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The Confirmatory Factor Analysis (CFA) of E-Procurement Adoption Model in Malaysian Construction Industry

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Abstract

Structural equation modelling (SEM) is the first generation path modelling that is widely used by researchers and practitioners nowadays to analyse the interrelationship among variables in a model. In this study, the questionnaire was designed based on nine constructs of exogenous, mediating and endogenous used. Performance expectancy, effort expectancy, social influence and facilitating condition are as exogenous constructs. The mediating constructs consists of usage, user satisfaction, user anxiety and user resistance. Performance impact becomes one single endogenous construct. The questionnaires were distributed to 300 contractors from G4 and G5 classifications in Malaysia Construction Industry during the workshops organized by CIDB. The total of 250 questionnaires were returned to the researcher for the validity and reliability test in this study. The ultimate objective of this article is to acquire the best fit of a research instrument for the effective study using structural equation model (SEM) that enables the study to take into account the unreliable factors (items) between exogenous and endogenous constructs. The items of the constructs undergo the confirmatory factor analysis (CFA) procedure involved in the uni dimensionality test, convergent validity, construct validity and discriminant validity. The result revealed the constructs of the research model achieved the validity and reliability for other further analysis in acquiring high accuracy on the prediction outcomes.

Keywords: AMOS, CFA, Reliability, Validity, Composite Reliability (CR), Average Variance Extracted (AVE)

Introduction

In this study, the relationship between exogenous constructs such performance expectancy, effort expectancy, social influence and facilitating condition; mediating constructs consists of usage, user satisfaction, user anxiety and user resistance; and one endogenous construct, namely performance impact will be assessed through a PROPERFORM Model, which has been designed by researcher guided by the few theories of Information System. Generally, the main

objective of this study is to investigate the impact of e-procurement usage on contractors' performance in the Malaysian construction industry. In short, this study attempts:

- To determine the factors influencing e-procurement usage among Malaysian contractors.
- To determine the effect of e-procurement usage among Malaysian contractors' performance. Since this study observes 9 latent variables, researcher will use structural equation model (SEM) to multiple correlated the latent variables concurrently in one measurement model that enable to taking into account the unreliable factors (items) between exogenous, mediating and endogenous constructs. Therefore, this paper is to emphasize the validity and reliability of constructs involve in this study using confirmatory factor analysis (CFA). In fact, CFA offers more parsimonious clarifications and greater modeling flexibility to achieve the fitness of the measurement model in SEM. Six models should be applied which are identification model, specification model, estimation model, evaluation model and modification verification model (Awang, 2012), the researchers used the analysis of moments structures (AMOS) version 23 to confirm the validity and reliability of the measurement model.

First of all, the items were tested for unidimensional reliability before validation of the constructs. The convergent validity and discriminant validity were undertaken to validate all constructs to ensure the consistency of the measurement model. The unidimensional, validity and reliability of measurement model were used to measure the constructs that could not be measured directly (Joreskog & Sorbom, 1993). To evaluate the fitness of measurement and structural model Holmes et al (2006) as well as Hair et al (2010) have suggested using, at least three fit indexes, which are absolute fit, incremental fit and parsimonious fit for construct validity.

From the CFA results, the researcher needs to look for the Fitness Indexes for the measurement model, the factor loading for every item, and also the correlation between constructs. The Fitness Indexes reflect the Construct Validity, while the factor loading indicates the importance of the respective item in measuring its construct. The assessment for Construct Validity is made based on Fitness Indexes and is shown in Table 1.

Table 1: The three categories of model fit and their level of acceptance

Name of category	Name of index	Level of acceptance
Absolute Fit Index	RMSEA	RMSEA < 0.08
	GFI	GFI > 0.90
Incremental Fit Index	AGFI	AGFI > 0.90
	CFI	CFI > 0.90
	TLI	TLI > 0.90
	NFI	NFI > 0.90
Parsimonious Fit Index	Chi sq/df	Chi-Square/ df < 3.0

Source: Awang (2015)

Literature Review

Electronic procurement, commonly known as e-procurement, can be defined as automating purchasing processes in an organization using web applications. E-procurement refers to the

purchase of goods and services for organizations (Turban et al, 2006). In this study, it will be reviewed in terms of usage, satisfaction, anxiety, resistance and performance impact.

The emergence and distribution of e-procurement systems in companies has provided a lot of information related to their use and implementation. There are many empirical studies that provide anecdotal evidence to support the that makes the procurement process more efficient and effective and has an impact on the company's results (Shukla et al., 2016; Chang et al., 2013; Tai., 2011; Gioconda et al., 2010; Teo and Lai., 2009). The following benefits can be seen such as: increased process quality, lower purchase costs, user satisfaction, faster response speed, better customer service, product innovations, market expansion, shortened purchasing time, shortened staff time and management efficiency. However, these empirical studies provide insight into a singular situation only; they do not provide a full and comprehensive list of benefits and the associated costs for a specific industry.

Murali et al (2010) have done a research to determine the factors that influence the intention to use and actual usage of a G2B system such as electronic procurement system (EPS) by various ministries in the Government of Malaysia. A questionnaire was designed and the responses from 358 users from various ministries were collected and analysed using structural equation modeling (SEM). The findings of the study indicate that: perceived usefulness, perceived ease of use, assurance of service by service providers, the responsiveness of service providers, facilitating conditions, web design (service quality) are strongly linked to the intention to use EPS; and intention to use is strongly linked to actual user behavior.

Norzaidi et al (2013) applied the Extended Technology Acceptance Model (TAM) (Davis et al., 1989) in the new context of e-procurement. The study used descriptive analysis to determine the factors affecting the use of e-procurement among contractor companies in Malaysia. The five factors identified in the study are: the use of e-procurement, perceived ease of use, perceived usability and approach to using e-procurement to understand the concept as well as the intention to use e-procurement. However, they did not focus on the effects of e-procurement on the organization in their research.

For this research, the researcher used many constructs of Information Systems from few researches as discuss earlier and developed PROPERFORM Model. It is important to test whether the measures of a construct are consistent with a researcher's understanding of the nature of the construct. In order to do this, confirmatory factor analysis (CFA) is used. In statistics, confirmatory factor analysis (CFA) is a special form of factor analysis, most commonly used in social researches (Kline, 2011). As such, the objective of confirmatory factor analysis is to test whether the data fit a hypothesized measurement model. This hypothesized model is based on the theory or previous analytic research (Preedy & Watson, 2009). CFA was first developed by Joreskog (1969) and has been built upon and replaced older methods of analysing construct validity such as MTMM Matrix as described in Campbell and Fiske (1959).

In confirmatory factor analysis, the researcher first develops a hypothesis about what factors he believes are the underlying the measures he has used and may impose constrains on the model based on these priori hypotheses. By imposing these constraints, the researcher is forcing the model to be consistent with the theory. Model fit measures could then be obtained to assess how well the proposed model captured the covariance between all the items or measures in the model. If the constraints the researcher has imposed on the model are inconsistent with sample data, then the results of statistical test of model fit will indicate a poor fit, and the model will be rejected. If the fit is poor, it may be due to some items

measuring multiple factors. It might also be that some items within a factor are more related to each other than others.

Methodology

Population and Samples of Study

The target respondents were among the contractors of G4 and G5 in Malaysian Construction Industry. In this study, they were randomly selected from those who attended seminars and workshops organized by Construction Industry Development Board (CIDB) in Kuala Lumpur. The samples were selected using the propositional stratified sampling technique since the target population is heterogeneous. They have to be stratified into homogenous groups to become similar characteristics (Zainudin, 2012).

The Measurement Instrument

The questionnaire was used as a primary survey instrument in collecting quantitative data in numerical form. The structure of the questionnaire was developed based on PROPERFORM Model. The questions were adopted and adapted from valid and reliability source based on the researcher's knowledge in the construction field. The 47 questions in the questionnaire were reviewed by two experts in construction and organizational behavior research to satisfy content validity. Before collecting the data from the samples, the questionnaire was verified for internal consistency using Cronbach's alpha and all constructs were found have Cronbach Alpha value more than 0.7 and therefore are accepted in this research (Zainudin, 2012; Hoque et al., 2016). The total of 250 questionnaires were answered and returned by the respondents who are the representative of their construction companies in Malaysia. These amounts of data are valid to be analysed.

Data Analysis

Before proceeding to the validity and reliability of the measurement model, the items were firstly confirmed for the unidimensional items of the measurement model. What CFA for every latent construct involves in the study was executed to confirm the first order unidimensional items in the measurement model. The threshold of the factor loading should be 0.6 and above (Zainudin, 2012). The items with factor loading low than threshold were deleted in order to achieve unidimensionality. In this study, unidimensionality is achieved when all measuring items have acceptable factor loading for the respective latent construct. After validity and reliability are achieved, the study needs to assess for normality distribution of all items measuring the construct before modeling the structural model and executing SEM. According to Awang (2015), Awang et al. (2015), Kashif et al. (2015, 2016), Mohamad et al. (2016), Mohamad et al. (2016a), and Yusuf et al. (2017), the study only needs to show that the values of skewness for all items do not depart from normality. Thus, the skewness values should fall within the range of -1.0 to 1.0 and is deemed acceptable.

Validity

All the constructs, endogenous, mediator and exogenous constructs were validated by three methods, which are convergent, construct and discriminant validity.

Convergent Validity

The convergent validity is the first method of validation processes on measurement model. According to Kline (2011), convergent validity is a set of items in one construct that are inter-

correlated and is measured through average variance extracted (AVE) where the threshold is above > 0.5 and indicates a high convergent validity (Fornell & Larcker, 1981). Moreover, factor loading of each item at ≥ 0.6 is considered high convergent validity (Hair et al., 2010).

Construct Validity

Since the model involves nine constructs and is too complicated, the study cannot carry out the Pooled Confirmatory Factor Analysis (Pooled-CFA) procedure at once for all constructs. Thus, the study had to carry out the Pooled CFA twice, namely Pooled-CFA1 and Pooled-CFA2 as illustrated in figure 1 and 2. However, in the last stage the study combined all constructs into one model in order to assess the discriminant validity.

Figure 1: The output for constructs under Pooled CFA1

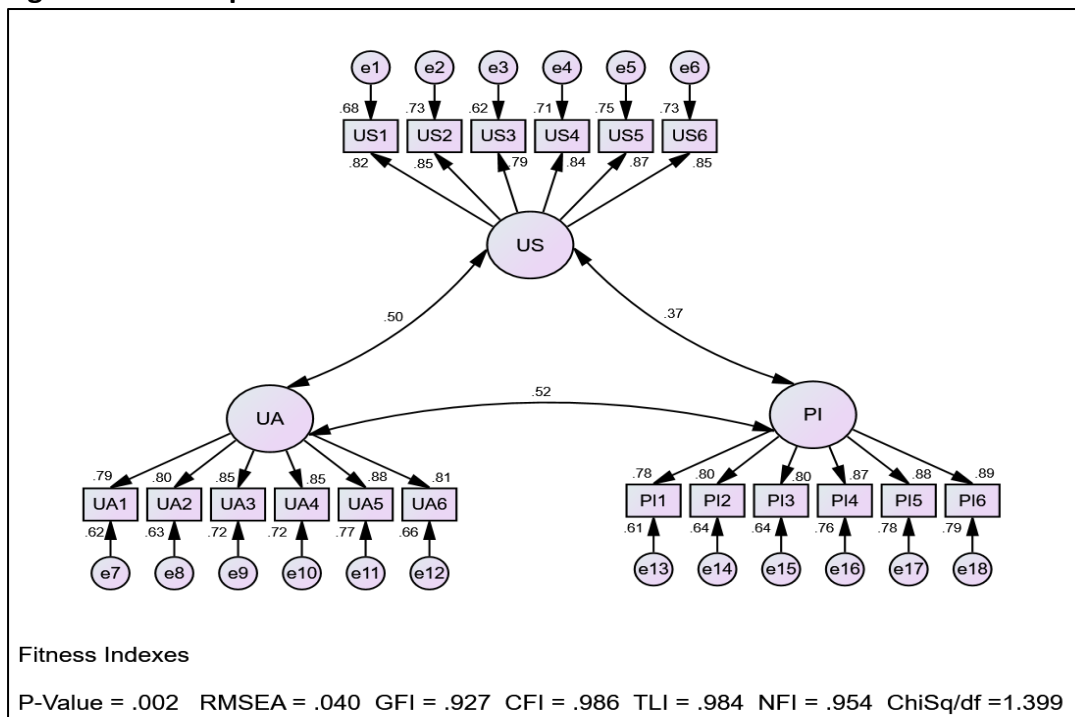
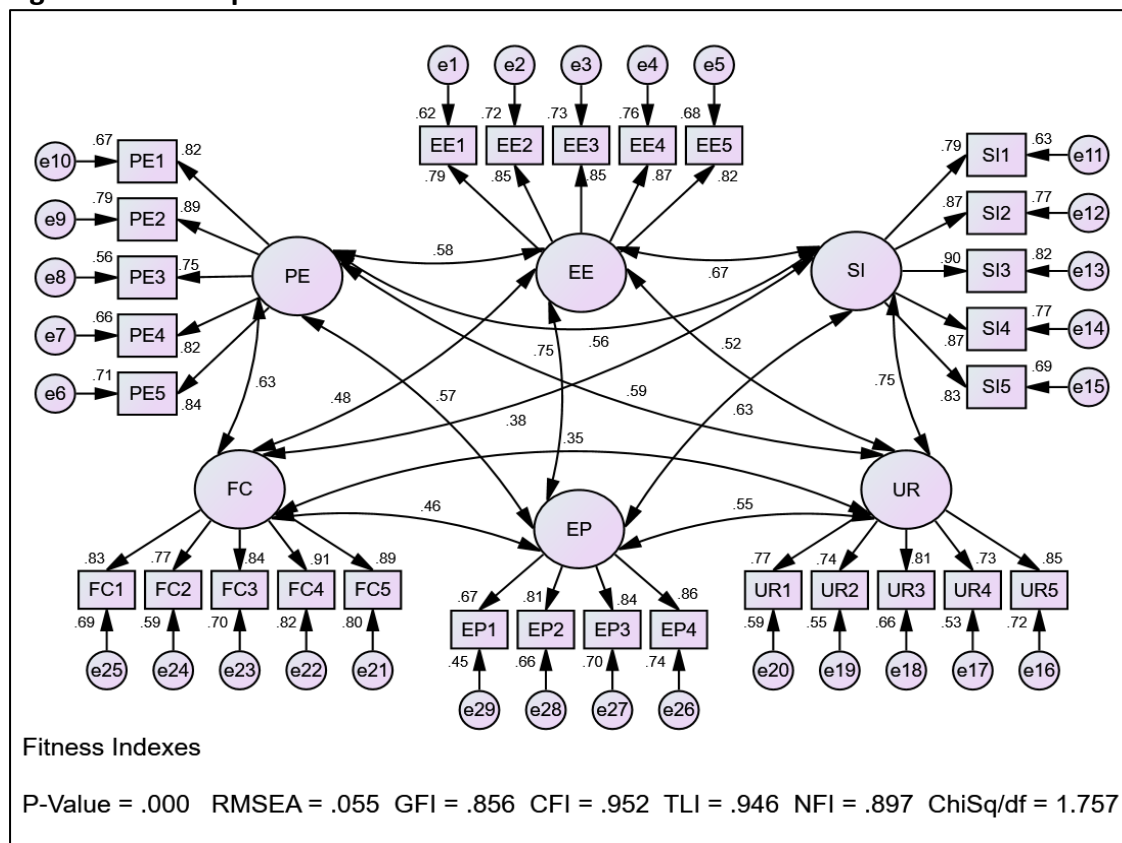


Figure 2: The output for constructs under Pooled CFA2



The construct validity on all constructs of the measurement model achieved the good fitness index as shown in table 2 below:

Table 2: The Fitness Indexes indicate the fitness of the construct to the data from the field

Name of category	Name of index	Index value of Pooled CFA1	Index value of Pooled CFA2	Comments
1. Absolute fit	RMSEA	0.040	0.055	The validity level is achieved
2. Incremental fit	CFI	0.986	0.952	The validity level is achieved
3. Parsimonious fit	Chisq/df	1.399	1.757	The validity level is achieved

Discriminant Validity

The discriminant validity is to avoid any redundant items in the measurement model (Zainudin, 2012). The items should not be related and are in reality not related. It involves the relationship between a latent construct and other constructs of a similar nature. Discriminant validity can be identified by comparing the variance shared by the average AVE between these two constructs (Bove et al., 2009). The estimated correlations between constructs should not be greater than 0.85 (Kline, 2011). The result is shown in Table 3.

Table 3: The Discriminant Validity Index Summary

	PE	EE	SI	FC	EP	UA	UR	US	PI
PE	0.83								
EE	0.69	0.84							
SI	0.68	0.71	0.85						
FC	0.63	0.63	0.74	0.85					
EP	0.69	0.70	0.72	0.77	0.80				
UA	0.35	0.35	0.42	0.46	0.37	0.83			
UR	0.45	0.42	0.51	0.48	0.46	0.56	0.78		
US	0.50	0.53	0.58	0.46	0.53	0.53	0.62	0.84	
PI	0.40	0.42	0.47	0.39	0.43	0.63	0.67	0.61	0.84

Reliability

Reliability will be assessed through three criteria namely, internal reliability using Cronbach alpha with threshold 0.600 and above (Nunnally & Bernstein, 1994) and calculated using SPSS. The construct reliability (CR) should be 0.6 and above and average variance extracted (AVE) should be greater than 0.5 using AMOS application. The result is shown in Table 4.

Table 4: The Composite Reliability (CR) and AVE for all constructs

Construct	Sub-Construct	Factor Loading	CR (above 0.6)	AVE (above 0.5)
User Satisfaction (US)	US1	0.82	0.934	0.704
	US2	0.85		
	US3	0.79		
	US4	0.84		
	US5	0.87		
	US6	0.86		
User Anxiety (UA)	UA1	0.79	0.930	0.690
	UA2	0.80		
	UA3	0.85		
	UA4	0.85		
	UA5	0.88		
	UA6	0.81		
Performance Impact (PI)	PI1	0.78	0.934	0.702
	PI2	0.80		
	PI3	0.80		
	PI4	0.87		
	PI5	0.88		
	PI6	0.89		
Performance Expectancy (PE)	PE1	0.82	0.914	0.681
	PE2	0.89		
	PE3	0.75		
	PE4	0.82		
	PE5	0.84		
Effort Expectancy (EE)	EE1	0.79	0.921	0.700
	EE2	0.85		
	EE3	0.85		

	EE4	0.87		
	EE5	0.82		
Social Influence (SI)	SI1	0.79	0.930	0.727
	SI2	0.87		
	SI3	0.90		
	SI4	0.87		
	SI5	0.83		
Facilitating Condition (FC)	FC1	0.83	0.928	0.722
	FC2	0.77		
	FC3	0.84		
	FC4	0.91		
	FC5	0.89		
EProcurement Usage (EP)	EP1	0.67	0.875	0.638
	EP2	0.81		
	EP3	0.84		
	EP4	0.86		
User Resistance (UR)	UR1	0.77	0.888	0.614
	UR2	0.74		
	UR3	0.81		
	UR4	0.73		
	UR5	0.86		

The result in Table 4 shows the Average Variance Extracted (AVE) and the value of Composite Reliability (CR) for all constructs exceed the threshold value of 0.5 and 0.6 respectively. Thus, the study concludes that the Convergent Validity and Composite Reliability for all constructs in the model have been achieved (Zainudin, 2012).

Normality Test

The skewness for all items as shown in Table 5 falls within -1.0 and 1.0. According to Awang (2014; 2015), the skewness values within that range reflects that the data is still normally distributed or at least the data distribution does not depart from normality. Thus, it meets the requirement for employing parametric statistical analysis. The result is shown in table 5 below:

Table 5: The assessment of normality for all items

Construct	Sub-Construct	Skewness
User Satisfaction (US)	US1	-0.514
	US2	-0.602
	US3	-0.722
	US4	-0.407
	US5	-0.860
	US6	-0.919
User Anxiety (UA)	UA1	-0.762
	UA2	-0.541
	UA3	-0.469
	UA4	-0.520
	UA5	-0.700
	UA6	-0.431
Performance Impact (PI)	PI1	-0.301
	PI2	-0.080
	PI3	-0.114
	PI4	-0.290
	PI5	-0.360
	PI6	-0.310
Performance Expectancy (PE)	PE1	-0.898
	PE2	-0.943
	PE3	-0.830
	PE4	-0.791
	PE5	-0.484
Effort Expectancy (EE)	EE1	-0.541
	EE2	-0.469
	EE3	-0.520
	EE4	-0.700
	EE5	-0.431
Social Influence (SI)	SI1	-0.128
	SI2	-0.070
	SI3	-0.162
	SI4	-0.330
	SI5	-0.212
Facilitating Condition (FC)	FC1	-0.602
	FC2	-0.722
	FC3	-0.407
	FC4	-0.860
	FC5	-0.919
EProcurement Usage (EP)	EP1	-0.461
	EP2	-0.256
	EP3	-0.272
	EP4	-0.065
User Resistance	UR1	-0.310
	UR2	-0.582

(UR)	UR3	-0.423
	UR4	-0.615
	UR5	-0.162

Discussion

As a research instrument, the questionnaire should go through the validation process to ensure its validity and reliability of the items involved for the accurate and reliable findings of the study. The validity and reliability of constructs of the study which are performance expectancy, effort expectancy, social influence, facilitating condition, usage, user satisfaction, user anxiety, user resistance and performance impact were measured using CFA with AMOS 23. Only the items of the constructs with factor loading >0.60 remain in the measurement model after the unidimensionality process. Afterward, the AVE of the remain constructs was calculated with the threshold above >0.5 achieve the convergent validity (Fornell & Larcker, 1981). Together with a factor loading of all items ≥ 0.6 are considered high convergent validity (Hair et al., 2010). Later, the construct validity is measured with good fitness index on the measurement model with RMSEA, CFI, and Chi-Square/df. Furthermore, the measurement model was run for the discriminant validity to confirm no redundancy of the constructs. The measurement of this study achieves the discriminant validity where the correlations between constructs are < 0.85 (Kline, 2011). All the construct of the study achieved threshold's validity and reliability for further correlation measurement of the research model.

Conclusion

The constructs of the study must undergo the validity and reliability process to confirm the unidimensional of its items in the measurement model as the research model of the study. All construct was correlated to each other in the form of structural equation model (SEM) as a measurement model to test factor loading of the 47 items. This paper developed a CFA-based model, going beyond a prior paper that reported on EFA findings (Elias et al., 2020). CFA procedures consist of unidimensionality, convergent validity, construct validity and discriminant validity. The CFA provides improved insight into the latent factor structure (Brown, 2015) and will serve as a precursor to future contributions. With the data and extracted factors reported in this paper, the authors plan to next examine structural equation models.

It is crucial to ensure all the constructs involve achieved the validity and reliability before proceeding to the next measurement of relationship and mediation. Fail to achieve the validity and reliability will lead to error and inaccurate statistical results. Consequently, the findings of the study will become totally insignificant.

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