Evaluating International Technology Transfer on Thai Construction Projects: A Case Study

Tanut Waroonkun
PhD Candidate, Griffith School of Engineering, Griffith University, Gold Coast, Australia

Rodney A. Stewart
Senior Lecturer, Griffith School of Engineering, Griffith University, Gold Coast, Australia

Abstract
In an effort to more rapidly develop their infrastructure, economies and living standards, many newly industrialised countries, such as Thailand, have embarked on a series of international Technology Transfer (TT) initiatives within the construction and other industries. However, these initiatives have not immediately translated into enhanced capabilities and competitiveness within indigenous firms, resulting in a sustained reliance on foreign firms. With few clues as to why TT ventures have not created expected outcomes for the indigenous construction industry, these countries lack direction on how to more rapidly diffuse best-practice technology. In an attempt to improve rates of TT in the Thai construction industry, this paper reports on an attempt to appraise international TT performance on five large construction projects. A previously developed framework, developed by the authors, was utilised for this purpose and includes a total of six enabling and outcome perspectives, namely: (1) relationship building; (2) transferor characteristics; (3) transferee characteristics; (4) economic advancement; (5) knowledge advancement; and (6) project performance. A questionnaire survey was utilised to solicit TT performance scores from forty seven (47) Thai construction professionals working on these five projects. Summated TT performance scores are illustrated for the five companies using spider diagrams. Moreover, in-depth discussion on the forces driving such scores is provided. Evaluating international TT on construction projects is the first step to assist host construction firms and government agencies to yield greater value from such initiatives.

Keywords
Technology Transfer, Benchmarking, Performance Measurement, Developing Countries, Thailand

1. Introduction

International technology transfer from developed to developing countries continues to stimulate rapid industrialisation and economic growth globally, particularly in the fast growing newly industrialised countries (Schnepp *et al.*, 1990). Numerous researchers have defined TT differently. Differences in definitions stem from the diverse fields of study of individual researchers. Tatum (1998) 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 the purpose of this study, international TT has been defined as the transfer of all types of knowledge relating to the construction field (e.g. design,

construction process, material use, equipment utilisation, etc.) from a foreign party (transferor) to a host party (transferee) that arranges 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 promotes benchmarking as a tool for measuring baseline and future performance across a wide range of TT perspectives.

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 literature review which closely examined existing models developed across all industry sectors, with the view to develop a conceptual model, specifically designed for the construction sector, can be found in Waroonkun and Stewart (2007). This conceptual model included four process enablers, namely, transfer environment, learning environment, transferor characteristics and transferee characteristics. The performance of and interaction between these enablers can influence the degree of value added to the host construction sector, in areas such as economic advancement, knowledge advancement and project performance (Figure 1).
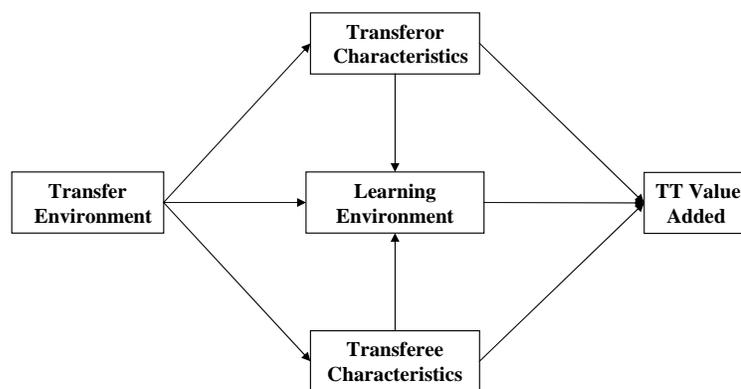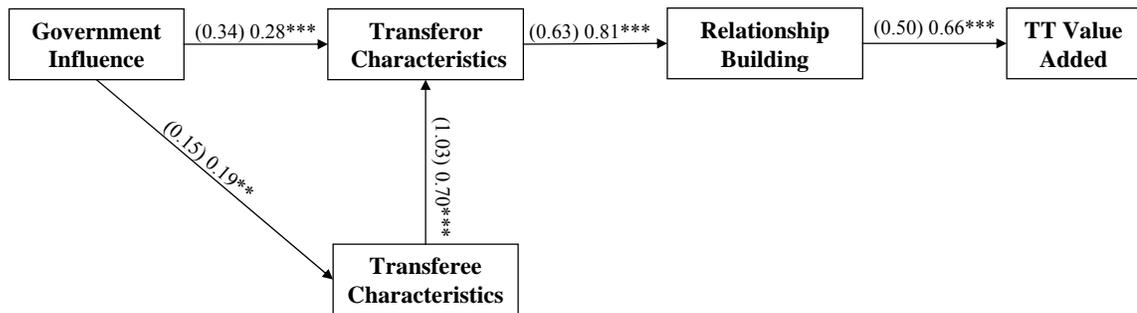

Figure 1: Conceptual model for international TT in construction projects

3. Developed Path Model for International TT in construction projects

Data collection for the primary study was undertaken with Thai construction professionals. The target group of respondents includes design and construction professionals from construction projects involving TT initiatives. This primary study only solicited the perceptions of transferees (Thai's) since TT initiatives are ultimately undertaken for the purpose of improving knowledge levels and enhancing the industry capacity of local (i.e. host) participants. The questionnaire survey of the primary study contained three distinct sections. The first section solicited descriptive statistics on the participating respondents and the past and present projects that they have been involved with where TT programs were integrated. This section enabled the establishment of a comprehensive respondent profile (i.e. experience, position description, etc.) and TT project profile (i.e. value, type, mode of transfer, etc.). The second session included questions relating to the enablers for successful TT, including transfer environment, learning environment, transferor characteristics and transferee characteristics. The third section focused on measuring the outcomes of the TT process in the following categories: economic advancement, knowledge advancement; and project performance. Statistical techniques including exploratory factor

analysis, confirmatory factor analysis and structural equation modelling were then adopted for developing international TT model in construction projects (Figure 2). A complete description of each of these statistical technique stages can be found in Waroonkun and Stewart (2007).

Note: Value in parentheses are unstandardised path coefficients, values not in parentheses are standardised path coefficients.
** p < 0.05; *** p < 0.01

Figure 2: Path model for international TT in construction projects

4. Research Method

The three significant paths determined from SEM were selected to develop TT performance benchmarking method for evaluating performance in the five construction company case studies, namely: transferee characteristics (TE) → transferor characteristics (TR); transferor characteristics (TR) → relationship building (RB); and relationship building (RB) → TT value added (VA). These three paths were identified through SEM as having the highest contribution (i.e. standardised path coefficient > 0.5) to TT value creation for the host construction sector of developing countries. The following reasons are offered to support the selection of these three significant paths. Firstly, as shown in Figure 2, the government influence perspective was a low significance predictor of the transferee characteristics perspective ($p < 0.05$). Secondly, the target group of respondents only included Thai design and construction professionals working in construction projects that involved TT initiatives. If the path model validation involved the government influence perspective, the target group of respondents should have also included senior executives and government officers that have a better comprehension on the impact of government policy and enforcement practices on the TT process.

The target group of respondents comprised Thai construction and engineering professionals who were involved on a current (at the time of survey) international TT construction project with a foreign partner in which some form of technology (e.g. management skills, construction techniques) was transferred. In total, 55 targeted surveys were distributed and 47 were returned with 9, 10, 11, 9 and 8 respondents from the companies numbered 1, 2, 3, 4 and 5 respectively, representing a response rate of 85 per cent. However, the questionnaire survey design for the case studies was based around the sub-factors in the three significant paths (TE→TR, TR→RB and RB→VA). A literature review was undertaken in Waroonkun (2007) to break down the established sub-factors into a series of TT performance indicators. This questionnaire survey contained two distinct sections. The first section enabled the establishment of a comprehensive respondent profile (i.e. experience, project description, position description, etc.). The second section contained a total of 40 questions relating to the sub-factors of the three significant paths. Respondents were requested to provide a rating for each TT performance indicator in the questionnaire survey measured on a five-point Likert scale. Specifically, the questionnaire asked respondents for their opinions about statements related to the sub-factors and associated indicators in the three significant paths, ranging from '1 = very low/very poor' to '5 = very high/very good'.

5. Case Studies

5.1 Profile

Only the basic details of the case studies and their respective participants are provided due to confidentiality requirements. Four international TT construction projects involving five construction companies in Thailand were selected for the case studies. Three of these construction projects were valued in excess of 300 million AUD and another one was valued around 30 million AUD. It should mentioned that companies 1 and 3 worked on the same construction project acting as consultant and contractor, respectively. As previously mentioned, all TT performance indicator ratings in the case study questionnaire survey were from the perspective of the transferees (Thai construction professionals). It should be noted that the respondents obtained from the case studies were not intended to have the degree of rigour required for any complex statistical analysis. Therefore, only a small sample was required for companies 1 – 5, n = 9, 10, 11, 9 and 8 respondents, respectively.

5.2 Rating TT Factors and Sub-factors

The mean and standard deviation value for factors and sub-factors are displayed in Table 1. In Table 1, the mean for the relationship building construct score (RB), is computed by equally weighting the mean scores of trust (RB1), understanding (RB2) and communication (RB3). The significant outcomes of this analysis are summarized below:

- The relationship building (RB: 3.49) factor was the highest for company 2 (Table 1). For sub-factors examining the relationship between the transferor and transferee in the TT process, trust and understanding were rated the highest for company 2 (RB1 same RB2: 3.63). This result indicates that face-to-face contact is essential for establishing understanding between parties, and that the transferor's project team that worked with company 2 had a highly uniform and knowledgeable approach.
- The transferor characteristics (TR: 3.49) factor was the highest for company 2 (Table 1). For sub-factors examining the transferor characteristics, degree of experience was rated the highest for company 2 (TR2: 3.97). This result confirms that the level of the transferor's degree of experience working with organisations from different nationalities is essential to improve TT process, and that the transferor's project team that worked with company 2 had the highest level of experience.
- The transferee characteristics (TE: 3.42) factor was the highest for companies 1 and 5 (Table 1). For sub-factors examining the transferee characteristics, the transferee knowledge base was rated the highest for companies 1 and 5 (company 1, TE3: 3.52; company 5, TE3: 3.54). These results confirm that a solid knowledge base of Thai professionals who worked with numerous transferors is essential for developing a high capacity to learn the know-how of technology and that the Thai professionals that worked with companies 1 and 5 had the highest knowledge base.
- The economic advancement (EA: 3.75) factor was the highest for company 2 (Table 1). For sub-factors examining the economic advancement, the transferee performance was rated the highest for company 2 (EA2: 3.80). This result confirms that the transferee performing at a higher level promotes economic growth in the host country, and that the performance of Thai professionals who worked on Project 2 had improved during the TT period.
- The knowledge advancement (KA: 3.48) factor was the highest for company 2 (Table 1). For sub-factors examining the knowledge advancement, enhanced working practices were rated the highest for company 2 (KA2: 3.63). These results confirm that the adoption of construction methods and advanced IT applications is essential to enhance working practices, and that the transferee's project

team that worked with company 2 had enhanced their knowledge in terms of new technology and advanced IT systems/applications.

- The project performance (PP: 3.25) factor was the highest for company 2 (Table 1). For sub-factors examining the project performance, improving the schedule performance was rated the highest for company 2 (PP2: 3.40). This result confirms that the effectiveness of TT between transferors and transferees has enhanced the schedule performance of project 2. Conversely, the lowest rated PP indicator was related to the degree of improving the schedule performance for project 1 (PP2: 2.56). This result highlights that TT between the parties involved might not contribute to the improvement of schedule performance.

Table 1: Mean and standard deviation for factors and sub-factors

Code	Descriptions	Company 1		Company 2		Company 3		Company 4		Company 5	
		Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
RB	*Relationship building*	3.15	0.94	3.49	0.72	3.02	0.78	3.25	1.00	3.13	0.67
RB1	Trust	3.07	0.89	3.63	0.73	3.03	0.74	3.11	0.69	3.38	0.72
RB2	Understanding	3.04	0.94	3.63	0.82	3.09	0.88	3.41	1.80	3.08	0.77
RB3	Communication	3.33	1.00	3.20	0.61	2.94	0.71	3.22	0.52	2.92	0.51
TR	*Transferor characteristics*	3.21	1.03	3.49	0.58	2.96	0.90	3.25	0.80	3.19	0.82
TR1	Willingness to implement	2.96	1.02	3.13	0.46	2.27	0.81	3.26	0.59	2.92	0.82
TR2	Degree of experience	3.48	1.05	3.97	0.77	3.33	1.06	3.33	0.81	3.21	0.79
TR3	Transferor management	2.96	1.00	3.30	0.53	2.94	0.91	3.19	1.02	3.38	0.69
TR4	Knowledge base	3.44	1.06	3.57	0.57	3.30	0.82	3.22	0.78	3.25	0.96
TE	*Transferee characteristics*	3.42	0.63	3.20	0.54	3.41	0.92	3.08	0.75	3.42	0.87
TE1	Degree of experience	3.33	0.61	3.30	0.75	3.39	0.96	3.04	0.92	3.38	0.79
TE2	Transferee management	3.41	0.50	3.17	0.52	3.33	0.91	3.00	0.68	3.33	0.98
TE3	Knowledge base	3.52	0.77	3.13	0.35	3.52	0.90	3.19	0.64	3.54	0.84
EA	*Economic advancement*	3.28	1.05	3.75	0.56	3.27	1.06	3.44	0.72	3.19	0.65
EA1	Competitiveness	3.22	1.09	3.70	0.48	3.18	1.08	3.33	0.71	3.13	0.83
EA2	Performance	3.33	1.00	3.80	0.63	3.36	1.03	3.56	0.73	3.25	0.46
KA	*Knowledge advancement*	3.17	0.90	3.48	0.58	3.21	0.95	3.20	0.66	3.17	0.69
KA1	Improved knowledge	3.15	0.89	3.33	0.54	3.18	0.79	3.07	0.53	3.08	0.57
KA2	Working practices	3.19	0.91	3.63	0.62	3.24	1.11	3.33	0.79	3.25	0.80
PP	*Project performance*	2.61	0.94	3.25	0.54	2.64	1.10	3.00	0.83	3.13	0.79
PP1	Financial performance	2.67	1.00	3.10	0.57	2.82	0.98	2.89	0.60	2.88	0.83
PP2	Schedule performance	2.56	0.88	3.40	0.52	2.45	1.21	3.11	1.05	3.38	0.74

5.3 Benchmarking TT Performance on Construction Projects

The previously presented method for benchmarking the performance of TT on international construction projects can be found in Stewart and Waroonkun (2007) and was again utilised for the described case studies. However, the government influence perspective was not included since it was a constant for all these Thai projects. These perspectives represented the enablers and outcomes of the TT process, namely: (1) relationship building; (2) transferor characteristics; (3) transferee characteristics; (4) economic advancement; (5) knowledge advancement; and (6) project performance. The benchmark score for each perspective was determined for the five construction companies. Calculations of the individual TT perspective scores and TT overall score can be found in Waroonkun (2007). Figure 3 presents the resultant performance scores for each perspective and the overall TT index for all five companies.

5.4 Company Comparative Analysis

Figure 3 provides clues as to the underperforming elements in the international TT process for each company. Specifically, this figure presents TT performance scores for the six TT perspectives (RB, TR, TE, EA, KA, and PP) for each company case study. Benchmark scores (TT index) for all companies ranged from 62-69 per cent providing evidence that all host construction companies involved with the case studies evaluated the construction TT process as operating moderately to highly effectively. On the other hand, these results also demonstrate that there is much potential for improvement.

In Figure 3 (a), company 1, the highest value was obtained for the transferee characteristics perspective (69%). Values for the transferor characteristics (65%) and relationship building (63%) perspectives were also relatively high. This indicates that Thai professionals working with company 1 were satisfied with their own characteristics, their foreign partner's characteristics and their relationship with their foreign partners. Moreover, the two outcome perspectives, economic advancement (66%) and knowledge advancement (63%), suggest that the Thai economy would gain technology development advantages from the construction of this project. However, the lowest scoring perspective was project performance (52%), suggesting that this construction project was not satisfying in terms of financial and schedule performance. It was found that delays had occurred in the project due to late government payment and poor construction scheduling.

In Figure 3 (b), company 2, the high scores for the transferor characteristics (70%) and relationship building (69%) perspectives indicate that Thai professionals were satisfied with their foreign partners' characteristics and that they developed effective relationships with them. However, the score for the transferee characteristics perspective (64%) shows that Thai professionals were reasonably satisfied with their own characteristics. Surprisingly, the two outcome perspectives of economic advancement (75%) and knowledge advancement (70%) indicated that this construction project should induce benefits for the Thai economy. Moreover, it should be noted that for this project the Thai professionals were highly satisfied with their improved knowledge in construction methods, technology and working practice. This project also produced comparably better performance in the project performance perspective (66%).
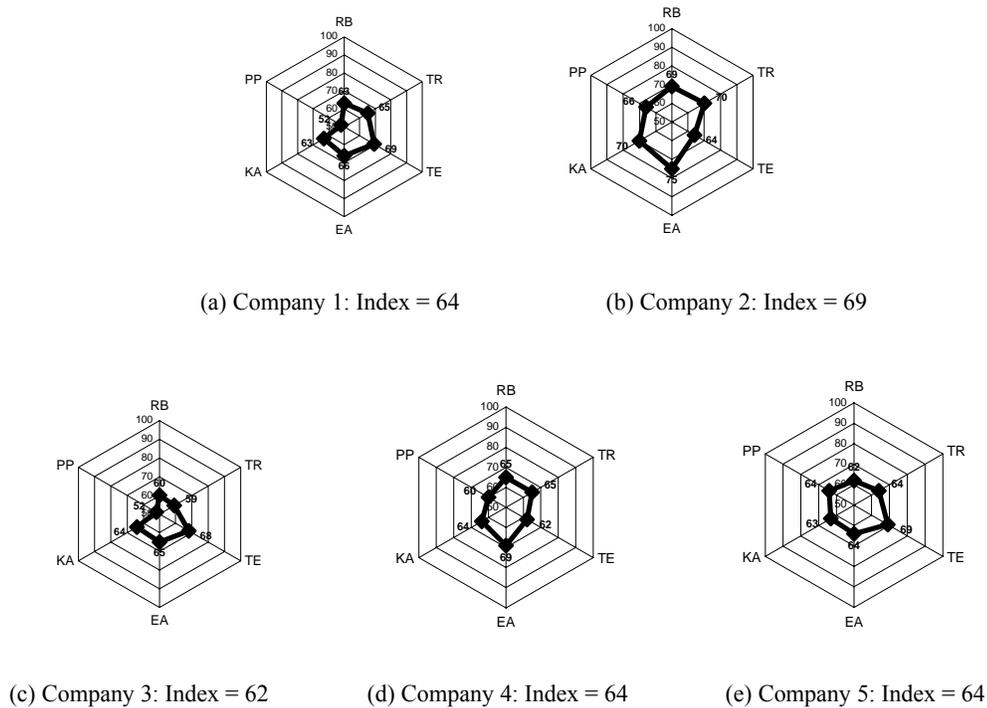
In Figure 3 (c), company 3 is presented. This company was working on the same project as company 1 but acted as the contractor. Similarly company 1, the project performance perspective (52%) was the lowest performing, suggesting that this project did not satisfy in terms of financial and schedule performance. This hints that problems with payment by the government led to a delay in the construction schedule. The transferee characteristics perspective (68%) scored the highest indicating that Thai professionals were satisfied with their own characteristics. The scores for the transferor characteristics (59%) and relationship building (60%) perspectives, were relatively low. For this project the respondents rated a low satisfaction with their foreign partners' characteristics and the development of effective relationships with these partners. The remaining two outcome perspectives, economic advancement (65%) and knowledge advancement (64%) scored reasonably, suggesting that the Thai construction sector and its employees should gain some advantages from this project.

In Figure 3 (d), company 4 is presented. Its high scores for the transferor characteristics (65%) and relationship building (65%) indicate that Thai professionals had a low satisfaction with their foreign partners' characteristics and the development of effective relationships with those partners. However, the score for the transferee characteristics perspective (62%) indicates that Thai professionals working on this project were reasonably satisfied with their own characteristics. The highest scoring perspective was economic advancement (69%), indicating that this project will strongly gain further benefits for the Thai economy. The remaining two outcome perspectives, knowledge advancement (64%) and project performance (60%) scored reasonably, indicating that Thai professionals were satisfied with improving

their knowledge to enhance working practice. This project also produced comparably better performance in the schedule performance perspective.

In Figure 3 (e), company 5 is presented. Its highest score for transferee characteristics (69%) indicates that Thai professionals were satisfied with their own characteristics, suggesting that Thai professionals had a strong degree of experience, knowledge base and management abilities to build the manufacturing factory projects using reinforced concrete and steel truss systems. Values for the transferor characteristics (64%) and relationship building (62%) perspectives were also relatively high. This indicates that Thai professionals were satisfied with their foreign partners' characteristics and their relationships with them. The three outcome perspectives, economic advancement (64%), knowledge advancement (63%) and project performance (64%) scored reasonably, suggesting that Thai professionals had a strong construction knowledge performing at a higher level which can promote economic growth in Thailand.

Moreover, this spider diagram shows that the German firm (company 2) that worked with Thai professionals was perceived to be the most effective for transferring construction technology. Specifically, this firm achieved higher scores in every perspective, except the transferee characteristics perspective. The higher TT index score for this case study (company 2) may have resulted from the following two predominant factors: (1) German firms have been one of the most dominant exporters of construction services in the Asian market for a number of years; and (2) this case study (Mass Rapid Transit Project) was considered to be the most important project providing highly complex construction technology within the underground railway system. However, whilst the overall TT index of companies 1, 4 and 5 was 64 per cent, the scores for the individual six perspectives (RB, TR, TE, EA, KA, and PP) for each company are varied.

(a) Company 1: Index = 64   (b) Company 2: Index = 69

(c) Company 3: Index = 62   (d) Company 4: Index = 64   (e) Company 5: Index = 64

Figure 3: Spider diagram showing the TT performance scores

6. Summary

TT initiatives have been in effect for a number of years in countries like Thailand with limited evidence that they have achieved envisaged objectives. Project promoters have a vested interest in creating a systematic approach to monitoring the effectiveness/success of technology transfer ventures. The TT performance benchmarking method was implemented to identify underperforming process and practices of five company case studies in Thailand. The analysis determined that these five companies have generally been operating moderately to highly effectively/successfully. Specifically, company 2 (German firm, project 2) had the highest overall TT index scores. This company was the most effective for transferring construction technology into Thai construction projects.

7. References

Benedetto, C. A. D., Calantone, R. J., and Zhang, C. (2003). "International technology transfer: Model and exploratory study in the people's Republic of China". *International Marketing Review*, Vol. 20, No. 4, pp 446-462.

Calantone, R., Lee, M. T., and Gross, A. C. (1990). "Evaluating international technology transfer in a comparative marketing framework". *Journal of Global Marketing*, Vol 3, No. 3, pp 23-46.

Gold, A. H., Malhotra, A., and Segars, A. H. (2001). "Knowledge management: an organizational capabilities perspective". *Journal of Management Information Systems*, Vol. 18, No. 1, pp 185-214.

Lin, B. W., and Berg, D. (2001). "Effects of cultural difference on technology transfer projects: an empirical study of Taiwanese manufacturing companies". *International Journal of Project Management*, Vol. 19, No. 5, pp 287-293.

Malik, K. (2002). "Aiding the technology manager: A conceptual model for intra-firm technology transfer". *Technovation*, Vol. 22, No. 7, pp 427-436.

Simkoko, E. E. (1992). "Managing international construction projects for competence development within local firms". *International Journal of Project Management*, Vol. 10, No. 1, pp 12-22.

Stewart, R.A., and Waroonkun, T. (2007). "Benchmarking construction technology transfers in Thailand". *Construction Innovation*, forthcoming [accepted September, 2006].

Wang, P., Tong, T. W., and Koh, C. P. (2004). "An integrated model of knowledge transfer from MNC parent to China subsidiary". *Journal of World Business*, Vol. 39, No. 2, pp 168-182.

Waroonkun, T. (2007). *Modelling international technology transfer in Thai construction projects*, PhD Thesis, Griffith University-Gold Coast Campus, Gold Coast, Australia.

Waroonkun, T., and Stewart, R.A. (2007). "Modelling the international technology transfer process in construction projects: evidence from Thailand". *Journal of Technology Transfer*, forthcoming [accepted March, 2007].