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Application of Confirmatory Factor Analysis in Government Construction Procurement Problems in Thailand

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ABSTRACT

This study aims to apply Exploratory Factor Analysis in government construction procurement problems in Thailand and to examine the suitability between model and evidence-based practices. Total 353 government agencies are used as the samples in this study. The survey was conducted through a questionnaire with Cronbach's Alpha Coefficient equal to 0.986. The result from the survey was then analyzed using percentage, mean, standard deviation, and model construct validity. According to the Second Order Confirmatory Factor Analysis, which has found the government construction procurement problems consist of 3 components which are procurement process problems, internal and external influence problems, and project management and technical problems. Ranking from the highest to lowest loading factors; furthermore, the construct model validity, the factor analysis second order normal form of which the items are indirectly influenced by the second order. The factor analysis second order normal form in which the items are directly influenced by the second order. Lastly, when comparing the suitability of the model, it has found that the model is directly influenced by the second order confirmatory factor and more suitable with evidence-based practices than the general model at a significant level of 0.01.

1. Introduction

It is argued that government procurement is important to global economy. Each country spends a huge budget for hiring people and buying material for the procurement between public organizations to provide products and services (Hazra, 2011; McKevitt & Davis, 2013). It is important for a government projects to be effective, and it should be transparent and fair (Pimsi,

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2005). In each country, the average government procurement accounts for 10-15% of Gross Domestic Product (GDP) (Khoman et al., 2009). Especially within the industrial sector, involved in government procurement up to 2,000 million dollars per year (Pimsi, 2005; Taemsakul, 2008).

Government procurement system of many countries has been improved, not only for creating effectiveness, transparency and fairness but also for coping with several aspects of a changing world: such as, globalization, advanced technologies increase, growing role of civil society and sustainability development, etc (Walker & Brammer, 2009). Thailand, for instance, has launched the Government Procurement and Supplies Management Act of 2017 and introduced the electronic procurement system, named Electronic Government Procurement (e-GP) (Chaithongrat, 2017). However, government procurement still cannot fulfill these matters nor satisfy the needs of stakeholders although electronic procurement system is already applied. It can be seen reflected from the research and media perspective several procurement problems such as corruption within the government construction procurement projects, higher procurement cost than actual cost. Cronyism is the result in poor quality work, excessive expenses, budget losses, and overprice of poor materials (Du et.al., 2007; Hazra, 2011; McKevitt & Davis, 2013). Therefore, this study aims to identify the component factors of government construction procurement problems by adopting a Confirmatory Factor Analysis. Moreover, the recommendations for solving procurement problems are presented.

2. Literature Review

In this section, the review of literature is divided into 2 research mainstreams which are General Factors and Confirmatory Factor Analysis to define the research assumptions used in this study.

2.1 Factors

According to the previous research such as Phuangngam (2006), Angkarnchun (2007), Namtrong (2007), Pesämaa et al. (2008), Khoman et al. (2009), Chaopetchdee (2010), Ameyaw et al. (2012), Gardenal (2013), Dza et al. (2013), Murimoga, R. & Musingafi, M.C.C. (2014), Licenji (2015) and Dzuke & Naude (2015) this study classifies factors into three groups as presented in Figure 1. The first group of factors is *Procurement Process Problems* consisting of 13 observed variables such as the lack of skills to draft TORs and contracts by officers, the lack of knowledge of the supplies and other regulations related to procurement by officers, the leakage of the information concern, the unclear criteria for defining performance measures, the lack of precision and confidence in rules and regulations by officers, the fix announcement period especially with mandatory plan, the restrictions according to the regulations that all agencies need to send the announcement details by the approval date of procurement, unclear clarification, inadequate time for pricing, definition of mid-price, incomplete pricing, no allowance for loss, inappropriate mid-price, mid-price being defined by the Comptroller Genera's Department in which the material price is not updated, to the offering price is higher than the mid-price, labor cost defined by Ministry of

Commerce is not consistent with current labor conditions, and the lack of accurate information for procurement planning. The second group of factors is *Internal and External Influences Problems* consisting of 14 observed variables which are, insufficient approved construction budget, changing executive, affecting the changes in utility and work progress, complex workflows, negative attitude toward their colleagues by officers, different opinions causing conflicts in the workplace, impact of politics, problems from external audits, audit agencies and NGOs, contractors not participating in biding or leaving their jobs, bidders' complaints within the procurement proves due to unclear announcement, complaints from the community, political and social problems i.e. protest, economic problems, rising in material prices, and poorly bidding by contractors resulting in lower than forecasted mid-prices. The last group of factors is *Project Management and Technical Problems* consisting of nine observed variables which are delayed work, insufficient number of procurement officers, officers' potential, difficulty working several functions, coordinated errors, mismatch problems between construction models, incomplete pricing, time conflicts, poor management, and different work quality within each function.

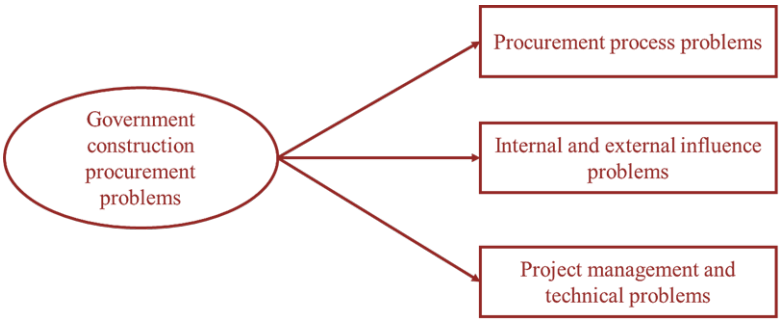

Figure 1: Measurement model

2.2 Confirmatory Factor Analysis (CFA)

Confirmatory Factor Analysis (CFA) is the analysis of the relationship between sub-factors, or observed variable and latent variable. CFA aims to confirm if the defined model can be used with the selected sample or not by conducting the first order CFA. After that, the analysis is repeated through the second order CFA which aims to confirm the validity of each latent variable by considering the suitability to either make a decision to accept or reject the model. It can be considered through four criteria as presented in Table 1 (Silpcharu, 2012).

Table 1: Criteria for goodness of fit of the model.

Item to evaluate	Criteria	Explanation
1) Chi-square probability level (MIN-p)	$p > 0.05$	p-value must be greater than 0.05. The greater p-value, the better.
2) Relative Chi-square (CMIN/df)	< 3	CMIN/df must be less than 3. The closer CMIN/df to 0, the better.
3) Goodness of fit index (GFI)	> 0.90	GFI must be greater than 0.90. The closer GFI to 1, the better.
4) Root mean square error of approximation) RMSEA	< 0.08	RMSEA must be less than 0.08. The closer RMSEA to 0, the better.

Sources: Chadcham and Kornpeipanee (2003), Hooper, et.al. (2008)

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3. Methodology

This study aims to analyze the components of government construction procurement problems by adopting CFA. The methodology used in this study is presented as follows.

3.1 Population and Sample

The unit of analysis is at the project-level for the government construction procurement problems. The population consisted of 3,025 government construction procurement projects, observed from January 2014 to January 2015. 353 projects were selected to be samples by adopting the sampling size calculation introduced by Yamane (1973) at the significant level of 95%. The sample size was defined by considering the basic requirements introduced by Field (2013) which the acceptable sample size should not be less than 300. Moreover, the samples were randomly selected by adopting Systematic Random Sampling approach (Neuman, 2006).

3.2 Instrumentation and Validity Test

In order to create and validate the questionnaire, the researcher defined 45 questions from the review of literature and relevant research. The questionnaire was designed using a rating scale. The questionnaire was preliminarily tried out by five experts who examined the content validity of the questionnaire. According to the experts' examination, 36 questions had IOC value greater than 0.60 so that the research improved the questionnaire and tried out with 30 projects which were not selected as the samples. Subsequently, only 32 questions with discrimination value greater than 0.02, ranging between 0.22 - 0.73, were selected for determining Cronbach's Alpha Coefficient (α) which is the measurement of accuracy. It is found that the coefficient (α) was 0.986 (Field, 2013) indicating that the questionnaire was highly reliable.

3.3 Data Collection

The researcher contacted the government agencies selected as the samples in this study together with informing the research objectives. The samples were asked to complete the questionnaires through Web Survey (Neuman, 2006) in the website of Comptroller General's Department, Ministry of Finance. The data collection took 60 days, from April to May 2016. As a result, the researcher received 353 complete questionnaires accounting for 100% response rate.

3.4 Data Analysis

In turn the data model was examined to see if it is fit with the evidence-based practice or not by considering Chi-square value, goodness of fit index, and standardized root mean square residual through the computer software. The analysis of the data is classified into three steps as follows:

1) Analysis of the basic information from samples.

2) Statistical analysis of the continuous variables such as mean, standard deviation, coefficient of variance (C.V.), min, max, skewness, and kurtosis. For nominal and ordinal variable, the percentage of each variable was determined.

3) Factor analysis and second order confirmatory factor analysis for examining the suitability

of the model of each latent variable. The Principle Component Extraction was conducted adopting Orthogonal Rotation and Varimax Rotation method in order to extract the variables based on the main components. The criteria for considering the components are that components must have Eigenvalue greater than 1.00m, and each variable in the component must have Factor Loading greater than 3.50. After that, the relationship between each variable was analyzed by defining Pearson's product moment correlation coefficient. Also, the correlation matrix between variables selected for component analysis was examined by conducting Bartlett's test of sphericity. The analysis was conducted through SPSS for Windows, and the suitability of the model was determined by using AMOS software.

4. Results and Discussion

4.1 General information of the respondents

It is reported that most of the respondents were male (54.4%), aged between 41-50 years (33.7%), and have a Bachelor degree (63.74%). Furthermore, most of them are the head of supplies or supplies officer (46.7%), followed by procurement auditor (22.9%). Most of the respondents have experienced in the procurement of construction projects for 9.5 years on average, with 7.6 standard deviation. Moreover, most of the projects belong to local government (26.5%), followed by general government (34.6%). 38% of the projects are in the central part of Thailand. It is also found that the special procurement is mostly adopted (34.6%), followed by tender (25.8%), and e-bidding (24.4%). Most of the projects are building construction (35.1%), followed by road construction (34%).

4.2 Component analysis of government construction procurement problems

Kaiser-Meyer-Olkin test (KMO) was conducted which the KMO index is equal to 0.971. It is found the KMO index is greater than 0.50 meaning the sample size is large enough for the component analysis.

First order CFA was conducted by modifying the assumption according to the suitability. It is found that for the first order CFA, Chi-square value is significant (p-value < 0.05) and relative Chi-square is equal to 11.095 which is higher than the defined value in the criteria. NFI, GFI, CFI, standardized RMR, and RMSEA are equal to 0.965, 0.938, 0.968, 0.036 and 0.169 (higher than the defined value in the criteria) respectively. Consequently, the model is not fit with the evidence-based practice. Therefore, the model needs to be modified to increase the suitability. The researcher modified the model according to the Model Modification Indices (MI). After modification, it is found that Chi-square value is not significant (p-value = 0.139), and relative Chi-square is equal to 0.139. NFI, GFI, CFI, standardized RMR, and RMSEA is equal to 0.997, 0.994, 0.998, 0.010, and 0.049, respectively. Therefore, it can be concluded that all the statistical indices pass the criteria. Meaning that the component factor of government construction procurement problem is fit with the evidence-based practice as presented in Figure 2 and Table 2.

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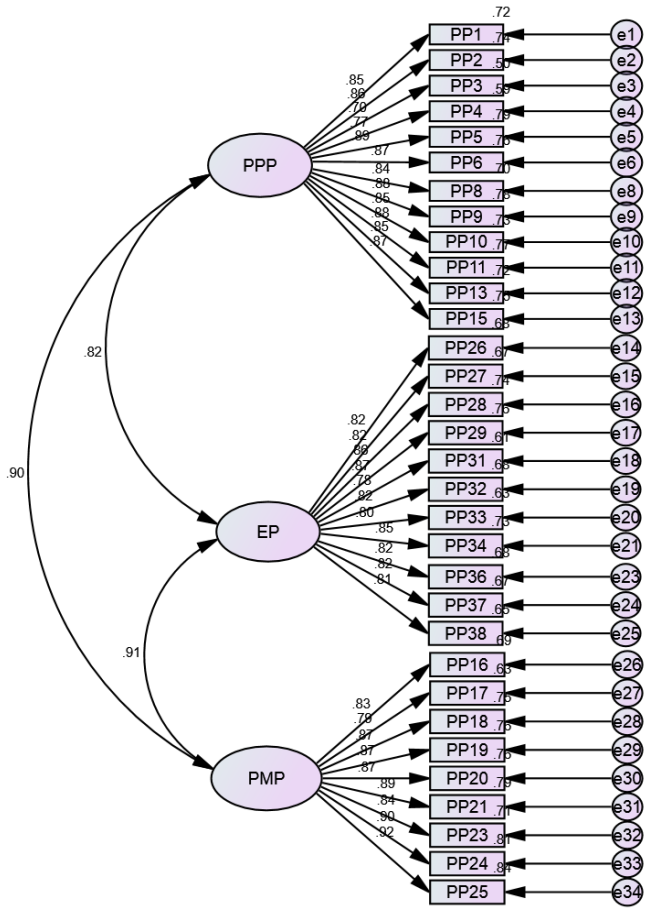
Table 2: Goodness of fit indices between the first order CFA model and evidence-based practice.

Index	Criteria	Before modification		After modification	
		Value	Result	Value	Result
X^2/df	< 3.00	55.474/5=11.095	Not pass	5.492/3=1.831	Pass
p-value of X^2	> 0.05	<0.001	Not pass	0.139	Pass
NFI	> 0.90	0.965	Pass	0.997	Pass
GFI	> 0.90	0.938	Pass	0.994	Pass
CFI	> 0.95	0.968	Pass	0.998	Pass
RMR	< 0.08	0.036	Pass	0.010	Pass
RMSEA	< 0.06	0.169	Not pass	0.049	Pass



Chi-squre = 2623.483, CMIN/DF = 5.691, df = 461, p = .000
NFI = .818, GFI = .648, CFI = .844, RAR = .054, RMSEA = .115

Figure 2: Confirmatory Factor Analysis of government construction procurement problems.

The factor loadings of government construction procurement problems are between 0.663 – 0.991 which are correlated at the significant level of 0.05 (Table 3).

According to the first order CFS, it is found that for component 1, procurement process problem consists of 12 factors with factor loadings between 0.696–0.991. For Component 2, internal and external influence problem consist of 11 factors with factor loadings between 0.663 – 0.908. For component 3, project management and technical problem consist of 9 factors with factor loadings between 0.677 – 1.131. The reliability scores of measurement (R^2) of 32 sub-components vary between 0.485 – 0.814 as presented in Table 3.

Table 3: The results of the first order CFA.

Item	**Procurement Problem**	Standardized Factor Loading	SE	t-test	SMC
PPP	Procurement process problems				
PP1	Officers lack of the skills to draft TORs and contracts.	0.824	1.00	**	0.679
PP2	Officers lack of the knowledge of the supplies and other regulations related to procurement.	0.840	0.34	30.309**	0.705
PP3	Some officers are worried that the information will leak.	0.696	0.54	14.735**	0.485
PP4	There are no clear criteria for defining performance measures.	0.755	0.54	16.550**	0.570
PP5	Officers lack of precision and are afraid of rules and regulations.	0.877	0.042	25.035**	0.769
PP6	Problems arising from fix announcement period especially with mandatory plan	0.850	0.047	21.868**	0.723
PP8	Problems arising from fix announcement period.	0.815	0.53	18.512**	0.664
PP9	Restrictions according to the regulations that all agencies need to send the announcement details by the approval date of procurement.	0.867	0.052	20.387**	0.751
PP10	Problems arising from unclear clarification.	0.881	0.058	18.720**	0.777
PP11	Problems arising from inadequate time for pricing.	0.876	0.051	20.697**	0.767
PP13	Problems arising from defining the mid-price, incomplete pricing, no allowance for loss, and inappropriate mid-price.	0.991	0.054	14.735**	0.752
PP15	Problems arising from referring to the mid-price defined by the Comptroller Genera's Department which the material price is not updated so that the offering price is higher than the mid-price. Moreover, the labor cost defined by Ministry of Commerce is not in consistence with current labor conditions.	0.718	0.062	13.831**	0.790
IEP	Internal and external influence problems				
PP26	Approved construction budget is not enough.	0.863	1	**	0.745
PP27	Changing executive affects the changes in utility and work progress.	0.794	0.046	20.523**	0.631
PP28	Problems arising from complex workflows.	0.880	0.043	22.702**	0.774
PP29	Officers have negative attitude toward their colleagues. Problems from different opinions and conflicts in the workplace.	0.875	0.046	22.405**	0.765
PP31	Problems arising from the impact of politics.	0.773	0.056	15.867**	0.598
PP32	Problems arising from external audits such as audit agencies and NGOs.	0.663	0.069	11.411**	0.658
PP33	Problems arising from the contractors not participating in biding or leaving their jobs.	0.757	0.053	17.472**	0.573
PP34	Problems arising from the bidders' complaints in procurement such as unclear announcement.	0.908	0.073	15.454**	0.684
PP36	Problems arising from the complaints from the community.		0.074	14.390**	0.599
PP37	Political and social problems such as protest.	0.776	0.049	18.234**	0.602
PP38	Economic problems such as rising material prices.	0.821	0.053	18.352**	0.675
PMTP	Project management and technical problems				
PP16	Problems arising from delayed work.	0.677	1	**	0.683
PP17	Problems arising from insufficient number of procurement officers.	0.790	0.088	13.031**	0.624
PP18	Problems arising from the officers' potential.	0.858	0.102	12.833**	0.736
PP19	Problems arising from the difficulty of working with several functions.	1.00	0.156	10.137**	0.747
PP20	Problems arising from coordinated errors.	0.843	0.103	12.679**	0.710
PP21	Problems of mismatch between construction models, and incomplete pricing.	0.926	0.116	11.988**	0.806
PP23	Problems arising from time conflicts.	0.131	0.141	11.901**	0.813
PP24	Problems arising from poor management.	0.899	0.099	13.308**	0.807
PP25	Problems arising from different working quality of each function.	0.902	0.099	13.386**	0.814

*Remark: ** is at the significant level of 0.01, and * is at the significant level of 0.05.*

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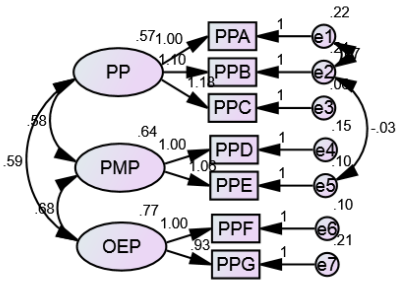
Second order CFA. According to the goodness of fit between the correlation coefficient from the evidence-based practice and the value synthesized by the construct formation by modifying the assumption based on the goodness of fit index, it has found that Chi-square value is not significant (p-value = 0.052) and relative Chi-square index is equal to 1.863. NFI, GFI, CFI, standardized RMR, and RMSEA are equal to 1.863, 0.994, 0.987, 0.997, 0.008, and 0.050 respectively. Therefore, all statistical indices pass the criteria, meaning that the second order component factor of government construction procurement problem is fit with the evidence-based practice as presented in Figure 3 and Table 4.

According to the factor loadings from the second order CFA, it is found that the model of government construction procurement problems has positive factor loadings in each component at the significant level of 0.05. This indicates that 3 components are important predictors for considering the government construction procurement problems. When considering each component in detail, it is found that procurement process component has the highest factor loading which is equal to 0.963, followed by internal problem (0.938) and technical problem (0.935). The reliability scores of measurement (R^2) of each component are between 0.722 – 0.928 showing that 3 components are important components of the government construction procurement problems as presented in Table 5.

These components are in consistent with the government construction procurement problems suggested by Dzuke & Naude (2015) stating that the components are procurement planning, bidding, and contract audit and compliance. Moreover, the concept of the procurement problem is in consistent with Gardenal (2013) stating that the components of procurement problems include supply planning and procurement process.



Chi-squre = 16.769, CMIN/DF = 1.863, df = 9, p = .052
NFI = .994, GFI = .987, CFI = .997, RAR = .008, RMSEA = .050

Figure 3: The results of second order CFA.

Table 4: Goodness of fit indices between the second order CFA model and evidence-based practice.

Index	Criteria	Before modification		After modification	
		Value	Result	Value	Result
X^2/df	< 3.00	5.398	Not pass	1.863	Pass
p-value of X^2	> 0.05	<0.001	Not pass	0.052	Pass
NFI	> 0.90	0.979	Pass	0.994	Pass
GFI	> 0.90	0.954	Pass	0.987	Pass
CFI	> 0.95	0.983	Pass	0.997	Pass
RMR	< 0.08	0.016	Pass	0.008	Pass
RMSEA	< 0.08	0.112	Not pass	0.050	Pass

Table 5: Factor loadings of government construction procurement problems from the second order CFA

Item	Procurement problem	Standardized Factor Loading	SE	t-test	SMC
PP	Procurement process problems				
PPA	Preparation and planning problems	0.850	1	**	0.762
PPB	Announcement and clarification problems	0.874	0.041	26.581**	0.880
PPC	Procurement process problems	0.963	0.045	25.960**	0.873
IEP	Internal and external influence problems				
PPE	Project management problems	0.898	0.036	29.361**	0.807
PPD	Technical problems	0.935	1	**	0.928
PMTP	Project management and technical problems				
PPF	Internal problems	0.938	1	**	0.764
PPG	External problems	0.873	0.036	25.988	0.722

Remark: ** is at the significant level of 0.01, and * is at the significant level of 0.05.

5. Conclusion

There are three components of government construction procurement problems in Thailand. The first component is *Procurement Process Problems* consisting of 3 component measures which are preparation and planning problems, announcement and clarification problems, and procurement process problems. The second component is *Project Management and Technical Problems* consisting of 2 component measures which are project management problems and technical problems. The last component is *Internal and External Influence Problems* consisting of 2 component measures which are internal problems and external problems. It is found that these 3 components can predict the procurement problems accounting for 82%.

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