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# ELECTRONIC VOTING SYSTEM CHARACTERISTICS AND VOTER PARTICIPATION INTENTION

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## Abstract

*The rapid development of communication and information technology has made electronic voting technologically and economically feasible. In this study, we will examine the differential impact of four electronic voting system (EVS) characteristics (privacy, accessibility, mobility, and accuracy) on voter participation intention (i.e., EVS voting) and on preferred EVS mechanism (telephone, Web-based, or touch-screen) for electronic voting.*

## 1 INTRODUCTION

Thomas Edison patented an "electronic voting device" in 1884, making electronic voting feasible (Larsen 1999). Today, electronic voting systems (EVS) are used in some political elections (Herschberg 1997). In the 2000 Democratic primary election in Arizona, 39,942 people voted electronically (Solop 2001). Done (2002) found that 62 percent of registered Arizona voters, given the opportunity, would vote online. The Sheffield City Council (Liverpool, England) tried several voting methods including a mobile phone, the Internet, and an electronic voting kiosk, hoping that remote electronic voting would stimulate interest and improve voter participation (*The Economist* 2002). Common EVS mechanisms include Web-based, telephone-based, and touch screen-based EVS.

Our study focuses on EVS and intended voter behavior, identifying EVS characteristics that affect voter participation intention (voting by EVS). We define an EVS as an entirely automated *electronic technology-based voting environment* that enables remote voting, facilitates monitoring, voting and tallying, eliminates manual registration verification (DuRette 1999), and has immediate and accurate results. We are interested in *remote* electronic voting (ballots cast away from official polling places, for example, from a home, an office, or a public library).

## 2 RESEARCH BACKGROUND

Electronic voting research spans a number of disciplines (Table 1). Computer scientists focus on EVS design, and developing security and privacy enhancing protocols. Psychologists investigate psychological factors influencing voter participation decisions. Political scientists research electronic voting impacts on participation. Economists focus on underlying economic impacts of voting methods (e.g., income diversity and EVS accessibility), and impacts on organizational structures. Ethicists, concerned with social impacts, investigate privacy issues and the "Digital Divide" (Carey 1998).

**Table 1. Electronic Voting Research Across Disciplines**

| Research Discipline | Research Topic | Major Studies |
|---|---|---|
| Technology and Computer Science | System development and security protocol improvement | • Voting system design (Roth 1998)<br>• Network security protocol and public key cryptography (Chaum 1981)<br>• Two agency protocol (Cranor and Cytron 1997)<br>• Accuracy and tally verifiability (Riera et al. 2000)<br>• Architecture design, system reconstruction (CalTech–MIT 2001) |
| Psychology | Increasing voting percentage | • Personal behavior commitment and actual behavior (Kiesler 1971)<br>• Voting motivation (Burgess et al. 2000) |
| Political Science | Influence of voting mechanism on participation | • Absentee voting laws (Ray 1914)<br>• Voting by mail (Patterson and Caldeira 1985; Slessenger 1991)<br>• Electronic voting and participation distribution: Arizona Democratic primary election (Reed 2000; Solop 2001)<br>• Technology updating management (CalTech–MIT 2001)<br>• Advantages and Issues with Online voting (Done 2002) |
| Economics | Influence of economic status on voter decisions | • Election forecasting model (Pindyck and Rubinfeld 1981)<br>• Influence of income and education on computer accessibility (Hoffmann et al. 2000) |
| Ethical Science | Race, voting rights and election choice | • Black voters, technology ability and accessibility (Heeks 1999)<br>• The "Race Ravine" in Internet voting (Solop 2001) |

Despite the diversity of research disciplines investigating electronic voting, there is little research on relationships between EVS characteristics, mechanisms, and voter participation intention. The 2000 presidential election events in the United States prompted the Massachusetts Institute of Technology (MIT) and California Institute of Technology (Cal Tech) to form a team of computer scientists, social scientists, and mechanical engineers to evaluate current voting technology and recommend voting technology design and implementation efficiency and accuracy improvements (CalTech–MIT 2001). They evaluated remote electronic voting and suggested delaying its implementation, but it was not their principal focus.

We will investigate the following questions

- *Will certain EVS characteristics influence voter participation intention?*
- *Will certain EVS characteristics influence EVS mechanism preference?*

and three EVS mechanisms: telephone-based, Web-based, and touch screen-based.

**Telephone-based EVS:** Interactive voice-based telephone voting system that uses databases to store individual electronic ballots, chosen because the telephone is the most popular communication media (96 percent of U.S. families own telephones) and can be used without additional device or knowledge investments.

**Web-based EVS:** Uses the Internet for voting, chosen because more than half of American households own computers (Associated Press 2002), enabling the selection of a computer-based voting system with user-friendly graphical interfaces.

**Touch screen EVS:** The operation of this mechanism involves ( 1) preassigned cards validate voter identity and (2) voting occurs by touching a candidate's name on an automatically generated ballot. Touch screen EVS are placed in convenient locations (e.g., malls, schools, post offices) and were selected because they have been successfully used in California, Florida, and Vancouver and their operation is similar to the familiar ATM technology.

# 3 ELECTRONIC VOTING SYSTEM CHARACTERISTICS

Cranor (2000) and Cranor and Cytron (1997) identified standard EVS development criteria that influence EVS adoption. Based on their research and more recent investigations (Done 2002; CalTech–MIT 2001), we selected four criteria for our study: privacy, accessibility, mobility, and accuracy. We treated them as EVS characteristics that influence voter attitude towards and acceptance of an EVS. Privacy and accuracy were selected because they are basic election requirements (Done 2002). Mobility was selected because it was the major motivation for the Arizona online election trial (Reed 2000). Accessibility was selected because it is important to equality issues in political activities (Solop 2001).

**Privacy:** An EVS should ensure that a ballot cannot be linked to a voter and that a voter cannot prove how he/she voted. There are legal traditions that emphasize and protect privacy in political activities (Hiller and Bélanger 2002). Potential threats to voter privacy can arouse strong negative voter reactions (Larsen 1999).

**Accessibility:** An EVS should ensure that eligible voters have equal and convenient access. Accessibility reflects both physical access and perceived ease of use for an EVS (i.e., confidence in understanding and using EVS technology and voting directions, in the ability to cast a ballot without special restrictions or skills, and in voting device familiarity). Varying experience with EVS mechanisms should result in different EVS accessibility perceptions. We believe if there is a choice between EVS mechanisms, the most accessible one will be chosen.

**Mobility:** Since 1978 (the year California began allowing any registered voter to apply for and vote an absentee ballot), the 20 percent increase in voter participation (Patterson and Caldeira 1985) is primarily due to the increased mobility and flexibility that absentee voting provides. An EVS can provide similar mobility and flexibility by eliminating location restrictions and time/schedule restrictions (availability). Therefore, it is reasonable to assume that an EVS with mobility could increase voter participation. Reed's (2000) research (Thurston County, Oregon) supports this premise (91.5 percent of trial voters would choose online voting and 66 percent indicated it was easier to vote online).

**Accuracy:** An EVS should guarantee that all valid ballots are accurately counted and that a validated voter votes only once. In the 2000 U.S. presidential election, African Americans claimed that ballots in Palm Beach County, Florida, weren't correctly recorded, resulting in strong protests and numerous recounts (Solop 2001). We believe that a well-designed electronic EVS will be perceived as more accurate than manual voting systems.

Our model (Figure 1) illustrates our belief that these four EVS characteristics will positively influence voter participation intention. We propose the following hypotheses:

*H1: An EVS with perceived high privacy will increase EVS participation intention.*
*H2: An EVS with perceived high accessibility will increase EVS participation intention.*
*H3: An EVS with perceived high mobility will increase EVS participation intention.*
*H4: An EVS with perceived high accuracy will increase EVS participation intention*

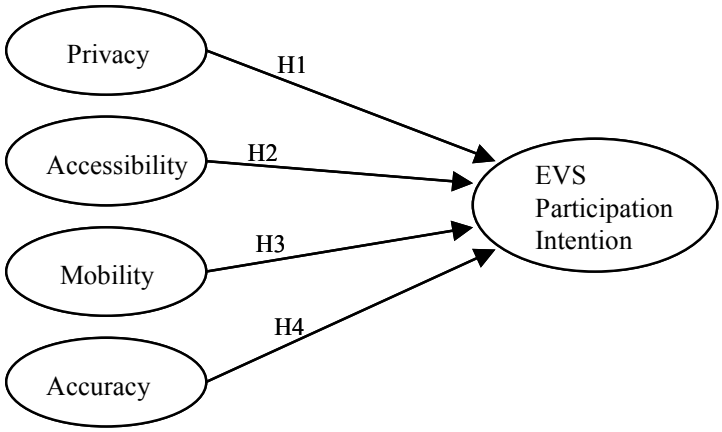


**Figure 1. EVS Participation Intention Model**

# 4 RESEARCH DESIGN

We developed a questionnaire based on the research discussed above as we did not find any previously tested instruments. Multiple items measure each of the five model constructs using a five-point Likert scale for each item. Respondents also ranked EVS mechanisms (telephone-based, Web-based, and touch screen EVS and traditional voting methods). Eight Information Systems and Decision Sciences faculty and Ph.D. students participated in the pretest; 137 MBA students participated in the pilot. A convenience sample of MBAs was chosen because their age group (25 to 44) represents about one third of total participating voters in the United States (Federal Election Commission 1999). There were 107 valid surveys. Invalid surveys included 16 international students, 11 full-time master's students without work experience, and three incomplete surveys (Table 2).

**Table 2. Demographic Details of Participating Subjects**

| | | Percentage |
|---|---|---|
| Age (years) | 20-25 | 40.2% |
| | 26-30 | 32.7% |
| | 31-40 | 20.4% |
| | 41-55 | 6.7% |
| Employment | Full-time MBA | 61.0% |
| | Part-time MBA | 39.0% |
| | Executive MBA | 24.0% |
| Gender | Men | 69.0% |
| | Women | 31.0% |
| Government Election Experience | Ever voted | 97.0% |
| | Voted in 2000 | 87.0% |

**Table 3. Measurement Model Results**

| Construct | Items | Loading | Reliability |
|---|---|---|---|
| Privacy | Privacy1 | 0.50* | 0.8 |
| | Privacy2 | 0.86* | |
| | Privacy3 | 0.79* | |
| Accessibility | Accessibility1 | 0.51* | 0.6 |
| | Accessibility2 | 0.61* | |
| Mobility | Mobility1 | 0.70* | 0.7 |
| | Mobility2 | 0.82* | |
| | Mobility3 | 0.67* | |
| Accuracy | Accuracy1 | 0.60* | 0.7 |
| | Accuracy2 | 0.66* | |
| | Accuracy3 | 0.65* | |
| Participation Intention | Participation Intention1 | 0.86* | 0.9 |
| | Participation Intention2 | 0.98* | |
| | Participation Intention3 | 0.96* | |
| | Participation Intention4 | 0.91* | |
| Measurement Model: GFI = 0.87 CFI = 0.94 RMSEA = 0.078<br>P = 0.00026 *P < 0.001 | | | |

Structural equation modeling (SEM) was used to evaluate pilot data. It is superior to traditional statistical methods because factor analysis occurs within the structural model (Hair et al. 1998), and it provides several overall model fitness measures (to evaluate model quality). The four EVS characteristics—privacy, accessibility, mobility, and accuracy—were the latent independent variables. EVS participation intention was the dependent variable. All constructs had acceptable reliability, discriminate validity, and internal consistency (Table 3). The measurement model indicated a good fit between the data and theoretical model: CFI = 0.94 (> 0.9) GFI = 0.87 (> 0.8), RMSEA = 0.078 (< 0.08), df = 80, and P = 0.00026 (parenthesis indicate normal acceptance requirements).

# 5 RESULTS AND DISCUSSION

The impact of the four EVS characteristics on voter participation intention was evaluated by the structural model path loadings (Figure 2). The four EVS characteristics combined explained 51 percent of EVS participation intention.

As predicted, the hypotheses that mobility (H3) and accuracy (H4) have a positive impact on EVS participation intention were supported. However, the hypotheses that accessibility (H2) and privacy (H1) have a positive impact on EVS participation intention were not supported (not statistically significant). This implies that designers of EVS should continue to emphasize mobility and accuracy to increase intended EVS use.

Interestingly, in this sample, subjects' intention to use an EVS was not influenced by privacy. In fact, the path loading was negative, although not significant (opposite of predictions). One possible explanation is that these subjects do not believe that an EVS can provide privacy, perhaps due to negative experiences, for example, the electronic voting problems (lack of accurate ballot storage, transformation, and count) during Vivendi Universal SA's shareholder meeting (Sayer 2002). Similarly, these subjects did not perceive that increased accessibility would significantly increase their intention to use an EVS. Possible explanations include: (1) these subjects are technically and electronically sophisticated and don't perceive that an EVS is more accessible, or (2) due to their privileged backgrounds, they do not perceive accessibility as an important voting mechanism characteristic. We hope to collect qualitative data (interviews or focus groups) to further explore these results.

The pilot study had several limitations. The sample size was too small to segment by preferred EVS mechanism, eliminating any meaningful results for that construct. MBA students tend to be highly educated, economically secure young adults. As such, they represent only a segment of their voting cohort. Therefore, it is unlikely that our results are generalizable (even to their own voting cohort). Future studies require larger, more diverse sample populations of actual voters. In addition, we measured intended not actual behavior (frequently higher than actual behavior). Unfortunately, it will be difficult to measure actual behavior until voters have a real choice in voting mechanisms.

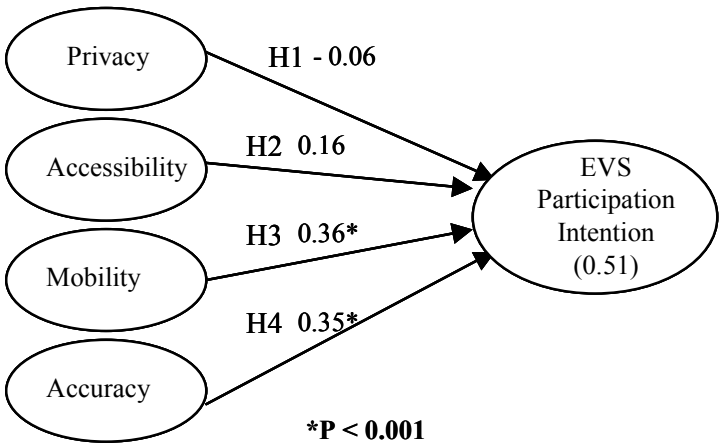


**Figure 2. Structural Model Paths**

Our intent was to validate our constructs and test our hypotheses using the pilot data. We believe our constructs are valid, but are concerned about unsupported hypothesized relationships. We plan to review the survey questions, perform another pilot, and use the newly tested survey on a larger population of real voters. We have contacted a state election office representative who will cooperate with us on survey administration in an upcoming state election.

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