling stations will be the main station for consolidating all votes from other secondary polling stations in order to tally and count all the votes in the district.

Authorities have to register eligible voters before the election day. When the election day is determined and announced by the Kuwaiti government then, on that day, citizens can only vote at the polling station where their name is registered, and cannot go to any other polling station to vote for their candidates. On arrival, they must first show their identification card (digital ID card) to the polling official to enter the polling station, then they should go directly to the adjudicator to verify their name, district and their eligibility to vote. After all personal information and their eligibility to vote are verified and accepted by the adjudicator, the voter has to sign the record list to indicate that he or she

Towards a Trusted e-election in Kuwait: Requirements and Principles

Dr.Asaad Alzayed
Dr.Abdulaziz Alkandari
Public Authority of Applied Education, Business College, Information Systems Department, Kuwait
Pr.Ray Dawson
University, Loughborough LE11 3TU, United Kingdom

الملخص:

يعتبر نظام التصويت الالكتروني في وقتنا الحاضر عنصرا أساسيا للعملية الديمقراطية في الدول المتقدمة. لذلك نرى ان الكثير من هذه الدول حاولت تغيير نظامها الانتخابي القديم الذي يستخدم التصويت الورقي الى نظام التصويت الالكتروني، ولكن القليل من هذه الدول التي نجحت في تطبيق نظام التصويت الالكتروني بالطريقة الصحيحة. دولة الكويت هي دولة ديمقراطية تستخدم نظام التصويت الورقي منذ فترة من الزمان وبالرغم أن الكثير من المواطنين اعتادوا على استخدام هذا النظام الا انه من خلال نتائج الاستبيان اتضح ان هذا النظام يحتوي على العديد من المشاكل التي جعلت العديد من المواطنين يفقدون الثقة به ويفضلون تغيره بنظام الكتروني يستطيع التغلب على معظم المشاكل الموجودة به. لذلك تقوم هذه الورقة بشرح كيفية تطبيق النظام الالكتروني المقترح الذي يناسب نظام الانتخابات المتبع في دولة الكويت على ان يكون استخدام النظام الالكتروني داخل مواقع الاقتراع فقط وليس خارجها وذلك لحل المشاكل الناتجة من استخدام النظام الانتخابات الورقي الحالي.

الكلمات المفتاحية: نظام الانتخابات، نظام التصويت الالكتروني، التصويت الورقي.

Abstract:

Electronic voting (E-voting) system must be considered as a highly desirable factor for enhancing the democracy process in any developed country. Some countries have tried to replace their paper ballot voting system with an e-voting system but, unfortunately, only a few countries have managed to do so. Kuwait is a democratic country that has been using the paper ballots for its parliament elections for many years. Although many people have confidence in the paper ballot system, a survey shows that this system has some problems and drawbacks, which has made some people lose their confidence in the current voting system and would prefer a replacement with an electronic system to overcome these problems. However, the survey also shows that voters are