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Conceptual Model of Critical Factors Affecting Performance of Construction Sites in Vietnam

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ABSTRACT

With the economic development, Vietnamese construction industry also progresses at a brisk pace and accounts for major factor of economy. Therefore, it is necessary to make the industry more efficient and effective in terms of better utilization of resources. Part of the most important resources include materials, time and cost. However, there are many problems such as wastes and losses of resources, cost overrun, time delay, and low quality, which lead to reduce the performance of construction site, need to be addressed. The objective of the study outlined in this paper is to construct a conceptual model of critical factors affecting performance of construction sites in Vietnam; the performance of construction sites is defined under form of cost and time. A survey was carried out and found out 25 key factors that influence on the performance of construction sites. The factor analysis revealed that these factors could be grouped into six major factors, namely, (1) management, (2) human resources, (3) technology, (4) finance, (5) material/equipment, and (6) design. Finally, multiple linear regression was applied to identify level of influence of each factor group on the performance of construction sites. The findings of this study can help the contractors to focus on the most important factors to upgrade their competency.

Keywords: *Construction performance, Key factors, Multiple Linear Regressions, Cost and time, Vietnam*

1. INTRODUCTION

In the present competitive environment of the furious construction market along with increasing higher user's requirements, Vietnamese contractors are faced with the demand to improve their competency, especially regarding construction performance. This demand is not only caused by the domestic contractors but the international contractors who have been joining the Vietnamese construction industry. In order to acquire it, they need to improve their management skill, technology, human resources, finance, etc.

The study on the factors that influence on the construction performance can help the contractors to focus on the most important factors to upgrade their competency. However, there are very few studies conducted so far in Vietnam. To meet the above demand on studying the factors affecting on performance of construction projects, this paper focuses on the following objectives:

- To review preliminary factors affecting project performance in construction phase in Vietnam.
- To develop a conceptual model of critical factors affecting performance of construction sites in Vietnam.
- To recommend appropriate solutions for improving performance of construction sites in Vietnam.

2. LITERATURE REVIEW

Investigation of factors impacting performance of construction project has attracted the interest of many researchers and practitioners. Table 1 represents the summary of research results relating performance of construction projects.

Table 1: Summary of research results relating performance of construction projects

Authors	Research objectives	Summary of research results
Iyer, K.C. and Jha, K.N. [1]	To identify factors affecting cost performance of construction projects in India	• 55 success and failure attributes relating to the cost performance of construction projects • 07 critical success factors which are: (1) project manager's competence; (2) top management support; (3) project manager's coordinating and leadership skill; (4) monitoring and feedback by the participants; (5) coordination among project participants; (6) owners competence and (7) favorable climatic conditions
Alwi, S. [2]	To identify factors influencing construction productivity in the Indonesian context	• Their causes influenced by three issues: (1) characteristics of contractors; (2) inadequate

		management strategy; and (3) organization's focus • The author proposed that the performance of projects would be increased, when identifying and eliminating waste during construction process
Makulsawatudom, A., Emsely. M., and Sinthawanarong, K. [3]	To identify critical factors influencing construction productivity in Thailand	• 23 factors affecting construction performance • Ten most significant factors to improve construction performance in Thailand are lack of material, incomplete drawings, incompetent supervisors, lack of tools and equipments, absenteeism, poor communication, instruction time, poor site layout, inspection delay and re-work
Mojahed, S. [4]	To study a project improvement system for effective management of construction projects	• 36 factors affecting construction performance • The top five components are skills and experience of workforce, job planning, worker motivation, management, and shortage of skilled labour
Enshassi, A., Mohamed, S., Mustafa, Z. A., and Mayer, P. E. [5]	To identify factors affecting construction performance in Palestine	• 45 factors, affecting labour productivity in building projects, divided into 10 groups: manpower, leadership, motivation, time, materials/tools, supervision, project, safety, quality, and external factors
Nguyen A. T. [6]	To identify factors affecting to cost overrun and time delay	• 10 factors affecting to cost overrun and time delayed including lack of experience of project management team, lack of capital ability of investor, supervision and organization at site, lack of capital ability of contractor, changes of design, fluctuation of constructional material price, difference between designed condition and actual condition, inadequate cost estimate and contingency amount, mistakes from design process, and late payment for the finished items
Tran V. T. [7]	To identify factors affecting to cost performance	• 12 similar factors affecting to cost performance such as: compensation and design changed by owner; lack of experience and accountability, mistake in survey and mistake in design of consultant; mistake in construction, lack of capital ability, lack of experience in management, inadequate bidding price, inadequate bill of quantity from the contractor; and fluctuation of constructional material price and improper implementation time
Saqib, M., Farooqui, F., and Lodi, H.S. [8]	To access critical success factors (CSFs) for construction projects in Pakistan	• Seven groups of factors which have a tendency to impact on the success of the construction projects in Pakistan • The top five CSFs are (1) Contractor-related factors, (2) Project manager-related factors, (3) Procurement-related factors, (4) Design team-related factors and (5) Project management factors
Razak, A., Jaafar, M., Abdullah, S., and Muhammad, S. [9]	To identify the work environment factors which affect to the performance of project managers within a construction firm	• The authors applied Friedman test – a kind of non parameter test to rank the 12 factors • This research considered the role of the project manager as the core of the problem to impose the success of a project
Masrom, M. A. and Skitmore, M. [10]	To develop a model to measure the performance of construction	• This research depicted two key elements to access the contractor satisfaction (Co-S) level of

	projects	performance attributes • The performance of construction projects is measured through two key components: 1. Direct attributes: They are performance attributes which consist of some elements such as participant's performance (service quality), project performance, business performance, and external factors 2. Indirect attributes: They are also known as contractor characteristics that include some elements such as knowledge, size of the organization, experience and culture

3. INITIAL RESEARCH MODEL

After doing the literature review, 31 factors were extracted and they were divided into 10 groups of factors. The initial research model of this study based on 10 these groups of factors with the dependent variable is "Performance of construction sites" and is shown as figure 1.

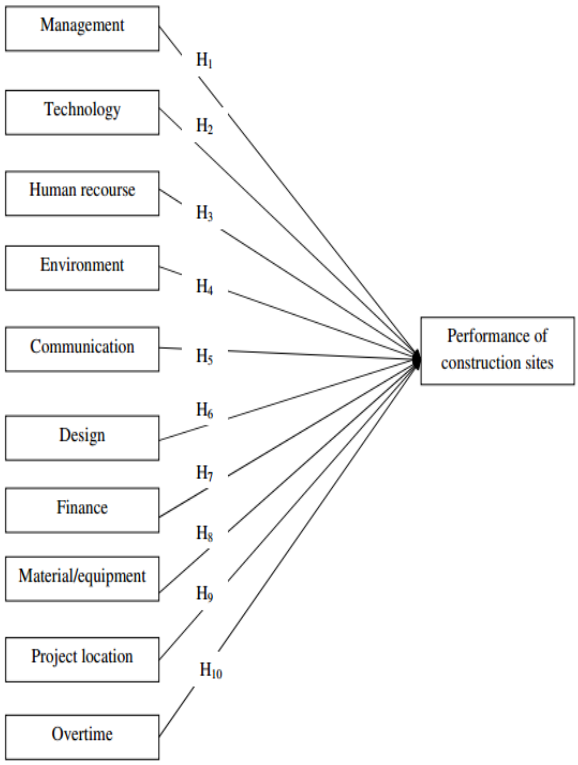

Fig 1: Initial research model

The hypotheses of the above models are summarized in **Table 2**.

4. RESEARCH METHODOLOGY

4.1 Research Procedure

A research framework was drawn in step-by-step as shown in Figure 2. This study was conducted in 7 states which are literature review, design questionnaire and pilot test, data collection, reliability test, exploratory factor analysis, multiple linear regressions, and last with conclusions.

4.2 Data Collection

From the results of the pilot test and interviewing the five experts working in the construction industry for more than 10 years, 30 factors were taken into consideration for research. These factors were divided into eight groups: management, technology, human resource, communication, design, financial capability, material/ equipment, location.

Table 2: The hypotheses of initial research model

Hypothesis	Description
H_1^+	The higher the level of project management, the higher the performance of construction sites.
H_2^+	The higher the level of advanced technology application, the higher the performance of construction sites.
H_3^+	The higher the quality of human resource, the higher the performance of construction sites.
H_4^+	The better the condition of environment; the higher the performance of construction sites.
H_5^+	The better the communication among stakeholders; the higher the performance of construction sites.
H_6^+	The higher the quality of the design; the higher the performance of construction sites.
H_7^+	The better the financial condition of the contractor; the higher the performance of construction sites.
H_8^+	The better the condition of material/equipment supply; the higher the performance of construction sites.
H_9^+	The better the condition of material/equipment supply; the higher the performance of construction sites.
H_{10}^-	The more the overtime is applied; the lower the performance of construction sites is gained.

Data were collected in four cities/ provinces in which construction industry has been considered as the top development in Vietnam. There were 220 questionnaires sent out, however, there were only 155 feedbacks. After filtrating data carefully, there were 147 answers can be used to analyze. Data were described as follows:

- **Position of Respondents:** Among 147 items collected from this survey, there are nine top managers equivalent to 6.1% of the sample size, 46 functional/project managers equivalent to 31.3% of the sample size, 62 engineers equivalent to 42.2% of the sample size and 30 other types of staffs equivalent to 20.4% of the sample size.

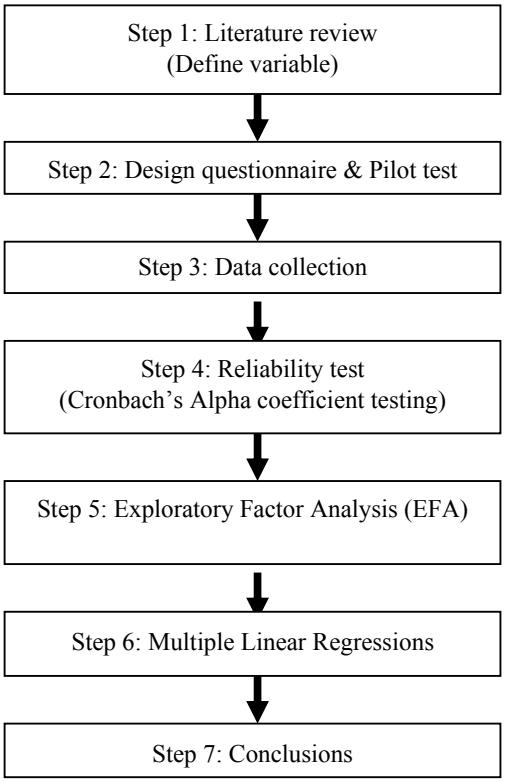

Fig 2: Research framework

- Experience of respondent: This survey includes 53 respondents who have less than five years experience equivalent to 36.1%, 49 respondents who have from five to 10 years experience equivalent to 33.3%, and 45 respondents who have more than 10 years experience equivalent to 30.6% of the sample size.

- Type of related party: This survey includes 10 respondents who work for Owners equivalent to 6.8% of the sample size, 68 respondents who work for Designers/Consultants equivalent to 46.3% of the sample size, 68 respondents who work for Contractors equivalent to 46.3% of the sample size and one respondent who works for other type of related party equivalent to 0.7% of the sample size.

- Scale of projects ever done by respondents: In this survey, there are 90 respondents who have carried out the projects from 1 million – 5 million USD equivalent to 61.2% of the sample size, 37 respondents who have carried out the projects from VND 5 million – 25 million USD equivalent to 25.2% of the sample size, and 20 respondents who have carried out the projects more than 5 million USD equivalent to 13.6% of the sample size.

5. ANALYSIS AND FINDINGS

5.1 Testing for Measurement Scale

After comparing means of collected factors, one factor of "Communication" group and three factors of "Location" group are deleted because their mean less than 3.6. The remaining seven groups including 26 factors will be tested next steps to evaluate the reliability and relevance of the measurement scale.

Correlation analysis was executed to find out the correlation between the variables within each factor group. Most of the correlation levels are higher than 0.3. According to Field [11], this result proves the relevance of the factor groups for the Factor Analysis next steps. That

means all remaining 26 factors are strongly correlated to each other in a group.

5.2 Testing Cronbach's Alpha Coefficient

Cronbach's Alpha coefficient (α) is computed by the software SPSS version 16.0 as the following formula:

$$\alpha = \frac{k}{k-1} * \left[\frac{1 - \sum S_i^2}{S_t^2} \right] \quad (1)$$

In which:

- k: number of individual items.
- S_i^2: Variance of the variable k.
- S_t^2: Variances of the sum of all items.

The Cronbach's alpha coefficient was used to test the reliability of the five-point scale. It determines the internal consistency among the factors. The acceptable lower limit for the Cronbach's alpha is usually considered to be 0.7, although values as low as 0.6 are sometimes acceptable for exploratory research (Hair et al. [12]). All Cronbach's Alpha coefficients if Item Deleted of the factors are bigger than 0.6, and the five-point scale measurement was therefore reliable at the 5% significance level. In addition, the correlation of every item compared with the total correlation is larger than 0.5. Therefore, all factors will be maintained for next analysis.

5.3 Factor Analysis

The result from SPSS software shows that KMO = 0.855 > 0.5 and the value Sig. < 0.05. According to Field [11], these factors are relevant for Factor Analysis.

Based on the result of Factor Analysis extracting from SPSS software, there is one item "Education level of site management unit members" that has the Communality value less than 0.5. So, this item will be deleted from the data set. And the remaining data set will include only 25 items.

Factor Analysis will be applied again with the remaining data set including 25 items to reduce the number of factors down to a reasonable amount. This time, the Factor Analysis result from SPSS software (**Table 3**) shows that KMO = 0.853 > 0.5, Sig. < 0.05 and Communalities of all items are more than 0.5.

5.4 Multiple Linear Regressions

After applying Factor Analysis, the research model is reduced to 25 items. These items were grouped into: Management, Resources of Contractor, Technology, Finance, Material/Equipment, and Design (Figure 3). Consequently, the research model will be revised as follows:

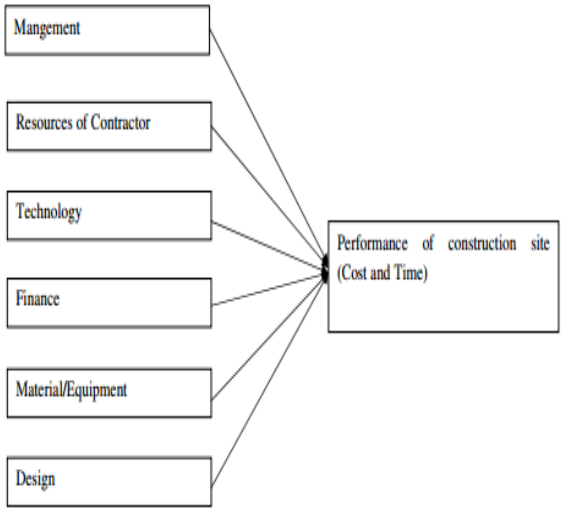

Fig 3: Revised model after EFA

Multiple Linear Regression will be applied to identify level of influence of each factor group on the performance of construction sites. In this research, the performance of construction sites is evaluated by the two dependent variables Cost and Time difference. The Ordinary Least Square (OLS) regression method is applied to analyze regression.

The factors influencing on the performance of construction site are filtrated and revised to six factor groups. These factor groups will be used as the input of Linear Multiple Regression model of SPSS by Enter method. The result of this Multiple Regression is shown as follows:

$$Y_1 = 19.313 + 1.093X_1 + 0.824X_2 + 0.913X_3 + 0.553X_4 + 1.008X_5 + 0.4X_6 + e. \quad (2)$$

$$Y_2 = 1.871 + 1.608X_1 + 1.304X_2 + 1.319X_3 + 1.072X_4 + 1.283X_5 + 1.045X_6 + e. \quad (3)$$

In which:

- Y1: Cost difference of construction sites.
- Y2: Time difference of construction sites.
- X1: Factors relating to management.
- X2: Factors relating to Resources of Contractor.
- X3: Factors relating to technology.
- X4: Factors relating to finance.
- X5: Factors relating to material/equipment.
- X6: Factors relating to design.

Table 3: KMO and Bartlett's test (re-calculating with 25 factors)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.853
Bartlett's Test of Sphericity	Approx. Chi-Square	1765.096
	df	300
	Sig.	0

5.5 Relevance Testing for the Regression Model

The relevance of the research model will be evaluated by some methods such as computing R square, F – statistic test, t – statistic test.

- Testing the relevance of the regression model by R square.

In the regression model, to explain the influence of factors on the cost and time difference, the R square is 0.301 and 0.762 respectively. This means that six independent variables in the model can explain 30.1% of the variance of the cost difference and 76.2% of the variance of the time difference.

Normally, in social economic research, R square can only explain around 25% of the variance of the dependent variable. So, the R square of this research can be considered rather high.

- Testing utility of model

F – Statistic test is carried out by Analysis of Variance (ANOVA) to consider whether the research sample can be generalized for the whole population or not. Based on the ANOVA table of both regression model of Cost and Time difference, the Sig. are less than 0.001, so the hypothesis R square of population = 0 is rejected. Therefore, there is at least one independent variable influencing on the variance of the dependent variables.

5.6 Testing the Assumption Violations of Linear Regression

The Linear Regression has its statistic meaning when the assumptions are not violated.

- Violation of linearity: in order to test this assumption, the Scatter Plot diagram with the Standardized Residuals on vertical axis and Standardized Predicted Value on the horizontal axis can be used. The residuals are relatively scattered at random. Thus, the assumption about linearity is not violated.

- Violation of constant variance of the errors: the results indicated that the Standardized Residual and Standardized Predicted Value vary differently and randomly. So, this can be concluded that the assumption of constant variance of the errors is not violated.

- Violation of normality of the error distribution: to do this, the histogram will be used to evaluate as shown in Figure 4. It is easy to realize that the error distribution is approximately the normal distribution (Mean ≈ 0 and Std. Dev. ≈ 1). So, the assumption about normality of the error distribution is not violated.

- Violation of independence of the error: to test this assumption, Durbin-Watson (d) value will be calculated. Normally, "d" value will vary from 0 to 4. If there is no serial correlation between Residuals, "d" value will be equivalent to 2. Durbin-Watson value calculated in case dependent variable is cost and dependent variable is time respectively is 1.822 and 2.056. So, it can be considered there is no violation of independence of the error.

- Violation of collinearity: in both cases the dependent variable is cost and time, the Variance Inflation Factors are very small. Therefore, this assumption is not violated.

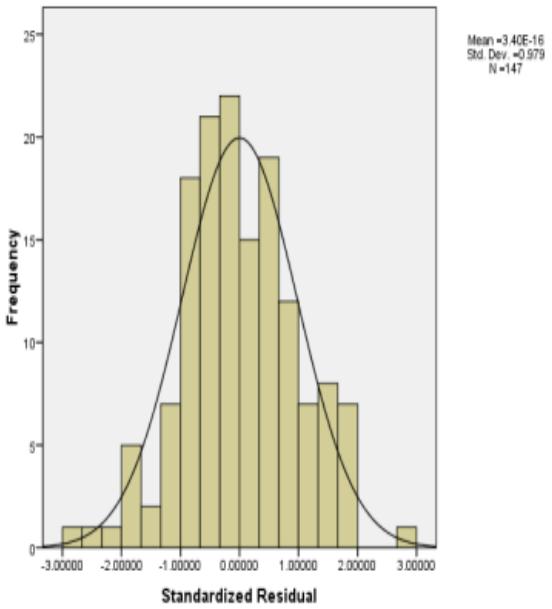

Fig 4: Histogram in case dependent variable is time

6. CONCLUSIONS

This research has developed and tested a model including 25 items remaining to be considered influencing on the performance of construction sites. These items are divided into 6 groups. They are ranked as following order management, technology, resources of contractor, material/equipment, finance and design. The contractors should allocate their limited resources on necessary fields

so that they can improve the performance of their construction sites.

7. RECOMMENDATIONS

- To improve management capacity: This paper confirmed the critical role of management knowledge in performance of construction sites. Project management performance is a kind of team work. It needs a smooth operation of every related provision of every related organization. As a result, the understanding and implementing by all related members at any levels in construction firms is requirements. It should be started from the highest top management to the lowest management staffs of. This management knowledge even should be updated and upgraded continuously to catch up the development of management science.

- To optimize limited resources of a contractor: Resources of a contractor include different kinds of assets in which, according to this study, the most valuable things are Human Resource and Information. In many situations, a contractor has to face with the difficulty of lacking of high quality workforce and valuable information. If they don't allocate their resources reasonably, they will cause a lot of waste in using their resources.

- To invest strongly into technology: The significant progress of science and technology has influence a lot on the productivity of every industry. Especially, the construction industry is usually deal with many kinds of challenging and complicated tasks. If contractors don't achieve a certain level of technology, it's impossible for them to carry out many jobs in construction works.

- To maintain healthy financial condition by pushing cash flow turnover: Operation of construction contractors depends a lot on their financial conditions. If they cannot keep their financial status healthy, they cannot keep their construction sites operated smoothly. In order to do this, it requires a proper co-ordination between functional departments in a construction company. It requires a good operation of the project management team to deliver the bill of interim claim in time. Then the accounting department should carry out its job to push the payment under the contract conditions.

- To prepare a good material supply plan and implement it strictly: The construction sites cannot be operated without materials. However, it usually takes time for the contractors to prepare and deliver materials at the site. Normally, there is a procedure from catalogues, sample and specifications presentation for the clients and consultant to approve to ordering and delivery the materials at the site. Especially, it takes very long time if materials are imported from foreign countries. Therefore, the contractors need to prepare for the material supply plan very well to cope with any difficulty at the beginning of the project. Otherwise, it will influence extremely to the site progress.

- To pay much attention to the design: Obliviously, the design is the guideline for contractor to follow. However, in many circumstances, it makes a lot of trouble for the construction sites. This may happen because of many possible reasons. Usually, the designers may not understand clearly how an item being constructed at the site. As a result, their solutions may not be unrealistic. The contractors who execute the tasks directly will know exactly which is the best solution for construction site operations. Thus, the contractors should review and suggest their solution if they can. So the progress of the construction sites will not be influenced by any possible revision of the design.

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