MODELING THE TECHNOLOGY TRANSFER PROCESS IN THE THAI CONSTRUCTION INDUSTRY: A PILOT STUDY

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ABSTRACT : Technology transfer (TT) has been defined as the shared responsibility between the source and the destination for ensuring that technology is accepted and at least understood by someone with the knowledge and resources to apply and/or use the technology. The adoption of TT in construction industries is necessary for economic growth to occur in developing countries such as Thailand. This process should provide numerous benefits for the host sector in areas such as increased productivity, enhancement of product quality, cost savings, improvements in market share and entry to new markets. However, there are many factors, which may impact on the TT process and its subsequent outcomes for Thai construction firms and individuals, including, the transfer environment, learning environment, transferor characteristics and transferee characteristics. The performance and interaction of these enablers will influence the degree of value added to the local construction sectors in areas such as economic advancement, knowledge advancement and project performance. This paper presents a conceptual framework for international TT that accommodates the numerous factors believed to impact on the processes effectiveness. Through a Pilot Study, where 27 industry professionals from Thailand were interviewed, the significant factors which impact on the TT process have been identified along with the strength of interrelationship between individual and groups of factors. Future research seeks to target a greater sample of respondents with the view to validate the conceptual model and apply it on a number of large Thai projects where international TT was incorporated into the project agreement.

Key words : Technology transfer, transferor, transferee, developing countries

1. INTRODUCTION

International technology transfer from developed to developing countries continues to stimulate rapid industrialization and economic growth globally, particularly in the fast growing newly industrialized countries [1]. Numerous researchers have defined TT differently. Differences in definitions stem from the diverse fields of study of individual researchers. Tatum [2] provides one of the most relevant definitions for TT in the construction industry. He defined TT as the transfer of a combination of materials and equipment resources, construction-applied resources and construction processes within project requirements and constraints. For this research, TT has been defined as the transfer of knowledge, material or equipment from one party (organization or person) to another party that arranged to receive it.

The process of TT in the construction sector includes many factors that can impact on its' effectiveness. These factors can be broadly defined as enablers; it is the interrelationship between the enablers that ultimately determines the success of the project and the value-added via the TT process. This paper provides a summary of enabling and outcome factors for the TT process and illustrates the refined conceptual model for international TT.

2. CONCEPTUAL MODEL

A number of researchers have developed TT models in the past few decades. However, none of these models address the process of international TT in the construction industry. A comprehensive literature review was undertaken to closely examine existing TT models and critique associated factors (see Table 1). As a result, several factors were determined, which represent enablers of the TT process and contribute to the degree of value added to the host countries construction firms and individuals. In total, four TT enablers were established, namely, transfer environment, learning environment, transferor characteristics and transferee characteristics (Table 1). Moreover, the value-added through

the implementation of TT initiatives can be measured across three different categories: economic advancement; knowledge advancement; and project performance (Table 1).

The transfer environment construct is concerned with the environment in which the technology is being transferred from and the mode of transfer. The learning environment construct is concerned with the relationship and communication between transferor and transferee and the effectiveness of implemented transfer programs. Transferor and transferee characteristics describe the characteristics of the technology transferor (foreigner) and receiver (host). The economic advancement construct is concerned with the degree to which TT has improved the hosts' economic prospects. The knowledge advancement construct is concerned with measuring how knowledge has developed at the individual and organizational level. The project performance construct is concerned with improvements in financial, schedule and quality performance.

A conceptual model for international TT has been developed (Figure 1). The relationship between the above-mentioned constructs is represented by six hypotheses, described below:

- H1: A supportive transfer environment should lead to an enhanced learning environment.
- H2: Appropriate transferee characteristics should enhance the effectiveness of the learning environment.
- H3: Appropriate transferor characteristics should enhance the effectiveness of the learning environment.
- H4: An effective learning environment should enhance the degree of value derived from the TT process.
- H5: Appropriate transferor characteristics may enhance the degree of value derived from the TT process.
- H6: Appropriate transferee characteristics may enhance the degree of value derived from the TT process.

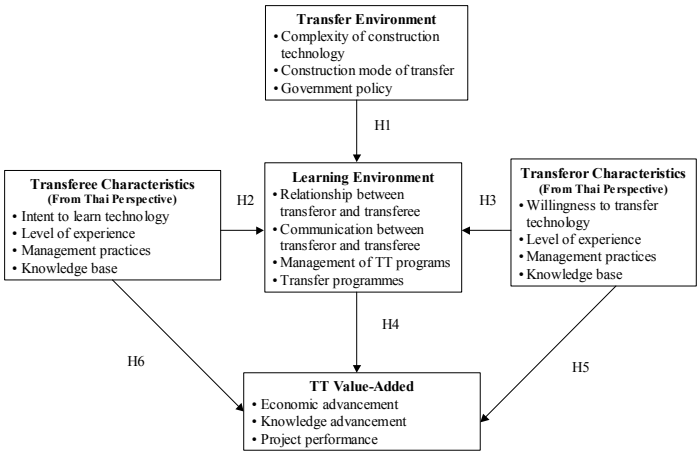

Figure 1. Conceptual model for international TT in construction

Table 1. TT model factors

Factors	Sub-factors	Ref.
Enablers		
Transfer environment construct	Complexity of construction technology Construction mode of transfer Government policy	[3-4]
Learning environment construct	Relationship between transferor and transferee Communication between transferor and transferee Management of technology transfer program Transfer programs	[3, 5-8]
Transferor characteristics construct	Willingness to transfer technology Level of experience Management practices Knowledge base	[6-8, 9-10]
Transferee characteristics construct	Intent to learn technology Level of experience Management practices Knowledge base	[6-10]
TT value-added		
Economic advancement	Competitiveness Performance improvement	[9]
Knowledge advancement	Improved knowledge Improved working practices Long-term adoption of transferred skills	[11-12]
Project performance	Financial performance Schedule performance Quality performance	[13]

3. RESEARCH METHOD

A pilot study was undertaken in January 2005 with construction professionals in Thailand. The target group of respondents includes design and construction professionals from construction projects involving TT initiatives. In total 70 pilot study surveys were distributed, and 27 were returned, representing a response rate of 39 per cent for the pilot study. The objective of this study was to test the validity and reliability of the data obtained and refine the questionnaire survey for the primary study. Statistical analyses was undertaken to derive the mean and standard deviation, correlation between variables, and regression scores. The questionnaire survey contained two parts with 29 questions in total. Part one examined the TT process enablers and their associated sub-factors, including: transfer environment; learning environment; transferor characteristics; and transferee characteristics. Part two focused on measuring the outcomes of the TT strategy in the following categories: economic advancement, knowledge advancement; and project performance. Other information was also solicited from respondents, such as, years of experience, position, education, etc. This section was included to ensure that information was received from valid sources.

Each question in the survey required the respondents to provide a rating of the importance (column A) and effectiveness (column B) of TT enablers and outcomes

factors. Column A asked respondents for their opinion about statements related to TT, ranging from 'strongly disagree' to 'strongly agree'. Column B seeks to gain information about respondents' perception of TT factors effectiveness/success in the construction environment, based on their experience. Specifically, they were requested to rate the effectiveness/success of factors highlighted in the statements ranging from 'very low' to very high'.

4. DATA ANALYSIS AND RESULTS

The respondent rate obtained for the pilot study was 39 per cent (27 respondents). A total of 27 complete questionnaires were deemed appropriate for analysis for the pilot study stage of the research project. The pilot study was a useful tool for this research investigation to: refine the data collection procedure; refine the questionnaire survey for the primary study; and examine the validity of the data analysis process.

Table 2 details the mean and standard deviation for each variable in the survey for both columns A and B. Mean values recorded in column A ranged from 3.30 to 4.33, and in column B ranged from 3.00 to 3.81, which suggests that all questions, representing variables, in the conceptual model are important for modeling the TT process. The standard deviation for both columns A and B was generally lower than 1 indicating that most of the respondents had similar responses to the provided statements (questions). The responses provide support for using the developed variables to model the TT process in construction and justify their inclusion in the main questionnaire survey investigation. It should be noted that column A results are consistently higher than column B. This trend suggests that most respondents agree that the presented variables are important for evaluating the TT process and its' outcomes, but from their practical experience, they believe that the variables are only performing at an adequate level.

Correlation analysis was undertaken for each construct in the proposed model. The objectives of the correlation analysis were to gauge the relationship between variables within each construct and between variables from different constructs of the conceptual model. The highest correlation value (0.854) between two variables was E 2.2.1 (clear understanding) and E 2.1.2 (mutual trust) at the 0.01 level of significance. This suggests that a clear understanding of TT goals and objectives and effective communication between the transferor and transferee requires mutual trust between parties. Without effective communication, stakeholders may not trust each other, which may adversely reduce the effectiveness of TT process. The lowest correlation coefficient value (0.381) at the 0.05 level of significance exists between E 1.3.1 (government policy) and E 4.4.1 (transferee's knowledge base) suggesting that a governments' policy for encouraging TT in the host nation has very little effect on the knowledge base of the technology transferee. This makes sense, as government policies don't include strong regulations for selecting participants in TT projects.

Table 2. Mean values for TT model factors

Code	Descriptions	Mean Column A	Std. Dev. Column A	Mean Column B	Std. Dev. Column B
E1	*Transfer Environment*				
E 1.1	Construction project	3.48	1.01	3.52	0.64
E 1.2	Construction mode of transfer	3.48	0.85	3.37	0.63
E 1.3.1	Government policy	3.78	1.22	3.00	0.88
E 1.3.2	Government enforcement	3.30	1.33	3.00	1.07
E2	*Learning Environment*				
E 2.1.1	Relationship	3.44	1.19	3.15	1.06
E 2.1.2	Mutual trust	3.96	0.85	3.63	0.84
E 2.2.1	Clear understanding	4.19	0.74	3.78	0.85
E 2.2.2	Effective communication	4.30	0.78	3.81	0.92
E 2.3.1	Commitment	3.96	0.71	3.59	0.69
E 2.3.2	Teamwork	3.85	1.10	3.67	0.83
E 2.4.1	Training	3.96	0.85	3.37	0.89
E 2.4.2	Local sub-contractors	3.96	0.94	3.07	1.04
E 2.4.3	Sufficient supervision	3.96	1.06	3.26	1.06
E3	*Transferor Characteristic*				
E 3.1.1	Willingness to implement	4.00	0.92	3.33	0.83
E 3.2.1	Transferor's degree of experience	4.19	0.68	3.70	0.72
E 3.3.1	Transferor management	4.04	0.81	3.48	0.98
E 3.4.1	Knowledge base	4.19	0.74	3.74	0.76
E4	*Transferee Characteristic*				
E 4.1.1	Willingness to learn	4.00	0.73	3.67	0.73
E 4.2.1	Transferee's degree of experience	4.11	0.80	3.59	0.84
E 4.3.1	Transferee management	4.04	0.71	3.74	0.81
E 4.4.1	Knowledge base	4.33	0.68	3.67	0.92
O	*TT value-added*				
O 1.1	Competitive	4.11	0.70	3.48	0.94
O 1.2	Perform at a high-level	4.11	0.70	3.67	0.88
O 2.1	Improve knowledge	3.96	0.76	3.48	0.80
O 2.2	Gained new knowledge	4.19	0.62	3.59	0.89
O 2.3	Long term	4.07	0.78	3.41	0.84
O 3.1	Financial performance	3.85	0.66	3.30	0.67
O 3.2	Schedule performance	3.96	0.81	3.52	0.70
O 3.3	Quality performance	4.37	0.63	3.67	0.96

Correlations also suggest that transferor characteristics should have a more significant impact on the learning environment than transferee characteristics. Moreover, transferor characteristic variables correlate significantly more with variables within the TT value-added construct than those within the learning environment and transferee characteristics construct. This result suggests that the transferors' characteristics are immensely important for

achieving value from the TT process. To the surprise of the authors, the transfer environment does not have a strong correlation with the learning environment.

Table 3 details the single regression analysis results for responses from column B of the questionnaire survey. The R^2 and Adjusted R^2 values indicate the coefficient of determination. Generally a higher value of R^2 produces greater explanatory power of the regression equation, and therefore the better the prediction of the independent variable [14]. The T value and the significance value both explain whether the addition of the predictor variable has a significant contribution to the model. A higher T value suggests a higher contribution to the model. Regression analysis indicates that the transfer environment can explain 46 per cent of the learning environment. Moreover, the transferors' characteristics can more strongly influence (0.651) on the learning environment when compared with transferee characteristics (0.424). When predicting the extent of value added from the TT process, regression analysis suggests that transferor characteristics (0.532) have a stronger influence than the learning environment (0.380) and transferee characteristics (0.405).

It should be noted, that due to the small sample size of the pilot study, the results obtained cannot be used to draw any final conclusion about the developed conceptual model. However, the results were helpful for refinement of the preliminary conceptual model.

Table 3. Regression analysis

Hypothesis	Independent Variable	Dependent Variable	R^2	Adjusted R^2	T value	Significance	Hypothesis Supported
H1	E1	E2	.468	.446	4.687	.000	Yes
H2	E4	E2	.447	.424	4.491	.000	Yes
H3	E3	E2	.664	.651	7.031	.000	Yes
H4	E2	O	.404	.380	4.116	.000	Yes
H5	E3	O	.550	.532	5.524	.000	Yes
H6	E4	O	.428	.405	4.326	.000	Yes

Significant < 0.05
Strong Significance < 0.01

5. SUMMARY

This paper details the conceptual model for international TT in construction. The pilot study described herein, was undertaken with the aim to examine the validity of the model factors and sub-factors, refine the questionnaire survey design and data collection method, and review the preliminary findings. Future work includes the completion of the main questionnaire survey with the goal to develop a robust international TT model, and validate it, through a series of case studies targeting Thai construction projects where international TT was incorporated.

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