# Comparison of International Technology Transfer in Construction Projects between Thailand and India

Tanut Waroonkun
*Faculty of Architecture, Chiang Mai, Thailand*

## Abstract

Technology transfer 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 knowledge and resources to apply and/or use the technology. Developing and newly developed countries such as Thailand and India stand to gain a great deal from successful of construction industries. This process should provide numerous benefits for both Thailand and India in area such as increased productivity, enhancement of productivity, cost saving, improvement in market share and entry to new markets. However, there are many factors which impact and influence on technology transfer process including the transfer environment, learning environment, transferor characteristic and transferee characteristics. The performance and interaction of these enabler factors influence on the degree of value added to the local construction sectors in areas such as economic advancement, knowledge advancement and project performance. This paper presents the comparison of numerous factors which impact on the international technology transfer process effectiveness between Thailand and India. Though, a main study in Thailand and India, where 145 and 33 industries professional from Thailand and India were respectively interviewed, the factors which impact on the technology transfer process have been identified with factor analysis and the mean and standard deviation value for factors and sub-factors are computed to compare the rating of TT factors and sub-factors between Thailand and India.

## Keywords

Technology Transfer, Thailand, India

## 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 as such Thailand and India (Schnepp *et al.*, 1990). Numerous researchers have defined the term of TT differently due to their individual fields of study. Chacko (1986) described TT in a scientific manner as converting physical/mental matter/energy into directly usable alternate form(s), and transfer means from one pocket into another pocket. Williams and Gibson (1990) defined TT as the shared responsibility between the source and the destination by ensuring that the technology is accepted, or at least understood, by someone who has the knowledge and the resources to apply and/or use the technology. In the construction sector, Simkoko (1992) attempted to build on this definition by identifying individual construction resources, as either materials or permanent equipment (e.g. steel beam, elevators, material) or construction-applied resources (e.g. information, skill). Waroonkun *et al.* (2005) defined TT as when knowledge, material or equipment in the construction technology area are transferred into construction from one party such as a person or organisation (transferor), to another party such as a person or organisation (transferee), that arranges to receive it. It should be noted here that although some

international TT models have been developed for other sectors, the authors are not aware of any comprehensive model developed specifically for the construction sector.

The TT process in the construction sector between developed and newly developing countries, such as Thailand, includes numerous factors that may influence its' effectiveness. These factors can be broadly defined as enablers and include the transfer environment, learning environment, transferor characteristics and transferee characteristics. The performance of and interaction between these enablers influence the degree of value added to the host country in areas such as economic advancement, knowledge advancement and project performance. Factor analysis was used to confirm and/or refine grouping of significant enabler and outcome factors.

## 2. Literature Review

International TT continues to be a key stimulant to industrialisation and economic growth in developing countries, particularly in the fast growing Asian countries such as Thailand, China, India, etc. (Marton, 1986; San, 2004; Schnepp *et al.*, 1990). In recent years, there have been many researchers that have studied and modelled the TT process, but none have targeted the construction sector. A literature review was undertaken in this study, which closely examined existing models developed across all industry sectors with the view to develop a conceptual model, which is specifically designed for the construction sector (Calantone *et al.*, 1990; Lin and Berg, 2001; Malik, 2002; Simkoko, 1992; Wang *et al.*, 2004).

### Table 1. Enablers and TT-value creation

| Construct | Description of variables | References |
|---|---|---|
| Transfer environment | Complexity of construction technology<br>Construction mode of transfer<br>Government policy | Calantone et al., 1990; Simkoko, 1992 |
| Learning environment | Relationship between transferor and transferee<br>Communication between transferor and transferee<br>Management of technology transfer program<br>Transfer programs | Black *et al.*, 2000; Lin and Berg, 2001; Malik, 2002; Simkoko, 1992; Wang *et al.*, 2004 |
| Transferor characteristics | Willingness to transfer technology<br>Level of experience<br>Cultural traits<br>Knowledge base | Benedetto *et al.*, 2003; Lin and Berg, 2001; Makilouko, 2004; Malik, 2002; Wang *et al.*, 2004 |
| Transferee characteristics | Intent to learn technology<br>Level of experience<br>Cultural traits<br>Knowledge base | Benedetto *et al.*, 2003; Lin and Berg, 2001; Makilouko, 2004; Malik, 2002; Wang *et al.*, 2004 |
| Economic advancement | Competitiveness<br>Performance improvement | Benedetto *et al.*, 2003 |

| Knowledge advancement | Improved knowledge | Gilbert and Cordey-Hayes, 1996; Gold *et al.*, 2001 |
| | Improved working practices | |
| | Long-term adoption of transferred skills | |
| Project performance | Financial performance | Chua *et al.*, 1999 |
| | Schedule performance | |
| | Quality performance | |

As a result of the literature review, several variables were determined and grouped as either enablers of the TT process or outcome variables (TT-value added to host sector) which may result from it. The enablers were divided into four main categories: transfer environment; learning environment; transferor characteristics; and transferee characteristics (Table 1). The performance of, and interrelationship between, the above-mentioned TT enablers contributes to the degree of value added to the host AEC sector. The benefits achievable from international TT can be derived in three main areas: economic advancement; knowledge advancement; and project performance (Table 1).

The transfer environment is concerned with the environment where the technology is being transferred from and how the technology will be transferred. The learning environment is concerned with the relationship and communication between the transferor and transferee and the effectiveness of implemented transfer programs. Transferor and transferee characteristics describe the personal characteristics of the technology transferor (foreigner) and the technology receiver (host). For the TT-value creation factors, economic advancement is concerned with the degree to which TT has improved the living standards and economic prospects of the host nation. Knowledge advancement is concerned with improvement in knowledge of host individuals and organisations in the construction sector. Project performance is concerned with the improvement of financial performance, schedule performance and quality performance on construction projects. A conceptual model for international TT has been developed (Figure 1).
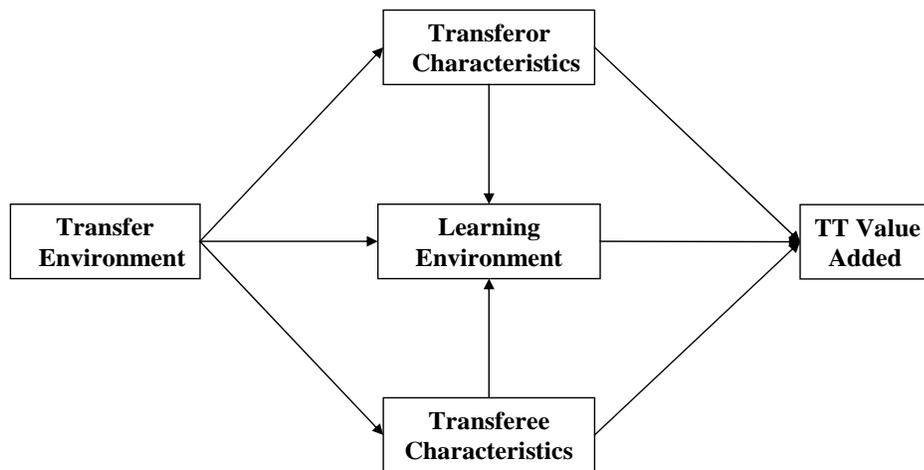


**Figure 1. Conceptual model for international TT in construction**

## 3. Research Method

During June-July 2005 and June-July 2007, data collection for this research was undertaken with construction professionals in Thailand and India respectively. The same primary questionnaire had been distributed and the target group of respondents includes design and construction professionals from

construction projects involving TT initiatives. Thailand, the total of 300 surveys were distributed and 162 were returned, representing a response rate of 54 percent. On the other hand, four Indian construction industries, which worked only with the foreign partner, the 33 company staff were selected to answer the questionnaire. The objective of this study was to compare the numerous factors within the conceptual model which impact on the TT process and its subsequent outcomes between Thailand and India. Results from this study can be used to improve the TT process for the new numerous developing countries. The questionnaire survey of the primary study contained two sections with a total of 29 questions representing individual variables in the conceptual model. 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. Other background information such as, years of experience, position, education, etc. was also solicited from respondents. 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 impact (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 sought to ascertain respondents' perception of the successfulness/effectiveness of TT factors in the construction environment, based on their experience. The scale of column B ranged from 'strongly negative' to 'strongly positive' and the results were utilised for the majority of statistical analysis and comparison of the TT effectiveness between Thailand and India.

## 4. Data Analysis and Results

## 4.1 Descriptive Analysis

Thai Respondents were classified into four categories: project manager (16%), site engineer (40%), consulting engineer (16%), construction manager/foreman (16%), architect (11%) and other (1%). The type of organisation the respondents were employed included main contractor (43%), sub-contractor (20%), consultant (35%) and other (2%). The education levels of respondents were divided into high school (1.2%), diploma (9.3%), bachelor degree (61.1%), master degree (27.8%) and doctorate degree (0.6%). The Thai respondents construction experience breakdown was 0-5 years (24%), 6-10 years (19%), 11-15 years (24%), 16-20 years (17%) and over 20 years (16%). On the other hand, the 33 Indian respondents were classified into six position categories: project manager (21%), site engineer (34%), consulting engineer (18%), construction manager/foreman (18%), architect (9%). The type of organisation the respondents were employed included main contractor (67%), sub-contractor (9%), consultant (24%). The education levels of respondents were divided into diploma (9%), bachelor degree (70%), master degree (21%). The Indian respondents' construction experience breakdown was 0-5 years (12%), 6-10 years (27%), 11-15 years (40%), 16-20 years (12%) and over 20 years (9%).

Comparing the position held by respondents in their respective organisation between Thailand and India, it has been found that almost 40 percent of Thai respondents and 34 percent of Indian respondents were site engineers. These respondents will have an informed perspective of all daily on-site operations and will be able to critically evaluate all project issues such as teamwork, understanding and communication. Main contractors in both Thailand and India accounted for the highest frequency of respondents around 43 percent and 67 percent followed by consultants around 35 percent and 24 percent, respectively. These

main contractors were directly targeted; their insight into the TT process will be valuable. The highest frequency of respondents in Thailand and India had a bachelor degree (61.1%) and (70%), respectively. Basic education level (Undergraduate level) was necessary to demonstrate that those respondents had sufficient education to develop a professional practice, particularly adopting the TT process from foreigners. The highest frequency of respondents had 11-15 years experience in both Thailand and India. A high experience of the respondents in the AEC sector means a greater understanding of project outcomes and influences.

Regarding to Thai respondents, Analysis of variance (ANOVA) was performed to ensure that respondents having different positions (e.g. site engineer, consultant, etc.) and from different types of organisation (contractor, consultant, etc.) could be considered as a single sample. ANOVA confirmed congeners between position types at the 0.05 level of significance (Black *et al.*, 2000). However, for the type of organisation, there was two variables (willingness to implement, financial performance) which had a significantly ($p < 0.05$) different mean value for two organisation type (main contractor, sub-contractor). Carefully examining mean values for these variables within their respective groups, it appears that sub-contractors do not believe that TT is being transferred to their level and will not help their financial performance. It should be noted that international TT typically involves only the larger contractors and consultants, thus these groups of organisations perceive that TT will generate more value for them. Therefore, since this variance was not widespread and only resulted in two combinations the data was treated as one useable sample.

ANOVA was performed to ensure that Indian respondents from different types of organisations (main contractor, sub-contractor and consultant) could be considered as a single sample. There were three variables relating with the type of organisation (complexity level of technology, degree of transferor's experience and performance) which had a significantly ($p < 0.05$) different mean value for two organisation types (main contractor and consultant). Examining mean values for these variables within their respective groups, it appears that Indian main contractors believed that a higher complexity level of technology that is being transferred from a high degree of transferor's experience working on international projects, will help to improve their firms overall performance on the long term with better management skills and an improved overall quality. However, it can be seen that TT with the high technology complexity mainly involves main contractors and sub-contractors comparing with TT involving consultants, thus these groups of organisations perceive that TT program will be highly beneficial for them. Therefore, this variance was not widespread and the data was treated as one useable sample

## 4.2 Factor Analysis

Exploratory principal component factor analysis, with varimax rotation, was conducted to condense the information contained in the original 29 variables as above mention into a smaller set of factors with a minimum loss of information (Hair *et al.*, 1998). Only, the data from Thai respondents can be adopted to define the fundamental constructs assumed to underlie the original variables. Results of exploratory factor analysis retained a 20 variable solution, removing a total of 9 variables (Table 2). However, the complete description of exploratory principal component factor analysis can be found in Waroonkun and Stewart (2006).

## 4.3 Comparison Rating TT Factors between Thailand and India

Results of exploratory principal component factor analysis, the mean and standard deviation value for factors and sub-factors are displayed in Table 2. In Table 2, 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 comparisons rating TT factors and sub-factors between Thailand and India can be summarized below:

937

- The technology characteristics (TC: 3.64) factor for India was higher than in Thailand (Table 2). For sub-factors examining the technology characteristics, the complexity level of the technology for India were rated the highest (TC1: 3.79). This result confirms that if the same complexity level of the technology will be transferred to Thailand and India, domestic firms in India will have more difficulty to transfer the technology because in India, there are less construction projects available for local firms to gain experience.
- The government influence (TR: 3.75) factor for India was higher than for Thailand (Table 2). For sub-factors examining the government influence, government policy for India was rated the highest (GI1: 3.76). This result indicates that the government enforcement of related politics in India is more essential for encouraging TT to occur into the construction domestic industry compared with Thailand.
- The relationship building (RB: 3.85) factor for India was higher than for Thailand (Table 2). For sub-factors examining the relationship between the transferor and transferee in the TT process, trust was rated the highest for India (RB3: 3.97) and communication were the highly rate for both India (RB3: 3.90) and Thailand (RB3: 3.92). This result indicates that face-to-face contact is essential for establishing a strong trust between parties, and that foreigners who worked in India and had a knowledgeable approach would gain the local industry's trust.
- The transferor characteristics (TR: 3.84) factor for India was higher than for Thailand (Table 2). For sub-factors examining the transferor characteristics, degree of experience was rated the highest. This result confirms that a high level of the transferor's degree of experience working with organisations from different nationalities in India is essential to improve the TT process.
- The transferee characteristics (TE: 3.96) factor for India was higher than for Thailand (Table 2). For sub-factors examining the transferee characteristics, the transferee knowledge base was rated the highest (India, TE3: 4.18). This result confirms that a higher solid knowledge base, particularly the English communication ability of Indian professionals is essential for developing a high capacity to learn the know-how of technology.
- The economic advancement (EA: 3.56) factor for Indian was higher than for Thailand (Table 2). For sub-factors examining the economic advancement, the transferee performance was rated the highest (India, EA2: 3.94). This result confirms that the transferee performing at a higher level promotes economic growth in the host country, and that the performance of Indian and Thai professionals who worked with numerous transferors improved during the TT period.
- The knowledge advancement (KA: 3.67) factor for India was higher than for Thailand (Table 2). For sub-factors examining the knowledge advancement, improved knowledge was rated the highest (India, KA1: 3.78). This result confirms that the adoption of construction methods and advanced IT applications is essential to improve the knowledge base of Indian local workers and that improving the knowledge of India and Thai professionals usually occurred during the TT.
- The project performance (PP: 3.38) factor for India was the higher than for Thailand (Table 2). For sub-factors examining the project performance, improving the financial performance was rated the highest (India PP1: 3.58). This result confirms that the effectiveness of TT between transferors and transferees has enhanced the financial performance of overall local companies. Conversely, the lowest rated PP indicator was related to the degree of improving the schedule performance of Indian local companies (PP2: 3.18). This result highlights that TT between transferors and Indian local companies might not contribute to the improvement of scheduled performance.

**Table 2 Comparison of perspective and indicator mean and standard deviation**

| Code | Perspectives – indicators | India | | Thai | |
|------|---------------------------|-------|-------|------|------|
| | | Mean Column A | Std. dev. Column A | Mean Column A | Std. dev. Column A |
| *TC* | *Technology characteristics* | *3.64* | *0.86* | *3.30* | *0.70* |
| TC1 | Complexity level | 3.79 | 0.65 | 3.24 | 0.65 |
| TC2 | Mode of transfer | 3.48 | 1.06 | 3.36 | 0.74 |
| *GI* | *Government influence* | *3.75* | *0.67* | *3.28* | *0.93* |
| GI1 | Government policy | 3.76 | 0.66 | 3.26 | 0.87 |
| GI2 | Government enforcement | 3.73 | 0.67 | 3.29 | 0.98 |
| *RB* | *Relationship building* | *3.85* | *0.75* | *3.62* | *0.93* |
| RB1 | Trust | 3.97 | 0.67 | 3.44 | 0.91 |
| RB2 | Understanding | 3.69 | 0.91 | 3.51 | 1.00 |
| RB3 | Communication | 3.90 | 0.68 | 3.92 | 0.88 |
| *TR* | *Transferor characteristics* | *3.84* | *0.70* | *3.63* | *0.86* |
| TR1 | Willingness to implement | 3.56 | 0.81 | 3.57 | 0.98 |
| TR2 | Degree of experience | 4.14 | 0.57 | 3.65 | 0.79 |
| TR3 | Transferor management | 3.54 | 0.86 | 3.61 | 0.84 |
| TR4 | Knowledge base | 4.13 | 0.56 | 3.67 | 0.83 |
| *TE* | *Transferee characteristics* | *3.96* | *0.64* | *3.60* | *0.78* |
| TE1 | Degree of experience | 3.53 | 0.82 | 3.62 | 0.82 |
| TE2 | Transferee management | 4.16 | 0.50 | 3.54 | 0.77 |
| TE3 | Knowledge base | 4.18 | 0.61 | 3.64 | 0.76 |
| *EA* | *Economic advancement* | *3.56* | *0.66* | *3.55* | *0.83* |
| EA1 | Competitiveness | 3.18 | 0.77 | 3.50 | 0.81 |
| EA2 | Performance | 3.94 | 0.56 | 3.59 | 0.85 |
| *KA* | *Knowledge advancement* | *3.67* | *0.71* | *3.44* | *0.91* |
| KA1 | Improved knowledge | 3.78 | 0.64 | 3.34 | 0.89 |
| KA2 | Working practices | 3.55 | 0.78 | 3.54 | 0.92 |
| *PP* | *Project performance* | *3.38* | *0.62* | *3.34* | *0.86* |
| PP1 | Financial performance | 3.58 | 0.56 | 3.24 | 0.90 |
| PP2 | Schedule performance | 3.18 | 0.68 | 3.44 | 0.81 |

## 5. Conclusion

TT initiatives have been in effect for a number of years in developing countries like India and Thailand without comparing the effectiveness/success of technology transfer venture. This paper presents the comparison of transferee's perspective relating to TT effectiveness in developing countries such as India and Thailand. The descriptive analysis and the factor analysis were implemented to identify the validity of

the model factors and sub-factors in an approach to monitoring TT effectiveness/success. In total, the mean and standard deviation of twenty sub-factors were presented. The results determined that Indian transferee's perspective had higher overall TT sub-factor mean scores than Thai transferee's perspective. This result indicates that India had a higher effectiveness/success of transferring construction technology into local construction firms.

## 6. 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*, 20(4), 446-462.

Black, C., Akintoye, A., and Fitzgerald, E. 2000. "An analysis of success factors and benefits of partnering in construction". *International Journal of Project Management*, 18(6), 423-434.

Calantone, R., Lee, M. T., and Gross, A. C. 1990. "Evaluating international technology transfer in a comparative marketing framework". *Journal of Global Marketing*, 3(3), 23-46.

Cao, Q., and Dowlatshahi, S. 2005. "The impact of alignment between virtual enterprise and information technology on business performance in an agile manufacturing environment". *Journal of Operations Management*, 23(5), 531-550.

Chacko, G. K. 1986. "International technology transfer for improved production functions". *Engineering Costs and Production Economics*, 10(1), 245-252.

Chua, D. K. H., Kog, Y. C., and Loh, P. K. 1999. "Critical success factors for different project objectives". *Journal of Construction Engineering and Management*, 125(3), 142-150.

Gilbert, M., and Cordey-Hayes, M. 1996. "Understanding the process of knowledge transfer to achieve successful technological innovation". *Technovation*, 16(6), 301-312.

Gold, A. H., Malhotra, A., and Segars, A. H. 2001. "Knowledge management: an organizational capabilities perspective". *Journal of Management Information Systems*, 18(1), 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*, 19(5), 287-293.

Makilouko, M. 2004. "Coping with multicultural projects: the leadership styles of finnish project managers". *International Journal of Project Management*, 22(5), 387-396.

Malik, K. 2002. "Aiding the technology manager: a conceptual model for intra-firm technology transfer". *Technovation*, 22(7), 427-436.

San, M. M. 2004. "Technology transfer a need for development of building sector". The Myanmar Time.

Schnepp, O., Von Glinow, M. A., and Bhambri, A. 1990. *United States-China Technology Transfer*, Prentice-Hall, Englewood Cliffs, NJ, USA.

Simkoko, E. E. 1992. "Managing international construction projects for competence development within local firms". *International Journal of Project Management*, 10(1), 12-22.

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*, 39(2), 168-182.

Waroonkun, T., Stewart, R. 2007. "Evaluation International technology transfer on Thai construction projects: A case study". *Fourth International Conference on Construction in the 21st Century (CITC-IV) "Accelerating Innovation in Engineering, Management and Technology" July 11-13, 2007,* Gold Coast, Australia, 541-548.

Williams, F., and Gibson, D. 1990. *Technology Transfer: A Communication Perspective*, Sage Publications, Beverly Hills, California, USA.

Zain, M., Rose, R. C., Abdullah, I., and Masrom, M. 2005. "The relationship between information technology acceptance and organizational agility in Malaysia". *Information & Management*, 42(6), 829-839.