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Factors Influencing Project Complexity in Construction Project A Case Study on Local Cambodian Constructions

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Abstract: The construction industry is a driver of growth in another sector due to its heavy reliance on an extended and varied supply chain. Like Cambodia as a developing country, the construction industry significantly contributed to the economic development and has created a lot of jobs. The construction becomes one of the important pillars supporting the Cambodian economy. However, the construction is typically more prone to the complexity of the project. Understanding the cause of project complexity in construction projects improves the efficiency of a local company and the success of projects. The study was carried out using a quantitative research method with 385 respondents from local construction companies, located in Phnom Penh city, Cambodia. The confirmation factor analysis (CFA) analysis the five important groups of project complexity: Environmental Complexity, Operational Complexity, Organizational Complexity, Technical Complexity, and Team Complexity. The findings are useful for local Cambodian construction companies in the avoidance of disputes and better improvement on customer satisfaction.

Index Terms **- Project Complexity, Environmental Complexity, Operational Complexity, Organizational Complexity, Technical Complexity, Team Complexity**

I.INTRODUCTION

Over the last few decades, the construction industry has increased in size, technology complexity, interdependencies, and variations in demands from clients (Yong, 2013). Global forecasts for the construction industry account for more than 11% of the global GDP and it is estimated that by 2020 it will account for 13.2% of the world's GDP (Betts et al., 2011). Cambodia's average annual economic growth has been around 7% for the last past 20 years, together with the garment industry, tourism, and agriculture, construction is the engine of the growth. The construction industry in Cambodia is booming due to rising foreign investments. The country's construction sector attracted a total investment of US$3.39 billion, which is an increase of 57% over the same period last year (Liyana Hasnan, 2019). Meanwhile, construction project activity in Cambodia has increased significantly in recent years, the construction sector is also facing many complex issues that cause loss of time and money, construction materials, and building safety problems accumulated over the entire building process, especially the dispute between parties involved in the construction project. Project Complexities are often unavoidable in construction. These projects are usually very complicated in nature (Chan et al., 2004). Project complexity also increases as a result of rapid changes in the environment, increased product complexity, and increased time pressure (Williams, 1999). The failure of a project can be interpreted as the failure of a contractor to meet the owner's requirements and satisfy them thoroughly. Understanding the factors affecting project complexity will boost project effectiveness and the satisfaction of the parties involved. This study will explore factors affecting project complexity in construction projects in Cambodia for local Cambodian construction companies.

II.NEED OF THE STUDY.

Complexity is considered an essential factor in the field of project management and the study. Nega, G. (2020) found that project complexity significantly affects the quality of construction projects. Nonetheless, the characteristics and nature of project complexity are a controversial debate. Project performance is closely related to project complexity; thus, it should be precisely measured to achieve effective management of projects (Abdou, S.M., Kuan, Y., & Mohammed, O., 2016). The term 'complexity' can be perceived through various connotations not only in different fields but also within the same field. Laurikkala, H., et al. (2001) stated that organization is the main type of complexity of the project. It includes the allocation of tasks, distribution of the responsibility and authority for decision-making, and designation of the relationship in terms of reporting and communication. Vidal, L.A., & Marle, F., (2008) highlighted the absence of unanimity on the technology conceptual definition has frequently been highlighted in the literature. Technology can be classified into three facets: characteristics of knowledge, characteristics of materials, and the equipment and sequencing of activities i.e. operations (Williams, T., 2002; & Baccarini, D., 1996). Abdou, S.M., Kuan, Y., & Mohammed, O., (2016) explore the five dimensions of project complexity such as:

1. Environmental complexity includes weather conditions, number of locations, interference between existing sites, number of different languages, and clarity of project goals.
2. Operational complexity including project duration, availability of financial sources, strict quality requirements, and a variety of tasks.
3. Organizational complexity includes uncertainty in methods, size of the project team, involvement of different time zones, and political influence.
4. Technical complexity includes lack of experience in the country, level of competition, and technical risks.
5. Team complexity includes lack of experience with partners, lack of resources and skills, and several project goals.

1	**Environmental Complexity**	**Code**
1.1	Weather conditions	PRC1
1.2	Number of locations	PRC2
1.3	Interference between existing sites	PRC3
1.4	Number of different languages	PRC4
1.5	Clarity of project goals	PRC5
2	**Operational Complexity**	
2.1	Project duration	PRC6
2.2	Availability of financial sources	PRC7
2.3	Strict quality requirements	PRC8
2.4	Variety of tasks	PRC9
3	**Organizational Complexity**	
3.1	Uncertainty in methods	PRC10
3.2	Size of a project team	PRC11
3.3	Involvement of different time-zones	PRC12
3.4	Political influences	PRC13
4	**Technical Complexity**	
4.1	Lack of experience in the country	PRC14
4.2	Level of competition	PRC15
4.3	Technical risks	PRC16
5	**Team Complexity**	
5.1	Lack of experience with partners	PRC17
5.2	Lack of resources and skills	PRC18
5.3	Number of projects goals	PRC19

III.RESEARCH METHODOLOGY

Saunders, Lewis, and Thornhill (2009) state that research methodology in a research study is considered an important element, and therefore determining the method of research methodology is a very important section of the study. The quantitative method is used in this study with primary and secondary data. The relevant data and information were gathered from top management of construction companies, contractors, country inspectors, national government officials, project owners, etc. who currently work at the site where located in Phnom Penh city in Cambodia. According to the report from the Ministry of Land Management Urban Planning and Construction, the number of construction and design companies registered is 1205 which 932 is a local construction company and 273 is foreign companies (MLMUPC, 2012). Most statisticians agree that 10% of the population is a good maximum sample size (Conroy, R.M., 2018). Therefore, in this study, the target site survey for local construction in Phnom Penh; is about 94 construction sites. And based on the Board of Engineers, Cambodia (2019), the total number of engineers is about 4014 registered including civil engineers, mechanical engineers, rural and geology engineers, electrical engineers, and architects. A sample is a subset of a population selected to participate in the study (Daniel, W.W., 1999) and it is a fraction of the whole selected to participate in the research projects. According to Daniel's formula (1999), the sample size in this research is defined in the following:

$$n = \frac{N*X}{X+N-1} \text{ and } \quad X = \frac{Z_{\alpha/2}^2 * p * (1-p)}{MOE^2}$$

Where:

$n = Sample\ Size$

$N = Total\ Population$ (4014)

$Z_{\alpha/2} = Critical\ value\ of\ the\ Normal\ Dirstribution\ at\ \alpha/2$

$MOE = Margin\ of\ Error$

$p = the\ largest\ posible\ proportion$ (0.5)

The total sample size in this research is 351 respondents using a value of the reliability of 5% (Z-value, 1.960), and a sampling Error of 5%. After collecting the data, data preparation is the first part of the process of transforming raw data into usable information (Hair, 2003), (1) data validation, (2) editing and coding, (3) data entry, (4) error detection, and (5) data tabulation. After making the necessary coding, Statistical Package for Social Science (SPSS) and AMOS were used to analyze the usage data collected from the respondents. The finding outputs are separated into two parts. First, is descriptive statistics describing a set of data in terms of its frequency and percentage for identifying the respondents such as: Gender, Education, Work experience, etc. And for the second part used structural equation modeling (SEM), correlation analysis, and reliability test to find the important factor of dispute in the construction projects in the case of local Cambodian constructions companies

IV.RESULTS AND DISCUSSION

4.1 Results of Descriptive Statics of Study Variables

Gender		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	120	31.2	31.2	31.2
	Male	265	68.8	68.8	100.0
	Total	385	100.0	100.0	

Major		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Civil Engineer	209	54.3	54.3	54.3
	Mechanical Engineer	4	1.0	1.0	55.3
	Electrical Engineer	57	14.8	14.8	70.1
	Architect	115	29.9	29.9	100.0
	Total	385	100.0	100.0	

Education Level		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Master Degree	98	25.5	25.5	25.5
	Bachelor Degree	286	74.3	74.3	99.7
	Undergraduate	1	.3	.3	100.0
	Total	385	100.0	100.0	

Year Experience		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 1 Year	11	2.9	2.9	2.9
	1-4 Years	216	56.1	56.1	59.0
	4-9 Years	121	31.4	31.4	90.4
	9-15 Years	36	9.4	9.4	99.7
	15-20 Years	1	.3	.3	100.0
	Total	385	100.0	100.0	

Project Role		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Main Contractors	104	27.0	27.0	27.0
	Sub-Contractors	1	.3	.3	27.3
	Inspector	71	18.4	18.4	45.7
	Site Engineer	12	3.1	3.1	48.8
	Project Owner or/and Client	1	.3	.3	49.1
	Consultant	71	18.4	18.4	67.5
	Designing Team	125	32.5	32.5	100.0
	Total	385	100.0	100.0	

Company Type		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Building Construction	207	53.8	53.8	53.8
	Finishing Work	72	18.7	18.7	72.5
	MEP Work	64	16.6	16.6	89.1
	Management	3	.8	.8	89.9
	Design & Consultant	39	10.1	10.1	100.0
	Total	385	100.0	100.0	

4.2 Reliability and Validity Analysis

Using Pearson Product Moment Correlation by SPSS program at a 5% of significance level, the critical value of the r_{xy} is 0.195 and the r_{xy} value obtained from the program is 0.573 > r_{xy} critical, Validated. Hair et al., (2006) the most common measure of reliability is the internal consistency of the scale. Cronbach's alpha coefficient can range from 0.0 to 1.0. Sekaran (2003) indicated the following table:

Close 1.0	High Internal Consistency Reliability
> 0.8	Is Considered Good
> 0.7	Is Considered Acceptable
Less than 0.6	Is Considered Poor

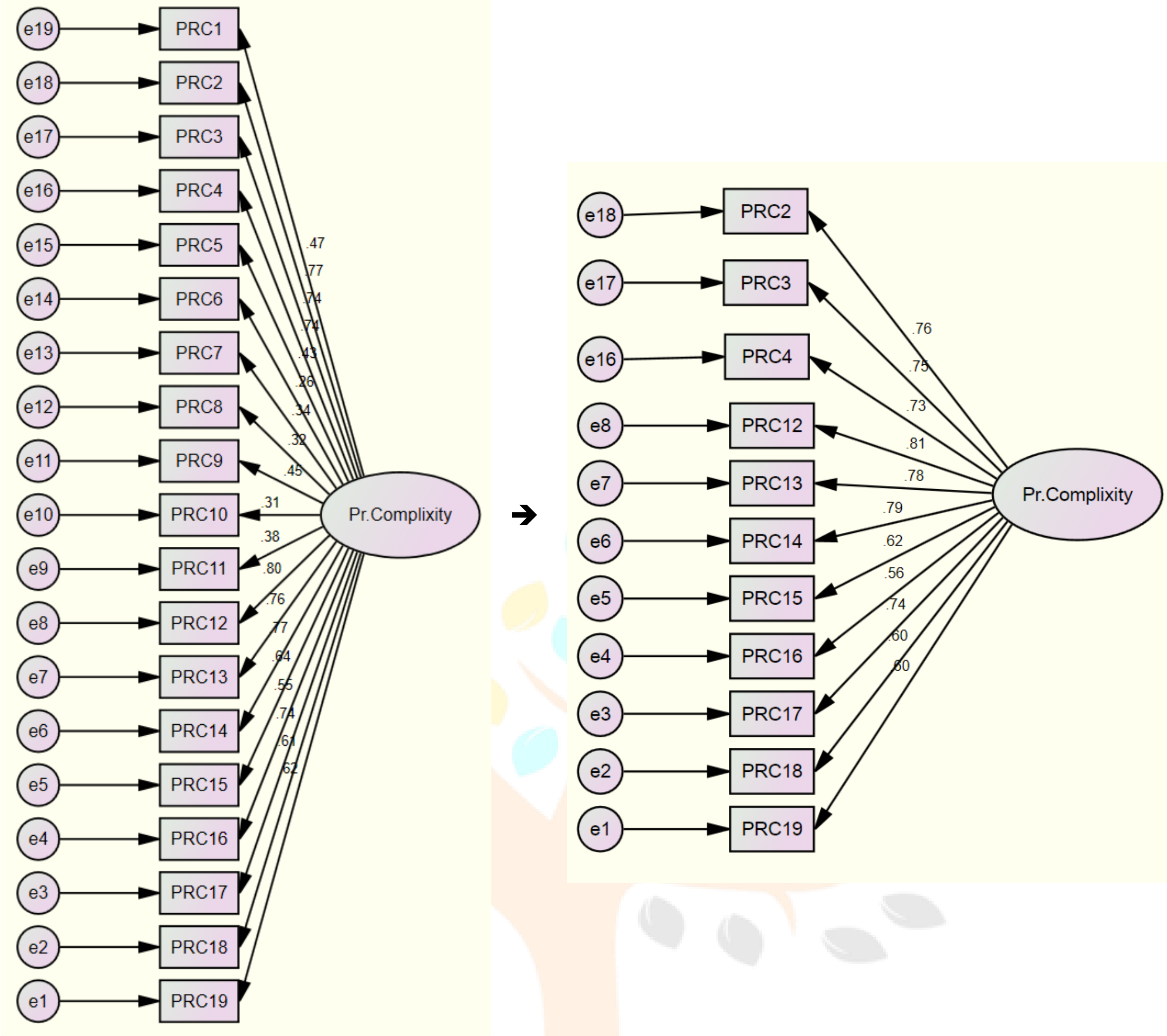
The result of the reliability test from SPSS is 0.902 which consider as good.

4.3 Factor Analysis

Factor analysis is used to uncover the latent structure of a set of variables. It reduces attribute space from a large number of variables to a smaller number of factors and as such is a non-dependent procedure. And to evaluate the criteria for the measurement model, CFA uses maximum likelihood (P-Value) estimation. To investigate the model's goodness of fit, several statistics were used overall χ^2 (Hooper et al., 2008), root means a square error of approximation (Steiger, 1990; Hooper et al., 2008). The model fit acceptance in AMOS comprises as the following indexes:

Acronym	**Explication**	**Accepted if**	**Reference**
Likelihood	P-Value	≥ 0.05	Joreskog & Surbon (1996)
CMIN/DF	Chi-square divided by degree of freedom	≤ 3 = acceptable fit ≤ 5 = reasonable fit	Kline (1998); Marsh & Hocevar (1985)
GFI	Goodness of Fit Index	1 = Perfect fit ≥ 0.95 = Excellent ≥ 0.90 = Good > 0.80 = Acceptable	Kline (2005); Hu & Bentler (1998); Steiger (1990); Hooper et al. (2008)
CFI	Comparative Fit Index	1 = Perfect fit ≥ 0.95 = Excellent ≥ 0.90 = Good > 0.80 = Acceptable	West et al. (2012); Fan et al. (1995); Steiger (1990); Hooper et al. (2008)
RMSEA	Root Mean Square Error of Approximation	> 0.10 = Poor < 0.10 = borderline fit < 0.08 = acceptable fit ≤ 0.05 = excellent fit	MacCallum et al (1996); Steiger (1990); Hooper et al. (2008)

ID	**Weight**	**Status**	**CFI**	**Status**	**GFI**	**Status**	**RMSEA**	**Status**
PRC1	0.47	NO	0.741	unacceptable	0.767	acceptable	0.121	poor
PRC2	0.77	OK						
PRC3	0.74	OK						
PRC4	0.74	OK						
PRC5	0.43	NO						
PRC6	0.26	NO						
PRC7	0.34	NO						
PRC8	0.32	NO						
PRC9	0.45	NO						
PRC10	0.31	NO						
PRC11	0.38	NO						
PRC12	0.80	OK						
PRC13	0.76	OK						
PRC14	0.77	OK						
PRC15	0.64	OK						
PRC16	0.55	OK						
PRC17	0.74	OK						
PRC18	0.61	OK						
PRC19	0.62	OK						



From the result above, we observe the construct measurement weight is below 0.50. So, we omit items PRC1, PRC5, PRC6, PRC7, PRC8, PRC9, PRC10, and PRC11 to model fit.

ID	Weight	Status	CFI	Status	GFI	Status	RMSEA	Status
PRC2	0.77	OK	0.903	good	0.900	good	0.114	poor
PRC3	0.74	OK						
PRC4	0.74	OK						
PRC12	0.80	OK						
PRC13	0.76	OK						
PRC14	0.77	OK						
PRC15	*0.64*	*OK*						
PRC16	*0.55*	*OK*						
PRC17	*0.74*	*OK*						
PRC18	*0.61*	*OK*						
PRC19	*0.62*	*OK*						

4.4 Structural Equation Modeling

Structural equation modeling (SEM) is a set of statistical techniques used to measure and analyze the relationships between observed and latent variables. Similar but more powerful than regression analyses (Tanya, N., & Claudio, V., 2010). Xia et al., (2015) introduce three steps to test the structural model hypothesis framed work.

4.4.1. Asses reliability and validity of model measurement

From the 11 construct measurements after CFA, the compound reliability (C.R) obtains 0.94 > 0.7 showing Good. In addition, the convergent validity of model measurement (AVE) is equal to 0.50 which is also acceptable. Moreover, the discriminant validity of model measurement is better after we dropped some items PRC15, PRC16, PRC17, PRC18, and PRC19 since those items have a regression weight score little.

4.4.2. Structural model fit

The predicting capability of the model can be done by the sum of the variance of independent variables in the dependent variables (Xia et al., 2015). The superior value is assumed by most potential. In SEM analysis, the value of variances is calculated by squared multiple correlations associated with dependent variables. Squared multiple correlations (R) are called the coefficient of determination which is defined as the proportion of the total variation explained by the model.

Squared Multiple Correlations	Estimate
PRC2: Number of locations	.549
PRC3: Interference between existing sites	.597
PRC4: Number of different languages	.572
PRC12: Involvement of different time-zones	.629
PRC13: Political influences	.631
PRC14: Lack of experience in the country	.590

Hair, Babin, & Anderson (2019) suggest that loadings of the items should be at least 0.50 and ideally 0.70. Higher loadings indicate that items are strongly related to latent variables. The squared multiple correlations of the dependent variables of the study is 0.835

4.4.3. Refined model measurement into SEM

After eliminating in section 4.4.1, we observed model is fit. The value of CMIN/DF (4.493 < 5, Ok), GFI (0.909 > 0.8, Ok), CFI (0.921 > 0.8, Ok), RMSEA (0.095 < 0.10, Acceptable), and convergent validity of the factors are more acceptable which value is bigger than 0.50.

4.5 Discussions

The study shows some important factors affecting the Project Complexity in the construction project. The six most important factors influence the complexity of the construction projects such as: 1-Number of locations (0.741), 2-Interference between existing sites (0.773), 3-Number of different languages (0.756), 4-Involvment of different time-zones (0.793), 5-Political influences (0.794), and 6-Lack of experience in the country (0.768).

In short, to get a good quality construction project one needs to be well prepared for Environmental issues such as several locations, interference between existing sites, and several different languages. Many site locations can make site engineers and parties involvement cannot focus on each site properly. Communication among parties' involvement in different languages also make misunderstandings. Since many locations and parties are involved, different time-zone can overlap and conflict with workflow. To get a good quality construction project, the motivation of employees to be observable deeply, which is influenced by the organization's policy. The last factor is the lack of experience among the parties involved. Changing sub-contractor and labor will make a site a new experience in both communication and technology. New sub-contractor or laborers make another new technology on the existing site.

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