



## International Technology Transfer (ITT) Projects and Development of Technological Capabilities in Malaysian Construction Industry: A Conceptual Framework

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### Abstract

The International Technology Transfer (ITT) projects has emerged as an important business and managerial concern to many developing countries across the globe as well as Malaysia. ITT projects according to many researchers involve the cross-boarder transfer of technology with the main purpose to enhance the local technology capabilities in response to a changing economic environment. These technology transfer projects could be viewed in the form of knowledge (soft technology), skill, and tools (hard technology) which usually congregate from advanced countries to the developing countries through construction project development.

Numerous modes (known as channels) of ITT could occur from the public and private firms of advanced countries to private and public sector locally. Some of the channels are considered effective while others are regarded as less effective. Therefore, the objectives of this paper are three folds; to investigate the major channels of international technology transfer (ITT) projects in Malaysia and how these channels and technology capabilities are diffused within the Malaysian construction industry. Finally, a conceptual framework is proposed for a successful ITT and development of technological capabilities for the Malaysian construction industry.

**Keywords:** International technology transfer (ITT) projects, Channels, Diffusion, Malaysia, Technological capabilities

### 1. Introduction

The phenomenon of 'international technology transfer' or ITT projects has emerged as an important business and managerial concern to developing countries. The main purpose of ITT projects is to enhance the local technological capabilities which, according to many researchers need to be improved and upgraded continuously (Saad et al. 2002; Putranto et al. 2003; Wie, 2003). In this respect, the construction industry is targeted due to the fact that the ITT transaction encompasses extensive and significant project based work throughout the four phases of project life cycle starting from the strategy formulation, procurement, construction, and project completion phase (Takim, 2005). It undertakes the production of various construction products in the form of buildings, infrastructure works, refurbishment works and the installation of various equipment and facilities.

The study presents an early research purely based on literature review on the understanding of international technology transfer (ITT) projects and development of technological capabilities in Malaysian construction industry taking into consideration the soft and hard issues of ITT, numerous channels of ITT, and the concept of diffusion in ITT projects.

### 2. Basic Concept

Technology, according to many researchers (Bell et al. 1984; Putranto et al. 2003; Wie, 2003), is a collection of physical processes that transform inputs into outputs with procedural techniques and organizational arrangements for carrying out the transformation. According to Chee (1981), technology is viewed as the knowledge and machinery

that are needed to run an enterprise. This could include both software (blueprints and operating manuals) and hardware (equipment). Stock & Tatikonda (2000) draws a more sophisticated definition for technology as a tool or technique, product or process, physical equipment or method of doing. While, in operational context, technology is defined as technical knowledge and could also be associated as a machine, an electrical or mechanical component, a chemical process, software code, a patent, a technique, or a person.

Technology transfer however, is the transfer of skills, technical know-how, machinery and other capital equipment (Wei, 2003). This is in line with the opinion of Putranto et al. (2003) that define technology transfer as the transfer of capital goods and operating skills to the development of technological capabilities. Technological capabilities could be in the form of investment (feasibilities and project execution) and production (process engineering, product engineering and linkages within economy). Furthermore, according to Lall (1996a), technological capabilities are the skills, technical knowledge and organizational coherence required to make industrial technologies function in an enterprise. Technological capabilities reflect not only the ability in using resources, but also capacities of resources, such as training, research and development (R&D), and maintenance of resources (Cohen, 2004).

As virtually, all advanced technologies are imported from advanced industrial countries. As such, international technology transfer (ITT) projects involve the cross-border transfer in which, technological capability regards the effective use of the imported technologies abroad which enable local firms or enterprises to adopt these technologies to the development of new products and processes in response to a changing economic environment. Several researchers (Perlmutter and Sagafi-Nejad, 1981; Contractor and Sgafi-Nejad, 1981; Simon, 1982 and 1991; Stobaugh and Wells, 1984; Agmon and Von Glinow, 1991) regard international technology transfer (ITT) project as a complex process that needs time to develop. The development process of ITT could be in the form of acquisition, adaptation, and improvement (Rosenberg and Frischtak, 1985). Given the above, ITT in construction is one option for a developing country to acquire newer technology internationally to enhance local technological capabilities.

In ITT, the process of knowledge diffusion however, is defined as a spread of technology transfer by means of communication in which potential users become informed about the availability of a new technology and are persuaded to adopt it through communication (Attewell, 1992). The process of diffusion could be made in five stages: knowledge, persuasion, decision, implementation, and confirmation (Rogers, 2003). Knowledge means gaining initial knowledge about new ideas; persuasion could be the altitudes towards new ideas, to adopt or reject; decision means decision making for adoption new ideas; and finally, confirmation is the confirmation of decision on the new imported ideas.

### 3. Statement of Research Problem

Over the last 20 years, the fast growing Asian region has experienced rapid industrialisation and economic growth. Much of this change can be attributed to international technology transfer (ITT) (Devapriya and Ganesan, 2002; Marton, 1986; Saad et al. 2002; Schnepf et al. 1990). The construction industry in Malaysia is of no exception, experiencing unprecedented growth through the formation of large building and infrastructure programs that are largely partnered with foreign enterprises (Economic Planning Unit, 2007). Therefore, the phenomena of ITT projects occurred at the macro and micro level in firms and organizations. The common question is how to managed technology development efficiently and effectively from the viewpoint of technology receivers.

Cohen (2004) reckons that there are numerous forms of channels or modes of ITT which takes place in the public and private sectors; that is from the private and public firms of the advanced countries to private and public sectors locally. Some of the channels are considered to be very effective (i.e., training programs, managerial and institutional programs, procurement and contractual contracts) whilst others are regarded as less effective (i.e. licensing agreement) (Ming 1999; Thee, 2003). The above statement is a concern of this study and the study aims to investigate further the effectiveness of different channels or modes of international technology transfer in the Malaysian construction industry.

As mentioned earlier, diffusion of knowledge is a spread of technology transfer by means of communication that could disseminate skills, licenses, patents, know-how and techniques in a more methodical and beneficial forms compared to diffusion of equipment such as machines and plants (Mansfield, 1995). The diffusion could be between the numerous channels to technological capabilities and could occur upon the demand of local stakeholders of that recipient country. The ease of knowledge diffusion and the level of absorptive capacity in the recipient country are widely cited as important in affecting the incentives for technology transfer. Farrands (1990) reckons that absorption patterns were crucial and to a certain extent it depends on their organization and management culture, the role and the structure of power relations within and between organizations. Furthermore, it is important for policy makers of the recipient country to understand the art of diffusion, the factors governing foreign firms' willingness to transfer technology, and the value of domestic firms' investment in international technology mastery. Therefore, the effects of knowledge diffusion on international technology transfer (ITT) projects are controversial and deserve further investigation, in particular in the Malaysian construction industry.

#### 4. Structure of Construction Sector

As mentioned by Stock & Tatikonda (2000), technology comprises physical elements such as: equipment, tools and machines, the methods applied in the utilisation of physical elements, knowledge and methods of these elements, and documentation that embodied the knowledge (i.e. specifications, drawings and computer programs). In construction, technology is defined as a combination of materials and equipment resources, construction-applied resources, construction processes, and project requirements and constraints (Tatum, 1988). According to Simkoko (1992), construction resources can either be materials and permanent equipment (e.g. steel beams, elevators), construction-applied resources (e.g. information, skills), or construction equipment. Construction processes on the other hand, include the methods and tasks needed to build a constructed product.

The technology transfer and acquisition process takes place through various different mechanisms. Simkoko (1992) declares that a technology transfer or acquisition program consists of the training efforts designed for local personnel at the operational, functional and management levels, the involvement of local construction firms and construction-related institutions, and the provision of employment to the local staff. In simple explanation, Simkoko (1992) states that the concept of technology transfer programmes emphasizes the formation of integrated project teams and temporary joint-venture organizations between local and foreign firms in the course of the implementation of international construction projects. The participation of local construction firms as subcontractors to foreign firms is an important element in the concept of technology transfer. It is believed that one of the major conditions for development is access to new technology. If developing countries are to become industrialized, the overwhelming part of such technology must be imported, at least at the initial stages (Able-Thomas, 1996).

With the rapid growth of construction on a global scale, Malaysia is increasingly looking forward to market her construction technology abroad to enhance their business growth, apart from importing international technology. With advancement in technology and communication connectivity, business opportunities continue to present themselves in a foreign country as well as within the Asia region. The global construction market is generally categorized into three types: developed (advanced industrialized), developing (newly industrialized) and least developed (emerging and countries in transition). The global construction market will apply international benchmarks and standards and as such, Malaysian builders must meet these exacting standards or fail to survive in the regional or global market (CIDB, 2007). Towards this end, it is important for Malaysian builders to undertake continuous efforts to upgrade their skills and knowledge. This is to ensure that any work undertaken by Malaysian builders has a strong branding presence and will be much sought after internationally. As part of a broader capacity-building process, Malaysian builders need to comprehensively integrate and more efficiently utilise new construction methods, practices and technologies in delivering high quality work (CIDB, 2007).

Moreover, the involvement of Malaysian contractors in many Mega projects locally and abroad has nurtured the capabilities and expertise of Malaysian contractors. The construction industry benefited tremendously with the implementation of large infrastructure projects encompassing highways, ports, airport, power plant, and urban development various function projects. Several major projects in Malaysia were speeded up through collaborations between the private sector and the public sector which helped to force the economic development of the nation. Consequently, Malaysia has world class infrastructure such as the Petronas Twin Towers and Kuala Lumpur International Airport (CIDB, 2007). Since 1995, it was reported that the Malaysian construction companies have completed almost 300 overseas construction projects amounting to RM 20,912 billion and are currently implementing 56 projects valued at RM 24, 583 billion. About half of these projects are roads and highways, while building works represent approximately one fifth of the total volume of work.

There are numerous channels or modes of ITT open to Malaysia. These include direct investment (domestic and foreign) and privatization. Through privatization channels, foreign technology is transferred by means of build-operate-transfer (BOT) and Private Finance Initiative (PFI) procurement systems. Through Construction Industry Development Board (CIDB), Malaysia External Trade Development Corporation (MATRADE) and Professional Services Development Corporation Sdn Bhd (PSDC), Malaysia has a more focused strategy to market construction services through Government-to-Government arrangements abroad.

Given the above, the concept of cross-boarder international technology transfer project in Malaysia could be in two forms: technology from the developed countries transfer to Malaysia and technology from Malaysia transfer to the neighborhood countries and any other countries within Asian and ASEAN regions

#### 5. Technology Transfer Models

Table 1.0 presents six types of international technology transfer models gathered from various researchers across the globe. Wei (1995) has classified the flows of technological content of ITT into three categories: Flow A, which consists of capital goods and technological services; Flow B composed of operating skills and technological know-how; and Flow C contains knowledge, experience and expertise in implementing technical change. These flows provide sources

of level of technological capability. It is from this point that the importing firm and economy get onto a dynamic path in which technical change is generated continuously at the international competitive rate. In addition, Wei's report concentrates on three important issues in ITT: the costs of technology transfer, the assimilation of the imported technology, and the extent to which technology transfer contributes to the development of technological capability. This model appears to be simple for international technology transfer but difficult to understand and to implement.

Lin & Berg (2001) propose a theoretical model for technology transfer effectiveness project. The major factors affect the performance of ITT project could be: the nature of technology to be transferred, international experience, and culture difference. However, based on his empirical findings the nature of technology and international experience are more significant than the culture difference in ITT. The reason could be due to the less attention was given to culture difference from the management level and is contradicted to the opinion of Pandia (1994). The strength of this model is that the overall concepts are easily understood and it is very simple to implement.

Saad et al. (2002) develop assessment of ITT projects by using 'extended life cycle approach' adopted from the Project Management Multiple Perspective (PM-MP) Framework. The assessment of ITT projects was carried out in four stages: project life cycle stage, technology transfer stage, the involvement of stakeholders, and the expected benefits that have impacts on the ultimate success of each of technology transfer projects. The involvement of stakeholders (suppliers, governments, workers, managers and wider community representatives) could produce different project benefits as well as problems associated with the ITT projects. The strength of this model is that it is easy to understand and comprehensive which takes into consideration stakeholders' viewpoint.

Putranto et al. (2003) propose a model of technology transfer using a feedback loop system emphasizing on the receiver's (transferee) point of view. From the receiver's point of view, technology transfer is best divided into four stages: preparation, production, operation, and evaluation stage. These four stages of ITT could contribute to the improvement of technological, investment and operational capabilities, the key important areas of ITT. The model developed by Putranto et al. (2003) is quite similar to the model developed by Saad et al. (2002) with the exception of stakeholders' involvement.

A conceptual model of technology transfer developed by Daghfous (2004) pays more attention to the technology and knowledge transfer of ITT. This model shows a relationship of learning processes, technology and knowledge transfer projects. A technology transfer projects is a form of knowledge accumulation task. Apart from explicit form, knowledge is often tacit which could not be transferred through blueprints and documentation. Instead, it is transferred through informal processes and communication channels. In ITT projects, technology transfer is a learning process. In addition, the model emphasises five stages of ITT i.e., prior knowledge, learning processes, project stage, intended benefits and unintended benefits that could contribute to the continuous capability development. The strength of this model is that it is easy to understand and simple to implement.

The five 'M' system approaches, illustrated by Haris & Haris (2004) present a sociotechnical system framework for contemporary ergonomics. This model shows how the five 'M's framework can be used to consider the likely effectiveness of ITT from one domain to another. In this model, they used the integration of user (Human), machine, mission, medium, and management. The human aspect encompasses the size, shape, personality, cognitive capabilities and training of the users. The machine component of the framework is the system with which operators interact to perform a mission (task). A mission commences when the human and machine components come together to perform a prescribed function. The management in turn, will task the mission and dictates some of the performance standard by providing the structures and oversees compliance with the regulatory standards required by medium (Physical and Societal Medium). The process of ITT occurs when the human used the machine to perform the task to fulfill the mission. This model appears to be appealing and sensible.

Given the above, most of the models approach above, if not all; focus on ITT across technology transfer project phase, by identifying the technology capabilities (Saad et al. 2002; Putranto et al. 2003; Wie, 2003). It should be noted that the six types of models described above could provide useful guideline in terms of: types of technology, the channels, stakeholders, barriers and benefits of ITT projects and contribution to the proposal of conceptual framework of ITT projects in Malaysia.

## 6. Propose Research Framework

Figure 1 proposes a conceptual framework for a successful international technology transfer (ITT) and development of technological capabilities in Malaysian Construction Industry. This has been developed based on a preliminary literature review undertaken on technology transfer processes. The conceptual framework consists of five major components; the types of technology (knowledge, skills and tools), the channels, the variety of stakeholders, barriers and the benefits of ITT projects.

The process of technology transfer to developing countries, such as Malaysia involves a complex series of stages. The first stage refers to the flow of technology transfer in the form of knowledge (soft technology), skills and tools (hard

technology) which usually congregate from advanced country to the developing countries. Knowledge transfer is about getting the right knowledge to the right people at the right time (Li-Hua, 2004). The knowledge is transferred perhaps when foreign and local managers have intimate interaction while working together. There are two major elements of knowledge namely: explicit knowledge and tacit knowledge. The explicit knowledge is transferred through formal means, such as conferences, meetings, seminars, and training sessions. Tacit knowledge on the other hand, is transferred in an informal manner, during job training sessions, telephonic communications, and other social occasions.

Apart from knowledge, potential barriers are also vital to be considered to the success of technology transfer. Li-Hua (2004) reckons that the barriers of knowledge transfer are known as cultural differences, language barriers, social values, and different objectives. Among others, culture difference could become the major barrier in ITT (Kedia and Bhagat, 1988). The cultural difference exists between the technology provider and the technology receiver. This is in line with the opinion of Black et al. (2000) and Malik (2002) pointed out that for the technology transfer to function properly, the organizations involved in the process should endeavor to build a culture of mutual trust through effective communication between transferor and transferee. Working in unfamiliar markets is often burdened with difficulties due to culture differences. New cultures and business practices require time to understand, placing greater pressure on international construction companies to adapt to their new surroundings (Malaysia Going Global, 2007).

Skills transfer however; comprise of the technical, managerial and institutional, which utilizes the capital equipment and technical information efficiently and could be also regarded as technological capabilities (Harris and Harris, 2004). Further, technological capabilities could be divided into four levels. The first level is production or operational capability in which skills are required to control the production process and the machinery in the plants or in the site. The second level is investment or acquisitive capabilities. It refers to search, assessment, negotiation, and procurement of relevant technologies as well as the installation and setting-up the production facilities. The third level refers to adaptive (minor change capability) in which the skills is required to digest the transferred technologies or improvements in the existing product. Finally, is the innovative (major change capability) in which skill is essential to perform research and development, products modifications and developing new products.

The tools of technology transfer could be referred as machine, electrical or mechanical component, a chemical process, software code, a patent and a technique. According to Bennett and Zhao (2004) the tools transfer could be benefited to developing countries in the form of generating greater revenues. Moreover, technology may be transferred between persons, between organizations, between regions and countries. Technology transfer occurs because of the existence seller (transferor) and buyers (transferee). Technology transfer normally refers to formal and direct arrangements between a transferee and a transferor or non-commercial arrangements between donor and recipient. This form of transfer in particular, may well be a two way process between transferor and transferee. Transferor and transferee play a major role in which, the transferor willing to transfer the technology and the transferee willing to learn the technology, hence encourages the technology transfer process.

The second stage refers to the different channels or modes of technology transfer which includes; direct, indirect, commercial and non-commercial channels (Cohen, 2004; Li-hua, 2004). The direct channels could be regarded as managerial and institutional comprising of operating international cooperation, licensing agreements, hiring expert and contractor, and training of technical staff to abroad. The indirect channels are the purchase machinery, exchange information at international meetings and attend exhibitions and trade fairs. The commercial technology transfer channels are described as foreign direct investment (FDI), joint venture (JVs), licensing, franchising, marketing contracts, technical service contracts, turnkey contracts and international subcontracting. Non-commercial technology transfer however, includes the review of technical publications (journals and books) and the training of foreign students (Benedetto et al. 2003). In short, firms from developing countries can accelerate the speed by which they can produce globally competitive products through rapid technology transfer from developed nations.

The third stage refers to project stakeholders and these could be the suppliers, governments, workers, managers and wider community representative that have a stake to ITT (Cohen, 2004). Stakeholders are those people or organizations who have vested interest in the industry. Stakeholders can be those who are affected by the industry, have influence and power over the industry, and have interest in the success and failures of the industry. Stakeholders are important as players to ITT despite the difficulties in defining significant stakeholders that could measure the benefits of technology transfer. The final stage is the benefit of technology transfer. Benefits are perceived in the form of improving project efficiency, effectiveness, increased profits strategic goal, user satisfaction, social & environmental impacts, personal development, professional learning, profit, minimized production problems and economy impact to surrounding community (Roger, 1962).

Given the above, the framework of ITT projects in Malaysia should comprises the five areas of concerned. These are: types of technology, the channels, stakeholders, barriers and benefits of ITT projects. More extensive empirical research works on these five areas are needed to refine for the future findings.

## 7. Conclusion

This research attempt to investigate International Technology Transfer (ITT) and development of technological capabilities in Malaysian Constructions Industry which reinforces the issues of types of technology transfer (knowledge, skill and tool), channels of technology transfer, technology capabilities, the involvement of stakeholders, the benefits and barriers that could emerged in ITT. The outcomes of the study could provide an insight in Malaysian construction project development and will hopefully provide valuable guidelines, especially to public or private sectors in Malaysia with regards to ITT.

The research presented in this paper is part of an ongoing PhD research at Faculty of Architecture, Planning and Surveying, UiTM to develop a framework of international technology transfer (ITT) and development of technological capabilities in Malaysian construction industry. The result of the study could provide an insight into the Malaysian construction project development and will hopefully provide valuable guidelines, especially to public or private sectors in Malaysia.

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Table 1.0: Types of Technology Transfer Models

Wei (1995)	Lin & Berg (2001)	Saad et al. (2002)	Putranto et al. (2003)	Daghfous, (2004)	Harris & Harris, (2004)
Technological content of technology transfer	A theoretical model for technology transfer effectiveness	The "extended life cycle" approach to the assessment of IT project success	Model of technology transfer as a process with a feedback loop	A conceptual model technology transfer	The Five 'M' frame work
<b>Major concerns</b> Technical change for technology importing countries -Exporting Firms -Importing Firms <b>Flow A</b> -capital goods -Technological services <b>Flow B</b> -Operating skills and Know-How <b>Flow C</b> -Knowledge, experience, expertise for generating and managing technical change	<b>The major factors affect the performance of ITT project</b> <b>The nature of technology</b> -Complexity -Maturity -Codification <b>International experience</b> -Transferee -Transferor <b>Cultural difference</b> <b>Result:</b> Cultural difference impacts on a TT project through complex mechanism	<b>Combination stages</b> <b>Traditional project life cycle</b> -Initiation -Development -Implementation -Hand-over <b>Technology Transfer stages</b> -Feasibility -Acquisition -Operation & maintenance -Disposal <b>Stakeholders</b> -Government -Managers & workers -Parent corporation -Capital suppliers -Subcontractors <b>Expected Benefits</b> -Improved efficiency -Improved effectiveness -Increased profit -Satisfied users -Contractor profit	-From the transferee point of view Four main stages -Preparation stage -Production stage -Operation stage -Evaluation stage Each stage to allow improving technology capabilities <b>Preparation stage</b> -Ideification project -Feasibility study -Specification of product -Negotiation <b>Production stage</b> -Design of product -Equipment improvement -Manufacturing product -Adaptation product <b>Operation stage</b> -Product operation -Product maintenance -Product repair <b>Evaluation stage</b> Dynamic learning	Relationship among learning processes, knowledge, and technology transfer projects -Prior knowledge -Learning processes -Project stage -Intended benefits -Unintended benefits	A sociotechnical system frame work of contemporary ergonomics and a frame work for assessing the likely effectiveness of technology transfer <b>Integration of</b> -User (human) -Machine -Mission -Medium -Management

Source: Wei (1995); Lin &amp; Berg (2001); Saad et. al. (2002); Putranto et al. (2003); Dagfous. (2004); Harris &amp; Harris (2004)

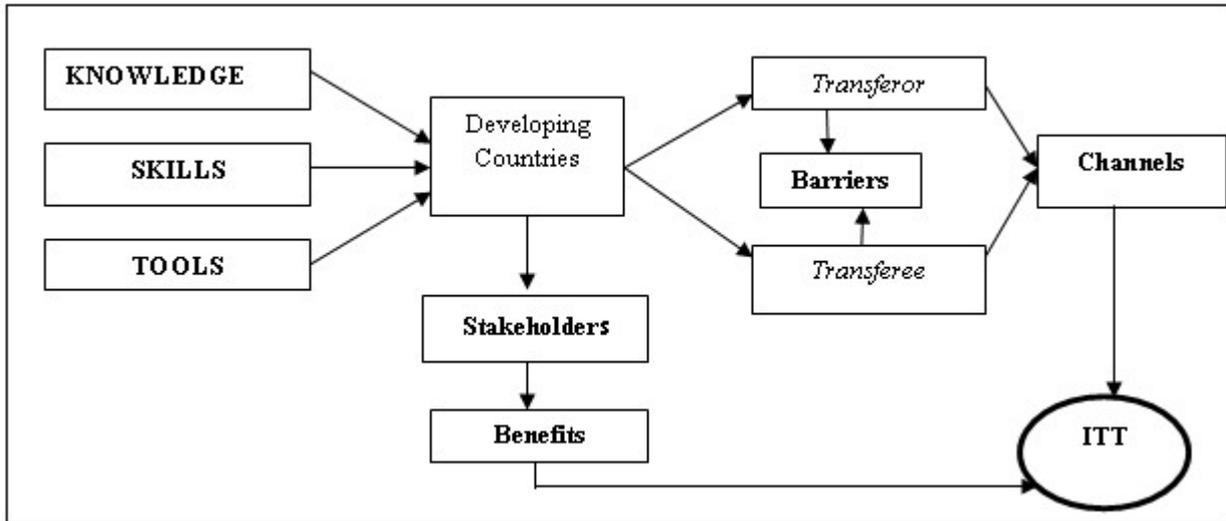


Figure 1. Proposed a Conceptual Framework for ITT projects in Malaysia