Technology Acceptance Model of a Generic, Computer-Based Election System: Basis for Improvement, Dissemination and Adoption

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ARTICLE INFORMATION

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ABSTRACT

The study assessed the perceived effectiveness of the computer-based election system called iVote. Two groups of respondents were identified to accomplish this task – the Polytechnic University of the Philippines (PUP) Multipurpose Cooperative (MPC) and the Nutritionist-Dietitians' Association of the Philippines (NDAP). The software was evaluated using the Software Performance variable composed of Accuracy, Completeness, and Reliability criterions, and the Software Usability variable with User-Friendliness as its sole criterion. The technology acceptance or acceptability criterion of the iVote software was likewise assessed by the respondents. A researcher-made instrument was used to gather data. Descriptive research design was employed together with purposive sampling technique. Statistical treatment included weighted mean, Pearson r, z-test and percentage. The study revealed that the iVote software implemented in the two organizations was highly accurate, complete, reliable, user-friendly, and acceptable.

Introduction

The advent of computers revolutionized how people learn, work, live, and interact with other individuals in the community. The hype on 'E' produced e-learning, e-governance, e-health, etc., which ultimately redounds to the changing landscape of how a 21st century man survives in the modern digital world. It is for this reason that we have attempted to computerize almost every transaction or process in our society, ranging from school enrolment, government processes up to the national elections.

The history of computer-based election can be traced in the US as early as 1960s with the advent of punch cards. Simple direct-recording electronic (DRE) voting systems evolved into modern online voting technologies (International IDEA Handbook, 2014). In the Philippines, however, computerized elections emerged in 2007 after a pilot testing in the ARMM elections (Calimag, 2008).

Despite the first national computerized election in the country in 2010, Filipinos experienced computerized elections only in state-run polls. The need for computerization of elections should also find its way in other organizations composed of members who are in search for their next leader.

The study of Wincler et al. in 2009 involved a pilot testing of an e-voting system called Prêt à Voter, which made use of an optical scan technology. The overall results revealed that Prêt à Voter is comparable to other e-voting systems in terms of usability.

Malhotra and Galletta (2004) featured in their article a study on the implementation of a Communication, Coordination and Collaboration system a.k.a. C3 at a national health care research and service center based in the United States. Seven hundred users were surveyed after using the system for five months. The study revealed that perceived usefulness and perceived ease of use of C3 indirectly influenced the attitude and behavioural intentions of the users to use the system. Information Technology (IT) designers were expected to focus on what users and managers expect from the system in terms of business performance.

These studies point out that regardless of the nature of the IT solution, a thorough study must be conducted to ascertain its effect and level of acceptability. Computerized applications by itself do not create value in an organizational unit. Instead, it is the people who make use of the different information and communication technologies (ICTs) who make a difference and influence acceptability.

In this study, the implementation of computer-based election software to the PUP Multipurpose Cooperative (PUP MPC) and the Nutritionist-Dietitians' Association of the Philippines (NDAP) was considered in order to determine the perceived effectiveness of the innovative tool. The study also looked into the acceptability of the election software using the Technology Acceptance Model (TAM).

Framework of the Study

This study primarily employed Technology Acceptance Model (TAM) developed by Davis (1989). It is an information systems theory which grounds on the idea that actual use of Information Technology innovation is dependent on its perceived usefulness and its perceived ease of use. This view was refined by Davis (1993) to include the system characteristics and the attitude towards the use of the technology.
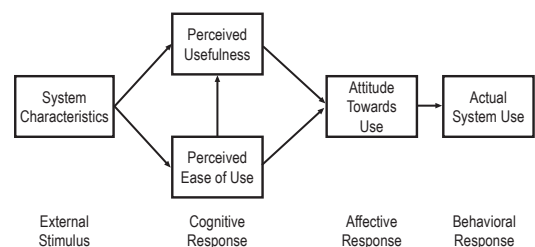

Figure 1. Technology Acceptance Model.

Davis considered the characteristics of a system as the external stimuli to which user would initially have a cognitive response. From this initial reaction, an affective response can be elicited, which will become the source of a behavioural response.

This model grounds on the Theory of Reasoned Action (Azjen & Fishbein, 1980), which postulates that beliefs influence attitude and social norms which in turn shape a behavioural intention guiding or even dictating an individual's behavior. Intention is defined as the cognitive representation of a person's readiness to perform a given behavior, and it is considered to be the immediate antecedent of behavior.

TAM has been refined several times producing variants such as TAM2 (Venkatesh & Davis, 2000) and Unified Theory of

Acceptance and Use of Technology or UTAUT (Ventakesh, Morris, Davis & Davis, 2003). TAM2 included additional key determinants in terms of social influences and cognitive instrumental processes while UTAUT focused on four constructs which play an important role as direct determinants of user acceptance and usage behavior, namely: 1) performance expectance, 2) effort expectancy, 3) social influence and 4) facilitating conditions. To this date, the original TAM theory is still evolving as scientists try to look into other factors which affect the acceptance of technology. In this study, the original TAM was considered because of its simplistic design and its applicability to the current study. Components of other variants of TAM such as social influences were not considered in this study due to some implementation constraints. The researcher was given only limited time to interact with the respondents and was actually advised to limit the exit poll or survey questionnaire to software characteristics.

Figure 2 presents the model for the study with iVote computer-based election software performance and the level of iVote technology adoption as the variables.
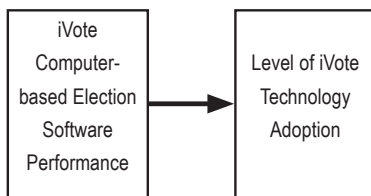
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┌──────────────┐        ┌──────────────┐
│    iVote     │        │              │
│  Computer-   │        │ Level of iVote│
│ based Election│──────▶│  Technology  │
│   Software   │        │   Adoption   │
│ Performance  │        │              │
└──────────────┘        └──────────────┘
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Figure 2. Conceptual Model of the Study.

The implementation of iVote Computer-based Election software determined the technology's level of usefulness and ease of use. The actual system usage variable of TAM was represented in this conceptual model with the level of technology adoption which is considered the dependent variable. As the dependent variable, it is affected by the performance level of the independent variable. A technology that is highly perceived useful and easy to use is expected to have higher adoption or higher acceptance level than a technology perceived to be not so useful and complicated to operate.

The relationship between the independent and dependent variables implies that perceived usefulness (software performance) and ease of use (software usability) experienced by the respondents during implementation of the iVote computer-based election software, can positively affect the level of technology adoption (acceptability).

Purposes of the Research

The study aimed to determine the level of technology acceptance of the computerized election system implemented to a professional organization and a cooperative. More specifically, it sought answers to the following research questions:

1. What is the evaluation of the respondents on the innovative computer-based election system in terms of:
    1.1 accuracy;
    1.2 completeness;
    1.3 reliability; and
    1.4 user-friendliness?

2. What are the differences between the evaluations of the NDAP and PUP MPC respondents in terms of the following:
    2.1 accuracy;
    2.2 completeness;
    2.3 reliability; and
    2.4 user-friendliness?

Research Design

Descriptive research method was used in the study for it primarily aimed to describe the very nature of the situation as it exists at the time of the study and to explore the causes of the phenomena (Adanza, 1995). In this research, the phenomenon investigated was the utilization of iVote software by the two groups of respondents.

The specific type of descriptive research employed in this study was the survey research design. Recent trends, however, veered towards the utilization of the internet as a medium for surveys, more commonly referred to as online survey.

This study also considered the descriptive evaluation design since it sought to appraise the worthiness of the object of the study, which in this case was the software technology (iVote) and the overall computerized election process. This type of research design inquires the extent a program or intervention achieved its goal (Ariola, 2006; Calmorin & Calmorin, 2007). In this study, the iVote software was evaluated by the multipurpose cooperative stakeholders and the stakeholders from the professional organization in order to gain a deeper understanding of the technology and the typical election process affected by the introduction of the innovative method. The evaluation conducted by the two groups of respondents determined the performance of the software technology and its level of adoption or acceptance by system users.

Participants

This study considered two major groups of individuals as respondents: 1) PUP Multipurpose Cooperative (PUP MPC) with 665 members and 2) Nutritionist-Dietitians' Association of the Philippines (NDAP) with 1,200 members. The two organizations were chosen based on their willingness to utilize iVote software as evidenced by a Memorandum of Agreement (MOA).

This study utilized a non-probability sampling technique which does not give members of the population equal chance of being selected as samples of the study (Heiman, 1999). Purposive sampling is applicable whenever the study is looking for a certain characteristic or trait from among the individuals in the sample, which is the basis for the purposeful selection (Dooley, 1995). In this study, the trait considered by the researcher was the participation in the process of election. Not all of the registered voters from PUP MPC and NDAP exercise their right to suffrage as some opted to abstain in the electoral process. The study used a minimum sample size of 250 members from the PUP MPC and 300 professionals from NDAP.

Research Instruments

This study utilized a researcher-made instrument called Software Performance/ Usability and Acceptance Survey (SPUAS), which aimed to assess the performance of the software based on the identified usability parameters such as accuracy, user-friendliness, completeness, and reliability. The preliminary part of the instrument focused on personal attributes of the respondents. The main part was concerned with the software attributes to evaluate software performance, software usability, and technology acceptance. The last part focused on the problems encountered by the respondents in using the system. The instruments were subjected to tests of validity and reliability.

The instrument was administered to a small group of respondents, not belonging to the research sample of the study, using a test-retest method of reliability test. This method aims to identify the stability or consistency of the instrument by administering the same scale or measure to the same respondents at two separate times (Zikmund, 1997). In this study, the iVote software was pilot tested to a group of students prior to the actual implementation. The second administration was conducted two weeks after the initial run to the same group of students. It served as the dry-run for the reliability test of the instrument. The result of the Spearman Rho computation revealed a 0.87 value equivalent to an interpretation of very high relationship. The study of Hendrickson et. al. (1993) likewise used the test-retest method to check the stability of David's TAM instrument on Perceived Usefulness

and Perceived Ease of Use scales. This study revealed high correlation, which meant that the instrument is stable and reliable.

Data Collection and Analysis

In addition to survey, the study also considered the use of other data gathering techniques to provide a deeper understanding of the phenomenon under study. The study used the observation technique during the actual election. The researcher participated in this exercise along with the other voters which made the process known as participant observation (Sanchez, 1998). A semi-standard interview was utilized from random voters after they casted their votes. This allowed the researcher to have guide questions but still have the freedom to probe further (Calderon & Gonzales, 1993). The semi-standard interview schedule was presented to researchers and information technology (IT) experts for validation. The combination of these multiple sources of data is called triangulation method since the data obtained from more than one sources were converged in order to provide a deeper understanding of the topic under study (Leedy & Ormrod, 2001). Triangulation supported the primary data collection tool which is the survey through the corroborative value of the participant observation and the semi-standard interview.

Results and Discussion

Software Performance – Accuracy Criterion.

Table 1 shows the respondents' evaluation of the software performance using the Accuracy criterion. The results revealed that all the Accuracy parameters received high evaluation ratings with a mean range of 4.46 to 4.63.

Table 1

Evaluation of the Respondents on the Computerized iVote Election Software using the Accuracy Criterion to Indicate Software Performance

Software Performance	PUP MPC			NDAP			Composite		
Accuracy Criterion	SD	$\bar{X}$	VI	SD	$\bar{X}$	VI	SD	$\bar{X}$	VI
1. Information presented by the software on screen are free from errors.	0.71	4.48	VS	0.55	4.63	O	0.63	4.56	O
2. The results of the processing/ computation exhibits high level of precision.	0.70	4.46	VS	0.57	4.60	O	0.64	4.53	O
3. Generated summaries are exact, truthful and acceptable.	0.76	4.46	VS	0.66	4.51	O	0.71	4.49	VS
4. Buttons/ tools perform their exact functionalities.	0.70	4.46	VS	0.63	4.51	O	0.67	4.49	VS
5. User instructions/ input commands are properly accepted by the software.	0.65	4.55	O	0.61	4.61	O	0.63	4.58	O
Overall:	0.69	4.48	VS	0.58	4.57	O	0.63	4.53	O

Legend: O – Outstanding, VS – Very Satisfactory, S- Satisfactory, G –Good, P – Poor

Licensed nutritionist-dietitian respondents were observed to be very particular with the correctness of the system since meticulosity is highly regarded in the daily practice of their profession.

NDAP members gave a mean range of 4.51 to 4.63 for the first four criteria while PUP MPC gave an evaluation with a mean range of 4.46 to 4.48. Both groups evaluated "*User instructions/input commands are properly accepted by the software*" as Outstanding. The overall evaluation of the software performance in relation to the Accuracy criterion received a mean of 4.53 equivalent to a verbal interpretation of "Outstanding," which means that the iVote software was deemed highly Accurate by both groups.

Similarly, the study of Teruel (2008) on Knowledge-Based System for Program Selection in the Technological Institute of the Philippines was evaluated using Accuracy as

one of its major evaluation criterion. The study revealed an overall mean rating of 4.09, equivalent to an Agree verbal interpretation. The staff gave the technology a higher rating than what the students gave. These findings are similar to the results of this study with the professional group giving iVote software with a higher rating than the rating given by the cooperative group. Another similar study was about the e-Record Management of the Jesus is Lord Church. The church officials evaluated the accuracy of the software with an overall Accuracy mean rating of 3.59 equivalent to a "Very Satisfactory" verbal interpretation (Novida, 2008). The study of Novida and Teruel, like this study, values the perception of the end-users on the Accuracy of the technology under evaluation.

Software Performance — Completeness Criterion

Table 2 presents the mean ratings extracted from the two groups of participants. The results revealed that all the Completeness parameters of the iVote software received high evaluation ratings. The results of the data processing for the completeness criterion of the software performance are as follows:

Table 2

Evaluation of the Respondents on the Computerized iVote Election Software using the Completeness Criterion to Indicate Software Performance

Software Performance	PUP MPC			NDAP			Composite		
Completeness Criterion	SD	X̄	VI	SD	X̄	VI	SD	X̄	VI
1. Software has a feature to change a previous input.	0.65	4.49	VS	0.61	4.60	O	0.63	4.55	O
2. Software shows all needed information.	0.64	4.50	VS	0.60	4.59	O	0.62	4.55	O
3. Software provides the user with instructions how to navigate to different parts of the software.	0.65	4.52	O	0.59	4.59	O	0.62	4.56	O
4. Software provides security to ensure confidentiality of records/inputs.	0.67	4.48	VS	0.62	4.50	VS	0.64	4.49	O
5. The software can generate relevant summaries.	0.62	4.53	O	0.65	4.50	VS	0.64	4.51	O
Overall:	0.64	4.50	VS	0.59	4.55	O	0.61	4.53	O

Legend:O – Outstanding, VS – Very Satisfactory, S- Satisfactory, G –Good, P – Poor

Similar to Table 1, NDAP gave higher evaluation to iVote software as compared to the evaluation given by PUP MPC, except item number 5, which is concerned with the execution of user input commands. This may be attributed to the fact that the NDAP members have a longer computer time because of the complex nature of their election. They had to vote for regional vice presidents on top of the national-level Board of Directors and the members of the Nomination Committee. The NDAP respondents appreciated the software being able to cater to their unique needs. As such, the mean rating they gave ranged from 4.50 to 4.60. In contrast with the PUP MPC respondents, the said organization elected only Directors, COMELEC, and Audit Committee officials. The evaluations of the PUP MPC members yielded a mean range of 4.48 to 4.53. The overall evaluation yielded a mean of 4.53 equivalent to an Outstanding verbal interpretation. The two organizations agree that the iVote software is complete with necessary features expected from an election software.

Magbayao (2012), involved investigations of shout boxes, social networking sites, links and online games in university websites, and used completeness as one of the parameter for evaluation. Her study revealed an overall mean rating of 3.40 tantamount to a verbal interpretation of "Partly Agree." This result is quite similar to the findings of this study which revealed a higher mean rating of 4.53 equivalent to "Outstanding." Results point out that in both the study of Magbayao and this study, completeness is an important factor for evaluating a technology from the vantage point of its users.

Software Performance — Reliability Criterion

Reliability, which is the third component of the software performance variable is presented in Table 3. It can be gleaned from this table that the respondents from the two organizations found the computer-based election system to be reliable. It is obvious among the three software performance indicators that the Reliability parameter received a slightly lower rating. This may be attributed to the occasional slow Internet/network connection which irritated certain system users.

The slow network connection projected a negative perception that the system is no longer responsive.. In Table 3, the responses of the two groups of respondents ranged from 4.33 to 4.53 which are verbally interpreted as "Very Satisfactory." This result implies that the two groups were not as satisfied with the reliability of iVote software as with its accuracy and completeness.

Reliability is an important evaluation criterion as indicated in the study of Faller (2013) concerning a Library Information System, which makes use of Radio Frequency ID (RFID).She considered Reliability as a primary evaluation criterion, which obtained an overall mean of 4.58 with a corresponding verbal interpretation of "Strongly Agree." Similarly, Bautista (2008) developed and assessed an Intranet-based Transcript of Record (TOR) Builder which was evaluated by graduate school students and faculty members/staff. The result of his study showcased a grand mean of 4.46 interpreted as "Very Good." These researches, like this study, considered reliability as an evaluation parameter to measure the software stability.

Table 3

Evaluation of the Respondents on the Computerized iVote Election Software using the Reliability Criterion to indicate Software Performance

Software Performance	PUP MPC			NDAP			Composite		
Reliability Criterion	SD	$\overline{X}$	VI	SD	$\overline{X}$	VI	SD	$\overline{X}$	VI
1. Software operates/ functions in a consistent manner.	0.70	4.53	O	0.70	4.45	VS	0.70	4.49	VS
2. Software behaves properly despite incorrect/ inappropriate inputs.	0.73	4.44	VS	0.67	4.45	VS	0.70	4.45	VS
3. Software is generally stable even under abnormal conditions.	0.70	4.48	VS	0.72	4.33	VS	0.71	4.40	VS
4. System can recover quickly from a serious fault or incident.	0.74	4.43	VS	0.66	4.50	VS	0.70	4.47	VS
5. Output is highly dependable and can be used readily.	0.69	4.50	VS	0.65	4.49	VS	0.67	4.49	VS
Overall:	0.70	4.48	VS	0.66	4.44	VS	0.68	4.46	VS

Legend:O – Outstanding, VS – Very Satisfactory, S- Satisfactory, G –Good, P – Poor

Software Usability — User-Friendliness Criterion

Under the software usability variable, the respondents evaluated the software using the user-friendliness criterion.Table 4 showed that the software was easy to use, even for non-IT users. The interface of the software appealed to both types of respondents. Despite the presence of a multitude of senior participants who may already have some eyesight conditions, the software was deemed intelligible.

Table 4

Evaluation of the Respondents on the Computerized iVote Election Software using the User-Friendliness Criterion to indicate Software Usability

Software Usability	PUP MPC			NDAP			Composite		
User-Friendliness Criterion	SD	$\overline{X}$	VI	SD	$\overline{X}$	VI	SD	$\overline{X}$	VI
1. User interface has a captivating design and is pleasant to the eyes.	0.69	4.53	O	0.68	4.45	VS	0.68	4.49	VS
2. Instructions, error messages and prompts are very helpful.	0.66	4.54	O	0.70	4.44	VS	0.68	4.49	VS
3. Instructions are simple, straightforward and easy to follow.	0.65	4.61	O	0.64	4.49	VS	0.65	4.54	O
4. Software is convenient and easy to learn.	0.61	4.60	O	0.67	4.46	VS	0.65	4.52	O
5. Font size are highly readable.	0.62	4.61	O	0.65	4.50	VS	0.64	4.55	O
6. System flow is clear and logically arranged.	0.62	4.60	O	0.62	4.47	VS	0.62	4.53	O
Overall:	0.63	4.58	O	0.65	4.47	VS	0.64	4.52	O

Legend: O – Outstanding, VS – Very Satisfactory, S- Satisfactory, G –Good, P – Poor

The overall evaluation of the software under the User-Friendliness criterion is Outstanding except for items number 1 and 2, which deals with the pleasantness of the graphical user interface and the instructions/error messages.

2. Differences on the respondents' evaluation of the computer-based election system

Software Performance

The succeeding table presents the z-values and p-values obtained in the evaluation of the respondents on the computer-based election system:

Table 5

Assessments on software performance

Software Performance	Z-value	P-value	Decision	Conclusion
Accuracy	-1.635	0.103	Not Significant	Reject Ha
Completeness	-0.944	0.346	Not Significant	Reject Ha
Reliability	0.559	0.576	Not Significant	Reject Ha
Overall	-0.651	0.515	Not Significant	Reject Ha

Not Significant at p<=.05

The preceding table presents the evaluation of the NDAP and PUP MPC respondents on the three criterions – Accuracy, Completeness, and Reliability, which comprise the Software Performance variable of the study. The z-values obtained for accuracy, completeness and reliability were 1.635, 0.944, and 0.559 respectively. These z-values are less than the critical value of 1.96. In addition, the computed p-values for accuracy, completeness, and reliability were 0.103, 0.346 and 0.576 respectively. These p-values are greater than the alpha level of 0.05. The z-values and p-values, taken together, revealed that each criterion had a Not Significant interpretation. Likewise, the overall evaluation revealed a not significant conclusion since the computed z-value of 0.651 was less than the critical value of 1.96 and the computed p-value of 0.515 was greater than the 0.05 alpha level. These results led to the rejection of the alternative hypothesis (Ha) because there is no disagreement between the evaluations of the two groups of respondents regarding the computerized system's accuracy, completeness and reliability. It can be inferred that the two groups have more or less the same level of evaluations on the software performance variable.

This study is similar to the study of Tiglao (2008) concerning an email management system. In her study, Tiglao tested the significant difference of the system using functional performance as evaluation parameter. The study obtained a t-value of

0.0231 at 0.05 level of significance which led to the rejection of the null hypothesis.

Software Usability

Table 6 presents the difference on the respondents' evaluation of the software based on the User-Friendliness criterion.

Table 6
Assessments on Software Usability

Software Usability	Z-value	P-value	Decision	Conclusion
User-Friendliness	2.110	0.035	Significant	Fail to reject Ha

Significant at p<=.05

The computed z-value was 2.110 which is greater than the critical value of 1.96. In addition, the calculated p-value was 0.035 which is less than the 0.05 alpha level. From these results it can be concluded that the user-friendliness criterion or the software usability variable had a Significant difference. This means that the two groups of respondents do not agree with the user-friendliness characteristic of the iVote software. Thus, there was a failure to reject the alternative hypothesis (Ha).

Conclusion and Recommendations

The PUP MPC and NDAP voters manifest similar perception on software performance in terms of accuracy, completeness, and reliability. In addition, the two groups profess dissimilar views on the software usability in terms of user-friendliness.

The study revealed that iVote software performance is outstanding in terms of accuracy and completeness criteria and very satisfactory in terms of reliability criterion. iVote usability is outstanding in user-friendliness criterion while technology acceptance is also outstanding in acceptability criterion. Software performance and software usability parameters have significant influence on technology acceptance.

Based on the findings and the conclusions made in this study, the researcher strongly recommends the promotion/dissemination of iVote software to other organizations to benefit from its capabilities and quality features.

It is also recommended that this software be enhanced for greater reliability, security, and interoperability. The next version of the software is expected to run on tablets and cellular phones without information distortion. Furthermore, the enhanced version of the iVote software should be made more inclusive for people with disabilities (PWDs). A good example is the use of text to speech applications such as the ORCA or JAWS software to enable the visually impaired to use the software.

Future researchers are encouraged to research on these areas for improvements. In addition, the next system can include higher-level statistical reports which include trends and other demographics.

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