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Factor Analysis Of The Influence Factor To Adopt E-Voting In Thailand Using Structural Equation Model (SEM)

By

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Abstract

The objective of this study was to determine the factor that influence changes of ballot paper to e-voting in Thailand general election. The mathematical analysis method was applied which is factor analysis: Exploratory Factor Analysis (EFA) for the preliminary model and Confirmatory Factor Analysis (CFA) for the measurement model. Then used Structural equation model (SEM) to evaluate consistency of the model fit. This study examined the e-voting adoption factor according to 12 variances. A total 342 responses were collected. The analysis results of EFA indicate that the factors could be divided into three main groups: Infrastructure consisted of 8 factors, E-participation consisted of 2 factors, and Human capital consisted of 2 factors. Then CFA was confirmed the hypotheses which assessed by convergent validity. Composite reliability and average variance were computed. The result showed that interrelationship of the construct was pass the criteria. The last analysis: SEM was measured the structure model and it fit to conditions. In this regard, all 2 models confirmed that these 3 factors had the impact to Thailand e-voting adoption which the Infrastructure ($\beta = 0.84$) had the highest loading factor, Human capital ($\beta = 0.62$) and E-participation ($\beta = 0.62$) had the same loading factor.

Index Terms—E-voting, Factor analysis, Structural equation model.

Introduction

The COVID-19 pandemic is an ongoing global pandemic. As such, there has been a need to adapt to the new normal life by maintaining social distancing. Information and communications technology has become involved in the new normal lifestyle. E-voting is a technology that is appropriate in this situation. The system allows the voter to vote without going to a polling station. However, individual countries have diverse requirements, which is why each e-voting solution is different for each country. The primary research (Phoonokniam, Siriya Kanchanasuntorn, 2020b, 2020a) in figure 1 there is four factors related to e-voting factor in Thailand which is stakeholder includes election actors and election authorities. The

stakeholders focused on here are election actors who are the voters in the election process. Adults in any age range and education level and those with a lack of technological knowledge should be able to use the system (Achieng & Ruhode, 2013; Osho, Yisa, & Jebutu, 2015). The environment includes transportation infrastructure, public trust in the government, fixed broadband, and internet use. Good transportation in terms of moving hardware and people can be one of the main points toward making this factor effective (Achieng & Ruhode, 2013; Dr. Ali M. Al-Khouri, 2012; Emaase & Mokodir, 2011; Sabo, Abdullah, & Arshad, 2015). The technology related to e-voting system requirement and Information and communication technology (ICT) readiness are the pillar supporting the e-voting system requirements. Poor ICT can present a significant challenge to e-voting adoption (Sabo et al., 2015). ICT will be one of the structures in the system that should be able to communicate between the system and a large amount of data; at the same time, the system can be accessed at any place, at any time, and on any device (Dr. Ali M. Al-Khouri, 2012; Sabo et al., 2015). The preparation of ICT includes development until launch to ensure the system works accurately without harming the election process (Emaase & Mokodir, 2011). The last one is communication and collaboration. The strong communication should describe the process, the project timeline, and the person in charge of each process (Dr. Ali M. Al-Khouri, 2012). Nowadays, using social media is one of the ways to communicate; thus, it is easy to raise the awareness of the new generation of voters concerning the e-voting process and the new system.

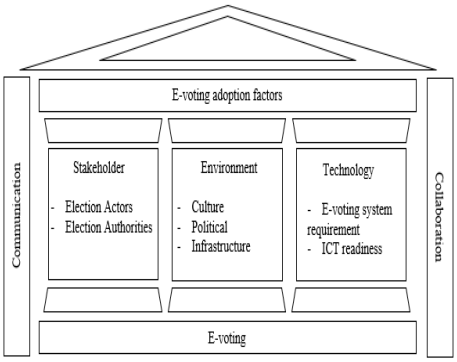

Figure 1. *E-voting adoption factors (Phoonokniam, Siriya Kanchanasuntorn, 2020b, 2020a)*

This research aimed to explore and confirm the factors model which involved to implement e-voting in Thailand. The factor has been evaluated in both quantitative and mathematical analysis method. The Exploratory factor analysis method was used to explore and groups the similar factor into the same group, then confirm the model by using the measurement model; Confirmatory Factor Analysis (CFA) to measure the interrelationship of the variance meet the criteria and the last method is to measure the model fit which is the Structural equation model (SEM).

Research Methodology

A. Questionnaire Proposal

This research was quantitative in nature, and a questionnaire was the primary tool used to obtain the data. The questionnaire was established from the literature review that was discussed in the last section. However, the researcher has investigated more in each variance and found out that some of them could be able to integrate into the same item in term of meaning and scope. At the same time, some variance had been linked to well-known index which was The Network Readiness Index (NRI), Global Innovation Index (GII), The Global Competitiveness Index (GCI), and Corruption Perceptions Index (CPI). The final factor model

for analysis consisted of 12 items according to table I which there was 6-items need to be cutoff because of no index can't be measured: Voter's age, Authority's knowledge in election system, Number of authorities, Political party's knowledge in election system, Number of voters per polling station, and New electoral management process to support the electronic system. But they would be included in the discussion as a supportive factor.

Table I *Final factor 12 factors*

From literature review	Label	New Factor	Source
Voter's education	EV1	Adult literacy Rate	NRI
Voter's ability to use technology Authority's ability to use technology	EV2	ICT skill	NRI
The reliability of voter in election system The reliability of political party in election system The reliability of the voting system developer	EV3	Corruption Perceptions	CPI
Rules for supporting new election system Electronic laws for certifying election results	EV4	Legal Frame's adaptability to emerging technologies	NRI
Transportation of election equipment and voters Local telecommunication systems	EV5	Quality of overall infrastructure	GCI
Available of voting system ICT infrastructure	EV6	ICT access	GII
Security of voting system	EV7	Secure Internet server	NRI
Laws of data Privacy Traceability of voting system	EV8	Cybersecurity	NRI
The availability and capacity of the hardware The availability and the potential for development of software	EV9	Availability of latest technologies	GCI
Budget for investing in new systems	EV10	Investment in emerging technology	NRI
Public relation affects the electoral process at any level. The involvement of new electoral process	EV11	Government promoting of investment in emerging technology	NRI
The participation of all sectors affects the electoral process at any level	EV12	E-participation	NRI

B. Research Respondents

The population and sampling of this research was based on the eligible voting age, which starts from 18 years old. The eligible voters can be of any education level, any region, and any occupation. The suggested sample size was at least 300 respondents (Comrey & Lee, 2016) to perform both EFA and CFA. Therefore, the total number of respondents who were eligible voters was 342: 285 general public respondents and 57 respondents from the authorities.

C. Data Collection

The questionnaire was put into an electronic form (Google Forms) and circulated through social media. For clarification, before respondents answered the questions, there was a cover letter explanation the objectives of the research to any response in the questionnaire was

kept confidential and anonymous. Respondents had to acknowledge this statement before proceeding to the question sections. Moreover, the questions were moderate in nature to reduce any political bias that might affect the answers to the questions. The data from this stage were used for an exploratory factor analysis, afterward a confirmatory factor analysis for validation. This ensured that using the same data for both analyses did not manipulate the results (Chen, Watson, & Hilton, 2018). The authors of the accepted manuscripts will be given a copyright form and the form should accompany your final submission.

D. Analysis Method

To achieve the aims of this research and advanced analysis methodology was used. The carefully chosen statistical analysis approaches included the execution of factor analysis along with structure equation models. The data were evaluated using IBM SPSS version 26.0 for the exploratory factor analysis (EFA) then the confirmatory factor analysis (CFA) was applied to testing the measurement variables represent a smaller number of constructs(Hair, 2010). The last method was Structural Equation Model (SEM) was the framed within CFA (Luna, Eva, Moreno, & Gómez, 2014) to support the investigation of underlying relationships among the latent variables.

Research Results

E. Respondents' Sociodemographic Details

Questionnaire contained two main segments: (1) Section 1: respondents' sociodemographic information and (2) Section 2: 12-factor-related questions. A 11-point Likert-type scale was applied for the questions in Section 2 (0 = not relevant, 10 = strongly relevant). The result shows the respondents sociodemographic details from the data collection. Most of the respondents were between 48 and 57 years old (30%). More than 63% of the respondents had graduated with a bachelor's degree, and 30% were registered residents in the Bangkok region. The occupations of the respondents included company employees (45%), with 21% still in education and 17% were the authorities who are associated with Thailand's election organization.

F. The Exploratory Factor Analysis (The preliminary model)

This research was quantitative in nature, and a questionnaire was the primary tool used to obtain the data. The questionnaire was established from the literature review which was 12 variables. To test the validity of the data, the statistical software SPSS was utilized on the variables to find the skewness which the absolute values should not be greater than 3 and kurtosis values should not be greater than 10 (Tabachnick, Barbara G. Fidell, 2001). The normality was tested, and the result was pass, then Cronbach's alpha was measured 0.908. An exploratory factor analysis (EFA) was performed to identify the simplest structure. Beforehand, the Kaiser–Meyer–Olkin (KMO) was verified dataset which must have value more than 0.7 (M S & W E, 2001) and Bartlett test of sphericity methods to confirm the dataset was suitable to execute the EFA. Varimax rotation was executed for the principal component analysis (PCA). The factor loading should have a loading value of more than 0.4 to be a stable factor structure with an appropriate sample size (Lin, Wu, Hsiao, Han, & Hung, 2017). The final value is the eigenvalue. This value is used to determine how many factors there should be. The suggested value should be over 1 (Yong & Pearce, 2013). The KMO value was 0.887, the Bartlett's test of sphericity value was approximately chi-squared = 3202.377, and p = 0.000 signified that the dataset was reasonable for factor analysis and that PCA was possible (Taherdoost, Sahibuddin, & JALALIYOON, 2014). The initial eigenvalue, a total of three components had an eigenvalue of more than 1 as per table II: 6.52, 1.32, and 1.27. The variance

was explained by the first three factors, which accounted for 54.30%, 10.96%, and 10.60% of the variance, respectively. These three factor groups explained a total of 75.86% of the **variance.**

Table II *Explanation of the total variance for e-voting factors.*

Component	Initial Eigenvalue		
	Total	Variance (%)	Cumulative Variance (%)
1	6.52	54.30	54.30
2	1.32	10.96	65.26
3	1.27	10.60	75.86

The varimax rotation was used, and factor loadings of more than 0.4 were kept (Lin et al., 2017). In table III, the first factor comprised eight high loading items with reliability 0.94 and was labeled as Infrastructure. The second factor contained two items with reliability 0.76 and was labeled as E-participation. The last factor included two items with reliability 0.63 was labeled as Human Capital.

Table III *The EFA results of the e-voting factors.*

Main Factor	Label	Factor loading	Cronbach's Alpha
Human Capital	EV1	0.83	α = 0.63
	EV2	0.78	
Infrastructure	EV3	0.81	α = 0.94
	EV4	0.81	
	EV5	0.73	
	EV6	0.85	
	EV7	0.84	
	EV8	0.85	
	EV9	0.89	
	EV10	0.75	
E-participation	EV11	0.88	α = 0.76
	EV12	0.81	

G. The Confirmatory Factor Analysis (The measurement model)

The confirmatory factor analysis (CFA) was used to check the hypotheses. The measurement model was evaluated by convergent validity. It contained factor loading, composite reliability (CR), and average variance extracted (AVE) (Fornell & Larcker, 1981; Lin et al., 2017). In the analysis results shown in Table IV, the loading factor in each label was between 0.59 and 0.94, indicating the stability of the factor structure (Lin et al., 2017). The composite reliability (CR) of the label should be more than 0.60 (Srinivasan, Lilien, & Rangaswamy, 2002). The average variance extracted (AVE) should be over 0.50, which is the minimum acceptable value (Fornell & Larcker, 1981). All measurement fulfills the recommended level. Therefore, this model was reasonable.

Table IV *Summary of the reliability and validity of the model fit.*

Main Factor	Label	Factor loading	AVE	CR
Human Capital	EV1	0.59	0.52	0.68
	EV2	0.84		
Infrastructure	EV3	0.81	0.65	0.94
	EV4	0.80		
	EV5	0.69		
	EV6	0.89		
	EV7	0.80		
	EV8	0.84		
	EV9	0.87		
	EV10	0.75		
E-participation	EV11	0.67	0.66	0.79
	EV12	0.94		

H. The Structural Equation Model (The structure model)

After the result of CFA, the second order CFA were used to perform SEM. SEM was used to measure how good model fit to the data by evaluating consistency of statistical method at the same time it measures the error in variable as well. The preliminary model fit index showed the model did not fit well so the modification index was conducted. Both initial model and fitted model were shown in Table V.

Table V *SEM analysis results*

Index	Evaluation Criteria	Initial Model	Fitted Model
CMIN/DF	<3	11.52	2.42
GFI	$0.95 \leq GFI \leq 1.00$	0.74	0.95
RMSEA	$0 \leq RMSEA < 0.08$	0.14	0.07
NFI	$0.95 \leq NFI \leq 1.00$	0.82	0.97
CFI	$0.95 \leq CFI \leq 1.00$	0.83	0.98

The indices for the final model show model fit. The initial chi-square value ($\chi 2(52) = 598.786$ ($p < 0.000$)) did not imply a model fit but it changed after conducing modification index, which suggests significant model improvement. CMIN/DF $\chi 2(42)$ was 2.42, suggesting model fit. The comparative fit index (CFI) and normed fit index (NFI) were 0.95, suggesting model fit; root mean squared error approximation (RMSEA) having a correction for model complexity is 0.07 which is < 0.08, indicating a (Kline, 2005). Goodness of fit index (GFI = 0.95) is 0.95 which suggests model fit. The observed variables in the model have strong loadings on second-order factors; loadings of variables on Human capital range from 0.59-0.84; loadings of variables on Infrastructure range from 0.69–0.89; loadings of variables on E-participation range from 0.66–0.92, shown in figure. 2 and table VI.

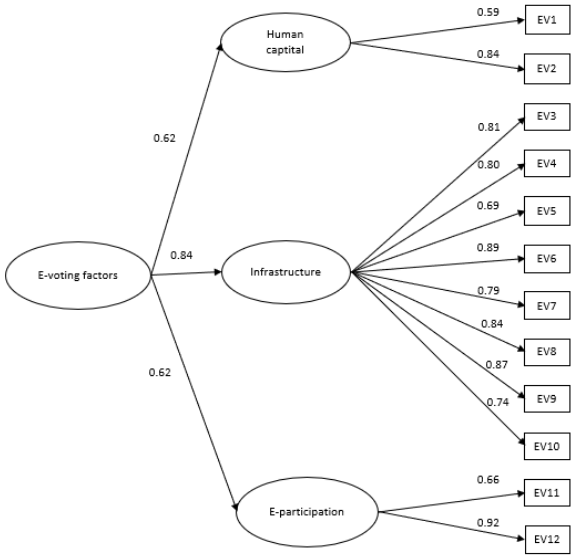

Figure 2 *Second-order factors (SEM)*

Table VI *Factor loading of second-order*

Main Factor	Label	Factor loading
Human Capital	EV1	0.59
	EV2	0.84
Infrastructure	EV3	0.81
	EV4	0.80
	EV5	0.69
	EV6	0.89
	EV7	0.79
	EV8	0.84
	EV9	0.87
	EV10	0.74
E-participation	EV11	0.66
	EV12	0.92

Discussion And Conclusion

For this research to study the hypothesis of e-voting adoption factor in Thailand. The results of the EFA show three components for e-voting adoption factors, and CFA and SEM confirmed these factors. The three components were named human capital, infrastructure, and e-participation, which had significant positive correlations with the e-voting adoption factors. The infrastructure must be the focus factor with the highest loading (β =0.84). This factor contained the pillar for developing e-voting; Corruption Perceptions (β =0.81) which related to the reliability in overall to be trusted when it changed to new the system. Legal Frame's adaptability to emerging technologies (β =0.80) which Thailand had the electronic legal framework as well. This framework was for the validity of digital signature and electronic transaction which was the importance filed in e-voting. Quality of overall infrastructure (β =0.69) was considerate. No matter it was the traditional election or e-voting, it still needed to transport the equipment to polling station on time and the day of election the voter needs to use all type of transportation to be there. For Thailand the overall transportation can be indexed 67 ranking from 137 countries (World Economic Forum, 2017). ICT access (β =0.89); Internet user and fixed broadband were showed that the network both hardware and software to connect

the electronic device and related party. In the election the network should cover all area and user can access anywhere and any device. According to International Telecommunication Union 2019 (ITU, 2019) report, about 97.86% in Thailand have fixed broadband subscription and 55.84% of population who use the internet. Secure Internet server (β =0.79) and Cybersecurity (β =0.84) were one of the most importance in these factors when it comes to digital implementation and can protect, prevent, and combat cyber threats. Availability of latest technologies (β =0.87) and Investment in emerging technology (β =0.74), this is the opportunity for us to invest and develop the new technology to support the system changes. The last two factors had the same loading human capital (β =0.62) and e-participation (β =0.62). The education was linked to adult literacy index (Portulans Institute, 2020) which was the percentage of the people aged 15 years onward who can read, write, and understand a simple sentence. In the report show that 92.01 precent in Thailand can read, write, and understand a simple sentence. In recent Thailand general election from 51M eligible voter, 38M (74.87%) casted their vote (The Bureau of Registration administration, 2019; The Election Commission of Thailand, 2019). The age majority was 36-50 (30%) and 51-65 (24%) (The Bureau of Registration administration, 2019; The Election Commission of Thailand, 2019). Only 53.51% in Thailand has ability to use technology (Portulans Institute, 2020). This was an opportunity to develop the system for ease of use. It was one of the key points to influence to voter to use new system (Osho et al., 2015) especially amongst the elderly eligible voters who had not much in technology knowledge. On the other hand, the e-participation, encouraged people to use information and communication technology (ICT) as an intermediate to reach everyone. As well as the ICT usage to interactive between government and people or among them. Thai's government establish the website to collect the citizen's opinion, the promote of crowdsourcing agenda so everyone can attend etc. This was the start point to people to reach out and interact with government more. This e-voting would be the game changing and the huge transformation in Thailand democracy. Thus, all stakeholders should be involved in every step. Engagement and communication were the key (Dr. Ali M. Al-Khouri, 2012; Sabo et al., 2015). Mock election should be occurred adequate and regularly across the country to gather voter and authorities' feedback to improve the usability (Adeshina & Ojo, 2015; Dr. Ali M. Al-Khouri, 2012). This would be an opportunity to allow participants to express their opinions about new system and guide improvement of system.

Future research can be analyzing these factors in the context of Thailand's elections to find out the possibility of adopting e-voting in the next election.

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