

# CAPACITY AND CAPABILITY BUILDING IN THE INDIGENOUS CONTRACTORS THROUGH TECHNOLOGY TRANSFER

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**ABSTRACT:** The indigenous construction firms in developing countries are characterized by mostly small and the lack of capacity and capability, confidence, motivation, long term aspirations, etc. Many are still struggling without basic foundation on which construction firms' internal strength depends on. The technology transfer has been one of the popular method for achieving the these objectives. It is expected that a substantial degree of technology would be transferred by foreign international contractors to indigenous contractors by the end of a contract period. However, the extent and quality of transfer varies with the parties involved. The variability in achieving a desired transformation objective is a major obstacle to the production of capable indigenous contractors. It is therefore, important to identify the factors affecting transformation performance; which include in this research, the internal characteristics of the receiving firms, the technology transfer program, and the type of technology. The respondents for this research were indigenous contractors with some past experience in technology transfer programs in construction projects in Malaysia. The findings of the research confirmed that the internal characteristics of firms, technology transfer program, type of technology and the transformation performance are significantly related.

**Keywords:** Capacity and Capability, Technology Transfer, Indigenous Contractors, Construction Industry, Developing Countries, Malaysia.

## 1. INTRODUCTION

The capacity and the capability of the construction industry in many developing countries, as in any infant industry, are still substantially deficient. These weaknesses are well known and had been widely reported (World Bank, 1984; United Nation, 1984; Kirmani, 1988; Turin, 1973; Wells, 1986). Various efforts were carried out to overcome these problems, including the introduction of the technology transfer program (Abbott; 1985). In construction, the formation of joint-ventures between local and foreign contractors has been recommended by the World Bank (1981). This is supported by Carrillo (1993), the integration of local and foreign constructors in construction projects can facilitate the transfer of technology. Numerous studies have been carried out on technology transfer in fields other than construction (Wallender III (1979), Germidis (1977), Bradbury (1978), Campbell (1984), Marton (1986), OECD (1981), Bennette and Zhao (2004) and many more). In construction, there are a few studies in technology transfer that had been carried out extensively. They are Drewer (1975), Abbot 1985), Mansfield (1992) Simkoko (1989), Carrillo (1993 and 1996), Ofori (1994).

In the process of the technology transfer in construction, it is expected that, at the end of the contract period, a substantial degree of technology has been imparted by foreign international contractors to indigenous contractors of host countries who will then be able to play a major role in undertaking similar projects in the future, both domestic and international. There are numerous factors affecting the performance of the transformation over time. It is assumed that the rate of success varies and is unique for each program and this depends on various factors, which include the internal factors of the receiving companies, the environments of host countries, the technology transfer program, and the type of technology in question.

ICCI - 2006

This paper investigates the impact of technology transfer on the capacity and capability development of the receiving construction companies with emphasis on factors affecting the transformation performance during the process of transfer of the required construction technology to the indigenous construction companies in Malaysia.

### **1.1. Research Objectives**

The main objective of the research is to study the role and contribution of technology transfer in developing and upgrading the capability and the capacity of the indigenous construction companies in developing countries from the receiving end. Other specific objectives are as follows:

1. To establish relationships between the degree of transformation and the factors affecting transformation,
2. To establish relationships between the factors affecting transformation, and
3. To establish the strength of these relationships.

### **1.2. Research Methodology**

A survey method was adopted where questionnaires were designed to obtain all the information needed for testing. 42 active Malaysian local contractors of various background and sizes and with experience in technology transfer were used as respondents in this study. Data collected was analysed with SPSS for Windows, a statistical package designed for social scientists. Since the numbers of respondents are small (n=42) and data are largely nominal and ordinal type, nonparametric statistical techniques were used. Thus, contingency table, chi-square test of association and Spearman's rank correlation are adopted in data analysis.

## **2. THE CONSTRUCTION INDUSTRY IN DEVELOPING COUNTRIES**

The construction industry in developing countries shares many of the problems as are found in the developed countries. According to Edmond and Miles (1984) the structure in developing countries is an extreme version of its developed country. There is a small number of large companies, often foreign-owned, who carry out the majority of the work (Kirmani, 1988). The World Bank (1984), Edmond and Miles (1984), Rau (1983), Kirmani (1988), UCERG (1972), Chang (1987), Abbott (1985) and many more have listed abandon of weaknesses, the construction industry in the majority of developing countries must be, as Wells (1986) put it, by any definition, 'inefficient', with low levels of productivity and high costs.

## **3. TECHNOLOGY TRANSFER**

In construction, technology transfer involves individuals at various level of an organization such as top and middle management and operative levels (Al-Jalal, 1991). The formation of joint ventures between local and foreign contractors has been recommended by the World Bank (1981). The integration of local and foreign construction companies in construction projects can facilitate the transfer of construction technology (Carrillo, 1993).

### **3.1 Technology Transfer In Construction**

According to Simkoko (1989), the technology transfer process in industrial projects differs somehow from construction projects, however both sectors undergo more or less similar phases in their realization. The evidence of similarity in life-cycles of the industrial and construction projects is seen in the following grouping of construction

project phases: conceptualization (i.e. conception, feasibility studies and inception); implementation (design, engineering and construction); and operation or utilization (Bell and Hoffman, 1981). In the construction delivery process, the capacities and capabilities are provided concurrently in the sense that construction techniques are employed in the project execution, while the know-how and managerial skills, and experience act as necessary inputs on the construction techniques. Thus, integration of both the local and foreign technological and managerial capabilities in the project delivery process can facilitate the transfer of technological capabilities to the developing countries (Simkoko, 1989).

### 3.2 Factors Affecting Technology Transfer

Many studies pointed out the important on the absorptive capacity in improving performance (Cohen and Levinthal, 1990, Mowery et al., 1996, Sher et al. 1996, Mukherjee et al. 2000, Santangelo, 2000). Lin, Tan and Chang (2002), in their studies have successfully identified various factors that are critical for determining the technology absorption capacity. Wallender III (1979), has discussed extensively on factors affecting technology transfer in his study in various industries, such as the variety of factors that influence the ability of a firm to receive and utilise technology can be grouped into three categories; firstly, the internal characteristics of the firms; secondly is the external environment and thirdly is the process of consultation. A total of 31 factors were identified as having some effects on the ability of the firm to receive and exploit technology.

## 4. RESEARCH MODEL

In establishing a relevant research model, a pattern of relationships has to be established by relating all the relevant variables. Adopting suggestions forwarded by Wallender III (1979), Mukherjee et al. (2000), Santangelo (2000) and Lin, Tan and Chang (2002), a model of transformation was established. The major variables affecting transformation can be identified as internal factors of the receiving companies, the program of technology transfer, and the type of technology (as shown in figure 1).

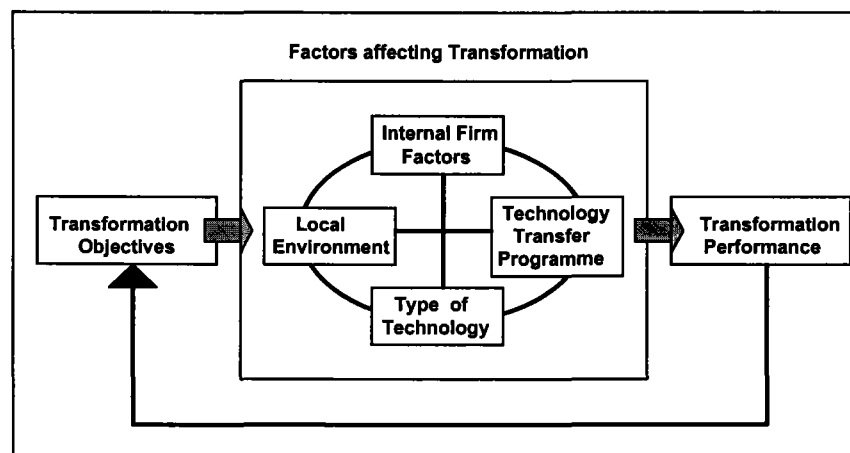


Figure 1: The Input-Output Model of the Transformation Process

### 4.1 Factors Affecting Transformation

Factors affecting transformation are numerous. This research, however, has identified and considered 4 major factors to be studied. They can be categorised as: the internal factors of the receiving companies, the environmental factors of host

countries, the program of technology transfer, and the type of technology (Bradbury and et. al., 1978; Wallender III, 1978; Simkoko, 1991; Collinson, 1992, Mukherjee et al. 2000, Santangelo, 2000 and Lin, Tan and Chang, 2002). This study does not include the aspect of environment as all respondents were from one country. It is reasonably acceptable to assume that the environmental factors are constant. The factors are as follows:

**1. Receiving Firms - Internal Factors**

**Management and Organization**

1. Management practices
2. Management style
3. Organizational structure

**The Historical Factors**

1. Stage of development
2. Technology acquisition history
3. Technology acquisition objectives

**Resources Factors**

1. Management resources
2. Technical resources
3. Financial resources

**2. Type of Technology**

Technology as knowledge:

1. General business
2. Industry specific
3. System specific
4. Company specific
5. On-going problem solving

**3. Technology Transfer Programme**

The mechanism used: direct

1. Mode of transfer
2. Training cost
3. Training duration
4. Management focus
5. Technical focus
6. Local company involvement
7. Transfer program

**4. Technology Transfer Performance**

1. Improved products
2. Improved process
3. Improved problem solving capability
4. Overall performance of technology transfer

**4.2 The dependent variable - the Variability in Transformation**

The variability of transformation in this case is actually companies' performance which can be measured in many forms. One of them is organizational effectiveness, described by organizational theorists in many different ways. It is difficult to identify which is an appropriate measure for this purpose. Steers (1980), Campbell (1983) and Schaan (1983) are among the many authors that discussed extensively on this matter.

The measurement adopted in this study includes financial (profitability), i.e., the change in profitability after their involvement in the technology transfer program; capacity, i.e., the change in the value of net assets after being involved in a technology transfer program and capability, i.e., the change in the stage of development in technology acquisition (Wallender III, 78) after involvement in a technology transfer programme.

**5 RESEARCH HYPOTHESES**

If one considers technology as a commodity that can be bought in the form of capital goods, which includes machinery and productive system and information, a very simplified mathematical model can be expressed to represent the argument (Bradbury, 1978; Simkoko, 1989) such as follows:

$Q_t = f(C, L, T, t)$ ; where  $Q_t$  is the production volume,  $C$  is the input of capital,  $L$  is the input of labour,  $T$  is the input of technology, and  $t$  is time.

Using the mathematical model of relationship suggested by Bradbury (1978) above, Simkoko (1989) has successfully carried out the test on his work which is related to factors impacting technology transfer in construction projects.

The question is:

*Is transformation performance a function of internal factors of firms? The technology transfer program? The type of technology? and technology transfer performance?*

This has led to the formulation of the overall hypothesis of this research which is: *when the technology transfer program and the type of technology involved are appropriate to the internal factors of firms, a better technology transfer performance can be achieved and this will induce a better transformation performance.*

The above hypothesis has generated five main hypotheses and they are as follows:

1. Transformation performance (TP) is a function of the internal factors of firms (IFF), the technology transfer program (TTP) and the type of technology involved (TT); in mathematical model, this hypothesis can be expressed as:  
 $TP \sim f(\text{IFF}, \text{TTP}, \text{TT}) \dots \dots \dots (1)$
2. Technology transfer program is a function of the internal factors of firm and the type of technology;  
 $\text{TTP} \sim f(\text{IFF}, \text{TT}) \dots \dots \dots (2)$
3. The type of technology is a function of the internal factors of firm;  
 $\text{TT} \sim f(\text{IFF}) \dots \dots \dots (3)$
4. The technology transfer performance (TTPerf) is function of technology transfer program and the type of technology involved; and  
 $\text{TTPerf} \sim f(\text{TTP}, \text{TT}) \dots \dots \dots (4)$
5. The transformation performance is a function of technology transfer performance.  
 $\text{TP} \sim f(\text{TTPerf}) \dots \dots \dots (5)$

This study incorporates 5 main variables. These main variables were then broken down into clusters of subvariables. To examine the overall hypothesis, 29 detailed hypotheses were constructed. To examine the 29 detailed hypotheses, each of them was broken down into detailed sub-hypotheses. A total of 545 sub-hypotheses were constructed. All the sub-hypotheses were expressed in terms of null hypotheses (Ho) for the purpose of applying test of association (see appendix 1).

## 6 ANALYSIS AND DISCUSSION

The research model developed in this study is intended to provide a framework for examining various variables influencing the transformation performance. Data gathered from the survey and interviews on the 42 construction companies in Malaysia were used to examine relationships between the variables within the model.

### 6.1 Background to The Sample

This research covers a period of 20 years, from 1970 to 1990. 42 Companies involved in this research were established in the seventies and eighties. About 26 companies (62%) were established in the seventies when construction was booming in Malaysia. Amongst the sample, a large proportion of respondents, 28 companies

(66%) in this research are in private ownership. 7 companies (16%) are large public companies, a few of them operating in the international arena. 5 companies are state owned where prefabricated housing is the major activity. 2 companies are owned by co-operatives, whose subsidiaries are involved in the less complex construction of low cost prefabricated housing, building of highways intersections and bridges. The majority of the samples were at the early stage of development before entering into a technology transfer program. 29 companies (69%) were in stage 2 or stage 3; searching for alternative technology. 10 companies were already in the process of acquiring alternative technology stage 4 (see table 1).

*Table 1. Stage of development before involving in the technology transfer*

No	Stage of Development before T. Transfer	Frequency	Percentage
1	Initial stage	2	4.8
2	Developing internal characteristics	12	28.6
3	Searching for alternative technology	17	40.5
4	Acquired alternative technology	10	23.8
5	Transfer technology	1	2.4
6	Total	42	100

## 7 ANALYSIS

In this section, analysis was carried out to examine the overall hypothesis of this study. This overall hypothesis was broken down, and shown in Table 2.

*Table 2. Summary of Hypotheses*

OVERALL HYPOTHESIS		
Main Hypotheses	Detailed Hypotheses	Sub-hypotheses
Main Hypothesis 1	10	120
Main Hypothesis 2	9	225
Main Hypothesis 3	8	140
Main Hypothesis 4	2	48
Main Hypothesis 5	-	12
Total	29	545

## 8 INTERNAL FACTORS OF FIRMS

From the analysis, the sub-variables of internal firm factors such as management practice, management style, organization structure, development stage 1, technology acquisition history, technology acquisition objective, technology transfer program and technology transfer were found to be highly and positively related to the transformation performance. Whereas type of ownership and resource factors were found to be relatively weakly related to the transformation performance.

### 8.1 Management Practices

The result of analysis shows that, contractors who practiced long range planning in their companies were found to achieve high performance in company's transformation. In terms of practicing management process, most of the respondents emphasized heavily on planning and organizing and less on controlling and leading. Result indicates that contractors who emphasized on planning and organizing achieved high performance in the transformation performance (see table 3).

Table 3. The association tests between sub-variables of Transformation Performance and sub-variables of management practices.

RELATIONSHIPS		CHI-SQ	Sig. Level P<
	<b>MANAGEMENT PRACTICE</b>		
1	Profitability and importance of long range planning are related.	0.61	0.00
2	Net Asset and importance of long range planning related.	0.54	0.00
3	Devt. Stage 2 and importance of long range planning are related.	0.51	0.02
4	Profitability and practice of long range planning are related.	0.57	0.00
5	Devt. Stage 2 and practice of long range planning are related.	0.58	0.00
6	Profitability and planning are related.	0.56	0.01
7	Net Asset and planning are related	0.48	0.06
8	Development Stage 2 and planning are related	0.51	0.03
9	Profitability and organizing are related	0.59	0.01
10	Net Asset and organizing are related	0.52	0.03
11	Development Stage 2 and organizing are related	0.57	0.01
12	Profitability and controlling are related	0.63	0.00
13	Development Stage 2 and controlling are related	0.58	0.02
14	Profitability and leading are related	0.51	0.02
15	Net Asset and leading are not related	0.47	0.08

## 8.2 Management Styles

On the style of management, interpersonal and human relation and superior make decision style seem to highly and positively relate to the transformation performance. Companies emphasized on interpersonal and human relation and superior decision making showed high achievement in the transformation performance (see table 4).

Table 4. The association tests between sub-variables of Transformation Performance and sub-variables of style of management.

RELATIONSHIPS		CHI-SQ	Sig. Level
	<b>MANAGEMENT STYLE</b>		
1	Profitability and high degree of formal authority are related	0.59	0.01
2	Net Asset and high degree of formal authority are related	0.48	0.02
3	Devt. Stage 2 and high degree of formal authority are related	0.51	0.01
4	Profitability and hi. deg. of interpers. and human rel. are related.	0.61	0.00
5	Net Asset and high degree of interpers. and human rel. are related.	0.54	0.01
6	Devt. Stage 2 and high deg. of interpers and human rel are related.	0.58	0.00
7	Profitability and hi deg dec makg made by superior are related.	0.49	0.01
8	Net Asset and hi deg dec makg made by superior are related.	0.51	0.01

## 8.3 Organizational Structure

On organization structure, analysis shows that the respond to changes in the external environment, the rate of change, the informal interaction, the interpersonal and informal coordination and the centralized decision making, the changing and adapting structural form were highly and positively related to the transformation performance.

The majority of the construction companies did respond to the changes in the external environment by changing their internal organization. Changing and adapting the structural form is one of the important characteristics of the organic structure of organization. Other characteristics such as informal interaction, interpersonal and informal coordination, centralized decision making, and faster response to changes in the environment were some of the characteristics that support the organic structure. Result of the analysis shows that construction companies, who adopted an organic structure of organization achieved high performance in transformation (see table 5).

*Table 5: The association tests between sub-variables of Transformation Performance and sub-variables of organization structure.*

	RELATIONSHIPS	CHI-SQ	Sig. Level
	<b>ORGANIZATIONAL STRUCTURE</b>		
1	Profitability and respond to change to environment are related	0.60	0.00
2	Net asset and respond to change to environment are related	0.54	0.00
3	Devt stage 2 and respond to change to environment are related.	0.58	0.00
4	Profitability and rate of change in the internal structure are related.	0.34	0.06
5	Net asset and rate of change in the internal structure are related.	0.32	0.08
6	Devt stage 2 and rate of change in the internal structure are related.	0.41	0.01
7	Profitability and formal activities are related	0.62	0.00
8	Net Asset and formal activities are related.	0.57	0.00
9	Development Stage 2 and formal activities are related.	0.58	0.00
10	Profitability and one way, top down directives are related.	0.61	0.00
11	Net Asset and one way, top down directives are related.	0.58	0.00
12	Development Stage 2 and one way, top down directives are related.	0.58	0.00
13	Profitability and interaction are related.	0.53	0.01
14	Net Asset and interaction are related.	0.51	0.02
15	Development Stage 2 and interaction are related.	0.52	0.02
16	Profitability and interpersonal and informal coordinatn are related.	0.57	0.01
17	Net Asset and interpersonal and informal coordination are related.	0.52	0.02
18	Devt Stage 2 and interpersonal and informal coordinatn are related.	0.57	0.00
19	Profitability and changing and adapting structural form are related.	0.58	0.01
20	Net Asset and changing and adapting structural form are related.	0.55	0.02
21	Devt Stage 2 and changing and adapting structural form are related.	0.63	0.00

#### 8.4 Historical Factors

##### i. Stage of Development 1

The analysis also shows that the stage of development of construction companies before entering technology transfer program (development stage 1) is highly and positively related to all the three subvariables of transformation performance, in particular with the stage of development after participating in technology transfer (development stage 2) (see table 6).

Construction companies with a higher development stage before entering technology transfer program, achieved higher stage of development after participating in technology transfer. 17 companies (40%) were at stage 3, i.e. searching for alternative technology, before entering technology transfer program and about 50% of the respondents move to stage 6 and 7 (i.e.; the stage of maintain and modify technology and the stage of developing new technology) after leaving technology transfer program.



*Table 6: The association tests between sub-variables of Transformation Performance and sub-variables of stage of development 1.*

RELATIONSHIPS		CHI-SQ	Sig. Level
<b>DEVELOPMENT STAGE 1</b>			
1	Profitability and development stage 1 are related.	0.53	0.03
2	Net Asset and development stage 1 are related.	0.46	0.01
3	Development Stage 2 and development stage 1 are related.	0.77	0.00

**ii. Technology Acquisition History**

On technology acquisition history, result of the analysis shows that, experience in technology transfer projects and number of local contractors' involvement in the technology transfer projects were positively related to transformation performance. This indicates that construction companies, who had experience in the projects that involved technology transfer, performed better than construction companies without experience. The result shows that, the more experience a company has on technology transfer, the better the transfer performance is and hence, also increased the transformation performance (see table 7).

*Table 7: The association tests between sub-variables of Transformation Performance and sub-variables of technology acquisition history.*

RELATIONSHIPS		CHI-SQ	Sig. Level
<b>TECHNOLOGY ACQUISITION HISTORY</b>			
1	Profitability and experience in t.t. project are related.	0.34	0.06
2	Net Asset and experience in t.t. project are related.	0.32	0.08
3	Development Stage 2 and experience in t.t. project are related.	0.35	0.06
4	Net Asset and no. of t.t. project involved are related.	0.46	0.08

**iii. Technology Acquisition Objective**

On the technology acquisition objective, all the subvariables were positively related to transformation performance. Majority of the construction companies had given greater emphasis and highly valued construction technology. High performance companies show that they were searching for upgrading existing technology and also searching for new construction technology. Thus, technology acquisition objective is highly and positively related to the transformation performance (see table 8).

*Table 8: The association tests between sub-variables of Transformation Performance and sub-variables of technology acquisition objective.*

RELATIONSHIPS		CHI-SQ	Sig. Level
<b>TECHNOLOGY ACQUISITION OBJECTIVES</b>			
1	Profitability and importance of construction technology are related.	0.54	0.00
2	Net Asset and importance of construction technology are related	0.51	0.01
3	Development Stage 2 and importance of construction technology are related	0.55	0.00
4	Profitability and upgrading existing technology are related	0.43	0.05
5	Net Asset and upgrading existing technology are related	0.49	0.01
6	Development Stage 2 and upgrading existing technology are related	0.51	0.01
7	Profitability and searching for new technology are related	0.46	0.03
8	Net Asset and searching for new technology are related	0.41	0.07
9	Development Stage 2 and searching for new technology are related	0.46	0.03

#### iv. Type of Ownership

The result shows that, type of ownership was not related to transformation performance. However, among the high performance companies were public and private companies. Other types of ownership, such as sole proprietors and government owned companies, show lower performance in transformation (see table 9).

*Table 9: The association tests between sub-variables of Transformation Performance and sub-variables of type of ownership.*

	RELATIONSHIPS	CHI-SQ	Sig. Level
	<b>TYPE OF OWNERSHIP</b>		
1	Profitability and ownership type are not related.	0.43	0.29
2	Net Asset and ownership type are not related.	0.44	0.25
3	Development Stage 2 and ownership type are not related.	0.46	0.16

#### v. Resource Factors

On resource factors, skill resources and the company's net asset show some forms of relation to transformation performance. However, management resources were not related to transfer performance. The possible explanation for this is that, most of the technology transfer program focused on transferring technical expertise to the local contractors (see table 10).

*Table 10: The association tests between sub-variables of Transformation Performance and sub-variables of resource factors.*

	RELATIONSHIPS	CHI-SQ	Sig. Level
	<b>RESOURCE FACTORS</b>		
1	Profitability and management resources are not related.	0.35	0.62
2	Net Asset and management resources are not related.	0.37	0.57
3	Development Stage 2 and management resources are not related.	0.44	0.26
4	Profitability and skill resources are not related.	0.47	0.17
5	Net Asset and skill resources are not related.	0.45	0.23
6	Development Stage 2 and skill resources are related.	0.50	0.06
7	Profitability and company's net asset are related.	0.55	0.01
8	Net Asset and company's net asset are related.	0.54	0.01
9	Development Stage 2 and company's net asset are related.	0.54	0.01

## 9. TECHNOLOGY TRANSFER PROGRAMME

### 9.1 Mode of Transfer

On technology transfer program, all sub-variables except for mode of transfer, were related to transformation performance. Only two mode of transfer were involved in this study. They were joint venture and licensing. Most of the construction companies in the study involved in the joint venture type of transfer. 33 companies (60%) were involved in the joint venture. However, only 17 companies (50%) of them achieved high performance. Out of 9 companies involved in licensing type, about 5 of them achieved high performance. There is no evidence in this study showing that, one mode of transfer out performed the other. There were many other factors which influenced the performance. However, both methods had their own merits and did show some degree of success (see table 11).

*Table 11: The association tests between sub-variables of Transformation Performance and sub-variables of technology transfer program.*

	RELATIONSHIPS	CHI-SQ	Sig. Level
	<b>TECHNOLOGY TRANSFER PROGRAM</b>		
1	Profitability and mode of transfer are not related.	0.07	0.87
2	Net Asset and mode of transfer are not related.	0.29	0.14
3	Development Stage 2 and mode of transfer are related.	0.21	0.40
4	Profitability and training cost are related.	0.56	0.05
5	Net Asset and training cost are related.	0.54	0.07
6	Development Stage 2 and training cost are related.	0.54	0.08
7	Profitability and training duration are related.	0.53	0.02
8	Net Asset and training duration are related.	0.51	0.03
9	Development Stage 2 and training duration are related.	0.53	0.02
10	Profitability and management focus are related.	0.58	0.00
11	Net Asset and management focus are related.	0.49	0.04
12	Development Stage 2 and management focus are related.	0.52	0.02
13	Profitability and technical focus are related.	0.44	0.04
14	Net Asset and technical focus are not related.	0.33	0.27
15	Development Stage 2 and technical focus are related.	0.48	0.01
16	Profitability and involvement of local contractors are related.	0.61	0.00
17	Net Asset and involvement of local contractors are related.	0.55	0.00
18	Devt Stage 2 and involvement of local contractors are related.	0.42	0.02
19	Profitability and technology transfer program are related.	0.46	0.01
20	Net Asset and technology transfer program are related.	0.45	0.01
21	Development Stage 2 and technology transfer program are related.	0.54	0.00

## 9.2 Cost of Technology Transfer

The cost of technology transfer was negatively related to transformation performance. This shows that their relationship were inversely proportional. The higher the cost of technology transfer, the lower the transformation performance. Subvariables management focus, technical focus, local contractors involvement and transfer program were also strongly related to the transformation performance. The technology transfer program that highly focused on the management and technical levels shows high achievement in the transformation performance. High level of involvement by local contractors in the transfer program also shows high achievement in the transformation performance. The result also shows that, the transfer program that involved on-the-job training showed higher performance in transformation than the other (see table 11).

Thus, a properly designed technology transfer program, which is low training cost, high training duration, high focus on management and technical transfer, high local contractors' involvement and using on-the-job training program, show high achievement in the transformation performance.

## 10. TYPE OF TECHNOLOGY

On the type of technology involved in the transfer, the result shows that, types of technology involved were mainly the system specific, firm specific and on-going problem solving and these type of technology were highly and positively related to the transformation performance (see table 12).

*Table 12. The association tests between sub-variables of Transformation Performance and sub-variables of the type of technology.*

	RELATIONSHIPS	CHI-SQ	Sig. Level
	TYPE OF TECHNOLOGY		
1	Profitability and system specific knowledge are related.	0.44	0.03
2	Net Asset and system specific knowledge are not related.	0.36	0.20
3	Development Stage 2 and system specific knowledge are related.	0.40	0.09
4	Profitability and firm specific knowledge are related.	0.62	0.00
5	Net Asset and firm specific knowledge are related.	0.56	0.00
6	Development Stage 2 and firm specific knowledge are related.	0.55	0.00
7	Profitability and on going problem solving capability are related.	0.64	0.00
8	Net Asset and on going problem solving capability are related.	0.56	0.00
9	Development Stage 2 and on going problem solving capability are related.	0.57	0.00

## 11. OVERALL DISCUSSION

Overall result of associations between independent variables and the transformation performance variable shows that, associations involving the development stage 2 (the measure of transformation of capability) and profitability (the measure of transformation in terms of financial performance) show stronger relations than the associations involving the net asset performance (i.e. the measure of transformation of capacity). The weaker relations between net asset performance and the independent subvariables may be explained by the fact that accumulation of capacity is relatively slow for any construction company. Most of the construction companies preferred to hire the construction plant and equipment to avoid under utilization of the equipment and also to increase liquidity.

Among the detailed variables of the internal factors of firms that have strong relations with transformation performance subvariables were management practice, management style, organizational structure, stage of development reached before becoming involved in a technology transfer program, technology acquisition history, technology acquisition objective and resource factors. Amongst the subvariables of transformation performance that have strong relations with subvariables mentioned above were the stage of development 2 (i.e. the stage of development after involvement in the technology transfer program) and profitability. The subvariable net asset performance had weaker but still positive relations with majority of subvariables of internal firm factors. Hence, the result of the analysis supports the main hypothesis 1; transformation performance is a function of the internal factors of firms, technology transfer program and type of technology.

The main hypotheses 2 and 3, the majority of relationships between subvariables of technology transfer program, type of technology and the internal firm factors were found to be highly and positively related. The result of the analysis shows that the relationships of the three major variables under study were appropriate (see appendix 1). The main hypothesis 4, the technology transfer performance is a function of technology transfer program and the type of technology was formulated to support that the technology transfer program and type of technology were appropriately designed. The subvariables of technology transfer program and type of technology were highly related to the subvariables of technology transfer performance. Thus, the main hypothesis 4 is supported (see appendix 1).

Analysis, which involved the main hypothesis 5, shows that, the technology transfer performance is highly and positively related to the transformation performance. The result shows that high emphasis on the importance of the construction technology, high improvement in the products, production process and the overall technology transfer performance have resulted in high achievement in profitability, net asset performance and development stage 2. Thus, the above analysis indicates that high performance in the technology transfer has also induced high performance in the company's transformation (see appendix 1).

From the above analysis, it can thus be concluded that the overall hypothesis underlying this study: when the technology transfer program and the type of technology were appropriate to the internal factors of firms, better performance in the technology acquisition can be achieved and will induce better company's transformation performance is supported.

## **12. CONCLUSION**

The study has examined the prospect of technology transfer promoting the development of the host country's construction companies, as receivers and users of construction technology. In view of that, it is necessary to investigate factors influencing the variability of transformation of development and inherent potential mechanisms for transferring and acquiring technological and managerial capabilities. The systems approach; and management and organization theory were chosen concepts in identifying the variables, providing a frame of reference and for constructing the research model.

The study has also so far revealed that technology transfer does contribute in some way or another to the development of local contractors. The role and contribution of technology transfer in developing and upgrading the capability and the capacity of the local contractors, as shown in this study, is vital. The technology transfer program involving cooperation between local and international contractors has greatly contributed to the development of local contractors and thus, the objectives of the study were achieved.

This research has shed some light into the process of developing indigenous contractors from small and lack of capability and capacity into contractors that are more capable of doing so. It has also identified various factors (within the scope of the study) that can be considered vital to the development of the indigenous contractors through technology transfer. Findings of the research indicate that some factors have stronger influences on the transformation performance of indigenous contractors than others. Thus, with proper attention to vital factors, the rate of success in transferring the required technology can be expected to be higher.

For the benefit of the Malaysian construction industry and other developing countries, it is hopeful that this research has provided some limited but vital information on the process of technology transfer. Future initiatives in the area must seriously focus on some factors that were identified as vital so as to achieve a greater height of success in the performance of technology transfer. It is the expectation of the author that, the result of this research when put into practice, will contribute to future more positive technology transfer in construction.

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APPENDIX 1: CORELATION TEST RESULT

	LRP	LRM	P	O	C	L	FAU	IR	TO	DM	RCERC	FA	OD	I	Co	DEMSF		
LRP																		
LRM	.64*																	
P	.64*	.65*																
O	.76*	.71*	.79*															
C	.53*	.43*	.59*	.76*														
L	.55*	.33*	.39*	.54*	.50*													
FAU	.35*	.38*	.41*	.29	.19	.04												
IR	.59*	.49*	.67*	.58*	.36*	.15	.65*											
TO	.04	.13	.22	.10	.19	.07	.12	.18										
DM	.52*	.34*	.28	.40*	.32	.12	.27	.27	.01									
RCE	1.0*	.64*	.64*	.76*	.53*	.55*	.34*	.59*	.03	.52*								
RC	.57*	.37*	.37*	.47*	.33*	.20	.01	.42*	.22	.12	.56*							
FA	1.0*	.64*	.63*	.76*	.53*	.55*	.34*	.59*	.03	.52*	1.0*	.56*						
OD	.88*	.56*	.49*	.60*	.33	.40*	.44*	.57*	.01	.41*	.88*	.52*	.88*					
I	.68*	.49*	.50*	.47*	.28	.23	.28	.37*	.16	.44*	.68*	.42*	.68*	.58*				
Co	.58*	.34*	.29	.27	.22	.09	.24	.30*	.00	.42*	.57*	.41*	.57*	.51*	.75*			
DEM	.37*	.23	.25	.28	.15	.15	.46*	.39*	.16	.34*	.36*	.35*	.36*	.38*	.28	.40*		
SF	.75*	.50*	.46*	.42*	.15	.33*	.25	.52*	.07	.13	.75*	.61*	.75*	.79*	.47*	.57*	.36*	
SD1	.67*	.25	.20	.34*	.34*	.29	.09	.31*	.20	.22	.67*	.59*	.67*	.63*	.48*	.60*	.36*	.67*
TTEXP	.45*	.26	.40*	.47*	.24	.04	.03	.45*	.29	.03	.45*	.80*	.45*	.41*	.30*	.30	.35*	.51*
TTNO	.45*	.23	.36*	.46*	.25	.06	.05	.40*	.28	.01	.45*	.75*	.45*	.42*	.26	.27	.30	.52*
CT	.82*	.50*	.57*	.64*	.51*	.58*	.36*	.58*	.05	.45*	.82*	.43*	.82*	.72*	.46*	.37*	.26	.60*
UT	.71*	.36*	.37*	.47*	.38*	.25	.30	.47*	.07	.42*	.71*	.32*	.71*	.60*	.48*	.56*	.36*	.54*
NT	.66*	.34*	.47*	.56*	.23	.21	.08	.30	.04	.33*	.66*	.40*	.66*	.51*	.51*	.42*	.25	.51*
OT	.48*	.25	.41*	.60*	.37*	.21	.32*	.40*	.20	.23	.48*	.27	.48*	.50*	.26	.20	.08	.35*
MR	.43*	.38*	.68*	.55*	.41*	.26	.30	.38*	.42*	.17	.43*	.23	.43*	.36*	.40*	.21	.15	.36*
SR	.51*	.55*	.58*	.42*	.23	.09	.39*	.47*	.50*	.14	.51*	.45*	.51*	.47*	.51*	.43*	.30	.59*
NA	.64*	.62*	.48*	.60*	.56*	.32*	.35*	.46*	.19	.44*	.64*	.42*	.64*	.53*	.45*	.49*	.22	.57*
MT	.04	.05	.01	.17	.03	.15	.06	.08	.09	.07	.04	.19	.04	.11	.02	.04	.08	.07
TC	.23	.02	.10	.04	.13	.14	.46*	.25	.30	.30	.23	.07	.23	.44*	.24	.27	.45*	.25
TD	.69*	.49*	.54*	.53*	.36*	.42*	.11	.51*	.19	.28	.69*	.60*	.69*	.58*	.44*	.35*	.23	.73*
MF	.64*	.44*	.57*	.48*	.36*	.26	.33*	.58*	.20	.40*	.64*	.42*	.64*	.59*	.68*	.50*	.34*	.43*
TF	.65*	.67*	.54*	.54*	.37*	.36*	.18	.47*	.24	.14	.65*	.50*	.65*	.64*	.53*	.40*	.19	.68*
LCI	.59*	.52*	.48*	.55*	.29	.23	.53*	.40*	.14	.56*	.59*	.13	.59*	.52*	.41*	.41*	.32	.37*
TTP	.68*	.44*	.34*	.50*	.43*	.29	.13	.43*	.05	.44*	.68*	.42*	.68*	.58*	.47*	.63*	.19	.58*
GB	.22	.13	.03	.24	.12	.14	.27	.41*	.27	.15	.22	.37*	.22	.21	.32*	.27	.28	.24
IS	.14	.10	.14	.02	.28	.14	.41*	.19	.08	.03	.14	.15	.14	.11	.13	.22	.24	.29
SS	.68*	.59*	.52*	.61*	.34*	.36*	.02	.43*	.01	.31*	.68*	.43*	.68*	.55*	.55*	.42*	.10	.50*
FS	.68*	.46*	.53*	.49*	.34*	.30	.24	.60*	.16	.32*	.68*	.45*	.68*	.55*	.55*	.56*	.30	.61*
PS	.69*	.45*	.44*	.55*	.30	.32*	.23	.5*	.01	.26	.69*	.51*	.69*	.55*	.60*	.64*	.40*	.58*
PROFIT	.68*	.52*	.35*	.47*	.31	.21	.54*	.46*	.01	.49*	.68*	.35*	.68*	.71*	.58*	.58*	.44*	.54*
NASSET	.57*	.33*	.13	.33*	.06	.26	.33*	.16	.07	.50*	.57*	.19	.57*	.59*	.44*	.44*	.33*	.44*
SD2	.72*	.43*	.39*	.55*	.59*	.48*	.05	.32*	.23	.30	.72*	.47*	.72*	.58*	.53*	.44*	.11	.55*
TTPROD	.75*	.57*	.69*	.78*	.56*	.32*	.35*	.63*	.14	.44*	.75*	.47*	.75*	.63*	.52*	.33*	.21	.44*
TTPROC	.69*	.54*	.57*	.65*	.44*	.35*	.28	.56*	.11	.19	.69*	.38*	.69*	.54*	.56*	.42*	.30	.48*
TTSOLV	.71*	.40*	.58*	.62*	.43*	.36*	.24	.43*	.12	.24	.71*	.36*	.71*	.67*	.56*	.44*	.28	.54*
TTSATIS	.67*	.59*	.54*	.58*	.34*	.18	.50*	.49*	.05	.40*	.67*	.32*	.67*	.67*	.57*	.50*	.24	.57*



	SD1	TTEXPTTNO	CT	UT	NT	OT	MR	SR	NA	MT	TC	TD	MF	TF	LCI	TTP	GB	
<b>SD1</b>																		
TTEXP	.45*																	
TTNO	.50*	.95*																
CT	.57*	.31*	.29															
UT	.55*	.27	.31*	.60*														
NT	.38*	.40*	.42*	.55*	.61*													
OT	.30*	.27	.30	.49*	.31*	.38*												
MR	.08	.26	.22	.40*	.20	.28	.54*											
SR	.36*	.39*	.35*	.44*	.36*	.41*	.41*	.72*										
NA	.43*	.29	.27	.53*	.38*	.33*	.32*	.47*	.57*									
MT	.05	.31*	.25	.00	.06	.19	.23	.06	.11	.17								
TC	.27	.15	.11	.35*	.28	.03	.19	.05	.18	.15	.11							
TD	.52*	.51*	.50*	.76*	.48*	.46*	.33*	.43*	.48*	.45*	.06	.23						
MF	.38*	.36*	.32*	.56*	.46*	.31	.31*	.56*	.48*	.40*	.25	.38*	.61*					
TF	.42*	.39*	.40*	.48*	.35*	.32*	.34*	.53*	.61*	.61*	.05	.12	.53*	.60*				
LCI	.21	.24	.19	.44*	.38*	.38*	.11	.34*	.26	.54*	.20	.21	.36	.37*	.28			
TTP	.52*	.42*	.41*	.49*	.55*	.48*	.29	.26	.32*	.66*	.15	.19	.44*	.51*	.54*	.53*		
GB	.19	.33*	.28	.25	.24	.22	.34*	.10	.32*	.19	.28	.55*	.29	.24	.15	.08	.15	
IS	.01	.07	.05	.12	.17	.16	.08	.26	.33*	.08	.22	.06	.24	.15	.10	.51*	.05	.08
SS	.39*	.41*	.45*	.53*	.42*	.50*	.22	.40*	.34*	.47*	.22	.08	.59*	.59*	.55*	.48*	.52*	.11
FS	.50*	.41*	.41*	.59*	.73*	.60*	.37*	.43*	.53*	.38*	.01	.04	.66*	.58*	.55*	.35*	.55*	.26
PS	.57*	.51*	.46*	.57*	.73*	.62*	.31*	.21	.36*	.35*	.14	.10	.52*	.51*	.49*	.48*	.60*	.24
PROFIT	.51*	.35*	.29	.58*	.35*	.34*	.25	.26	.34*	.55*	.07	.40*	.39*	.50*	.45*	.70*	.51*	.22
NASSET	.42*	.22	.15	.43*	.29	.29	.08	.03	.07	.37*	.01	.37*	.25	.25	.16	.65*	.33*	.03
SD2	.76*	.34*	.42*	.58*	.53*	.37*	.27	.23	.34*	.54*	.04	.11	.52*	.47*	.54*	.29	.59*	.15
TTPROD	.37*	.41*	.42*	.64*	.60*	.57*	.59*	.54*	.49*	.52*	.17	.05	.60*	.57*	.55*	.38*	.52*	.20
TTPROC	.38*	.38*	.39*	.51*	.66*	.50*	.24	.25	.27	.35*	.14	.02	.48*	.48*	.48*	.45*	.54*	.21
TTSOLV	.25	.30	.35*	.48*	.56*	.49*	.42*	.53*	.34*	.37*	.11	.10	.51*	.68*	.59*	.43*	.57*	.05
TTSATIS	.25	.33*	.30	.58*	.53*	.57*	.58*	.67*	.66*	.59*	.12	.27	.49*	.53*	.66*	.55*	.53*	.29

	IS	SS	FS	PS	PROFIT	NASSET	SD2	TTPROD	TTPROC	TTSOLV
<b>IS</b>										
SS	.07									
FS	.27	.63*								
PS	.25	.57*	.80*							
PROFIT	.29	.58*	.46*	.52*						
NASSET	.22	.39*	.16	.39*	.78*					
SD2	.09	.53*	.44*	.41*	.46*	.31*				
TTPROD	.06	.55*	.61*	.55*	.32*	.11	.56*			
TTPROC	.25	.54*	.61*	.74*	.35*	.17	.57*	.73*		
TTSOLV	.14	.51*	.53*	.49*	.35*	.16	.41*	.63*	.66*	
TTSATIS	.31	.50*	.60*	.52*	.59*	.32*	.30	.65*	.47*	.65*

\* - Signif. I.E. .05

## **ABBREVIATIONS**

LRP - Long Range Planning  
LRM - Long Range Management  
P - Planning  
O - Organizing  
C - Controlling  
L - Leading  
FAU - Fix Assets Acquisition  
IR - Interpersonal and Human Relation  
TO - Technology to Other Firms  
DM - Decision Making  
RCE - Respond to Changes Occur in the External Environment  
RC - Respond to Changes  
FA - Formal Authority

### OD – Internal Organizational Change

I - Internal Activities  
Co - Co-ordinations  
DEM – Decision Making  
SF - Structural Form  
SD - Stage of Development  
TTEXP - Technology Transfer Experience  
TTNO – No. of Technology Transfer Projects  
CT - Construction Technology

UT - Upgrading Technology  
NT - New Construction Technology  
OT - Overall Performance of Technology  
MR - Management Process  
SR - Satisfied with the Results  
NA – Net Asset  
MT - Maintaining and Modifying Technologies  
TC - Technology Capabilities  
TD - Technology after Diagnosis  
MF - Motivated in the Firm  
TF - Technology to other Firms  
LCI – Local Contractor Involvement  
TTP - Technology Transfer Programmed  
GB - General Business  
IS - Industry Specific  
SS - System Specific  
FS - Firm Specific  
PS - Problem-solving  
PROFIT - Profitability  
NASSET - Net Asset Performance  
SD2 - Stage of Development After Tech Transfer  
TTPROD - Technology Transfer Product  
TTPROC - Technology Transfer Process  
TTSOLV - Technology Transfer Solve  
TTSATIS - Technology Transfer Satisfied