

The Concept of Absorptive Capacity in Technology Transfer (TT) Projects

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¹Abstract. The conceptualisation of absorptive capacity in technology transfer (TT) in construction organisations could occur simultaneously, involving the flow of imported technology (i.e., knowledge, skills and tools) via construction projects. The absorptive capacity is the ability of the firm to assimilate imported technology, depending on their organisational technological capabilities. There are numerous studies concerning absorptive capacity, but little empirical research has been conducted on how to measure the absorptive capacity of TT via construction projects into organisations.

This paper aims to investigate and review different models of measuring absorptive capacity of TT projects from several industries (i.e., manufacturing, construction and finance) to capture the critical variables for a successful transaction of absorptive capacity within organisations. Based on the consideration of these models, the paper proposes a conceptual framework for measuring absorptive capacity in TT projects. The framework emphasises the two-key components: employees' ability and motivation which are measured through performance appraisal, employees' training, performance-based compensation, and merit based promotion. The goal of TT is to measure the level of absorptive capacity in the form of knowledge, skills and tools via construction projects to improve local technological capabilities for construction organisations.

Keywords: Absorptive capacity, Technology Transfer (TT) and Technological Capabilities

1. Introduction

Importing technology is important for the development of indigenous technology of a developing country such as Malaysia (Sanusi, 2008). This phenomenon is known as technology transfer (TT) from a country to another. Technology is a collection of physical processes that transform inputs into outputs with procedural techniques and organisational arrangements for carrying out the transformation (Bell et al. 1984; Putranto et al. 2003; Wie, 2003). Technology can also be defined as technical knowledge and could also be associated with a machine, an electrical or mechanical component, a chemical process, software code, a patent, a technique, communication, or a combination of different components. The transfer of technology could take place from one entity to another, from one organisation to another or from one country to another, while the components of TT process encompasses the transfer of skills, technical know-how, machinery and other capital equipments (Wie, 2003; Li, Hua, 2006).

The success of TT processes depends on the roles of employees within firms to yield the optimal benefit of TT. According to Davenport and Prusak (2000), these roles are fulfilled by the ability to operate, learn, acquire, absorb and apply new external technologies and knowledge embedded in product materials to maintain and sustain high level of production. As TT involves the process of transmission and absorption of knowledge, the recipient firm's ability to absorb the knowledge transferred is depended on the degree of their

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absorptive capacity (Sazali et al., 2009). However, Lin et al. (2002) noted that in the real world; firms cannot successfully assimilate and apply external knowledge without greater absorptive capacity. Hence, it is worthwhile exploring the critical variables/ components of absorptive capacity through its impact on transfer performance via construction projects.

Absorptive capacity of a firm is primarily a function of the recipient firm's level of prior related knowledge. Prior related knowledge is closely related to the individuals units of knowledge available within the organisations. Prior related knowledge which includes basic/minimal skills, a shared language, positive attitude towards learning, relevant prior experience and up-to-date information on knowledge domain, is critical for an organisation to assimilate and exploit new knowledge (cited in Sazali et al. 2009; Cohen and Levinthal, 1990; Szulanski, 2003 and 1996). Based on this notion, an organisation's absorptive capacity does not simply depends on the organisation's direct interface with the external environment, but on the transfer of technology (i.e., knowledge, skills and tools) across and within sub-organisations (Cohen and Levinthal, 1990). Thus, to understand the sources of a firm's absorptive capacity, this study attempts to investigate the critical elements of absorptive capacity in TT projects based on the different models across the globe.

The study is purely based on literature review. It reviews the theoretical aspects of research work of absorptive capacity models in manufacturing, finance and construction industries. The decision to undertake literature review as the main methodology for the study arises from the desire to survey the latest knowledge on the field from the international experts to capture relevant issues with regards to absorptive capacity. A rigorous literature review would provide breadth and scope of the study to be undertaken.

2. Concepts of Absorptive Capacity in Technology Transfer (TT) Via Construction Projects

The concept of absorptive capacity has been extensively reviewed in both theoretical and empirical studies. According to Leonard-Barton (1995), starting in the late 1980s, much research attention has been directed to the processes of learning and knowledge transfer, especially in the context of TT projects. Both streams of literature, on TT and organisational learning, increasingly recognise and provide empirical evidence of the unintended (i.e., spill over) benefits that are achieved through learning activities performed by the recipient firm during a technology transfer projects. For inter-organisational collaborations in general, important intangible benefits are primarily of the learning type, how to transfer knowledge across alliances and to locate the firm in its capability of enhancing network positions (Daghfous, 2004 and Powell et al. 1996).

Once again, Davenport and Prusak (2000) cited in Daghfous (2004) stated that the knowledge process consists of transmission and absorption, culminating in a behavioral change by the recipient. They considered lack of absorptive capacity in the recipient as friction, which slows or prevents technology transfer. The success of organisational learning is depended on the firm's absorptive capacity, which itself is determined by the firm's prior related knowledge (Kim, 1998). This prior related knowledge confers to the recipient's firm ability to recognise the value of new knowledge, assimilate, and apply to commercial ends. This ability was labeled as *absorptive capacity* by Cohen and Levinthal (1990).

Most studies focus on absorptive capacity which provides evidence that R&D could generate new knowledge for firms, enhances its ability to assimilate and exploiting existing knowledge (Cohen and Levinthal, 1989). They argued that R&D provides a spillover benefit, which consist of enhancing the firm's ability to learn from external sources of knowledge and, subsequently create new knowledge. Nevertheless, some industries failed to manage sufficient resources (time and people) in an attempt to improve some of their existing technology for the fact that the employees were too busy with their current and required tasks. In normal circumstances, employees had very little time to learn new technology other than what was needed to perform their immediate jobs (Daghfous, 2004).

In many instances, knowledge sharing and transfer within the company were mainly through informal discussions. Although newsletters were used to share information and insightful experiences, lesson learned from previous projects were not properly documented for future references. Some companies failed to have systematic procedure for documenting lessons from past projects (Daghfous, 2004). In TT projects, the recipient organisation is essentially a learning system and TT is a learning process that results in intended and unintended benefits. Therefore, from the recipients firm's perspective, it is the manager's responsibility

to lead the development of the requisite absorptive capacity, prior related knowledge, and learning processes that would maximize these of benefits (intended and unintended) to the firm from the TT projects.

Given the above, various models of absorptive capacity have been investigated from the literature. These models of absorptive capacity are taken from various industries namely: manufacturing, construction and finance. These models serve to enlighten the critical variables that are needed to mark successful transaction and practical issues in the TT processes. The purpose is to review the existing absorptive capacity models from different authors (i.e., Minbaeva et al. 2003; Abu Bakar, 2004; Escribano, 2008; Liao, 2009; and Sazali et al. 2009) in order to capture critical variables for successful transaction of absorptive capacity of TT process via construction projects.

3. Absorptive Capacity Models

Table 1.0 presents five types of absorptive capacity models gathered from various researchers across the globe. A conceptual model of absorptive capacity developed by Minbaeva et al. (2003) covers 169 subsidiaries of multinational corporations (MNCs) operating in the USA, Russia, and Finland, focusing on manufacturing industry. The data was collected through questionnaire survey. Minbaeva et al. (2003) have classified the measurements of absorptive capacity into three categories: employees' ability and employees' motivation which are underpinned by control variables in the form of company age, company size, share of expatriates and strategic mission.

Minbaeva's model of manufacturing industry contributed to the conceptualisation of absorptive capacity by emphasising *employees' ability* and *employees' motivation* as the important aspects of absorptive capacity. The employees' ability relates to job related skills and educational level. Employees' motivation on the other hands is a measure of the overall motivation of a company's employees which consists of *performance based compensation* and *merit based promotion*. Performance based compensation is measured by the proportion of employees who have the opportunity to earn individual, group or company-wide bonuses, and merit based promotion pertaining to qualified employees have the opportunity to be promoted to better paid positions. The study by Minbaeva explores various types of organisational mechanism to increase absorptive capacity through employees' ability and motivation. The strength of this model is that the overall concepts are easily understood and very simple to implement.

Abu Bakar (2004) proposes a theoretical model of absorptive capacity for effectiveness of TT in projects. The data were gathered from 42 Malaysian construction companies by means of questionnaire to examine the relationships between *independent* and *sub-variables*. The independent variables are financial, capacity, and capability. The sub-variables however, consist of experience in TT projects; the number of TT projects undertaken; ownership; resource; TT programme and technology as knowledge. This model is comprehensive in nature, but is more suitable to measure the technological capabilities of employees in the organisation instead of absorptive capacity via construction projects. One of the weaknesses of this model is that the variables are not grouped based on employees' ability and motivation and failed to focus on measuring of absorptive capacity.

Escribano et al. (2008) develop a model of absorptive capacity on innovation performance. The dataset used in this study is assembled from the Community Innovation Survey (CIS) conducted in Spain. The survey collects detailed information about innovation activities for manufacturing Spanish firms by using questionnaires to 4000 firms. In this model, they focused on three important variables: *innovation performance*, *external knowledge flows* and *absorptive capacity*. Innovation performance could be measured by percentage of total annual sales over the period 2000-2002. The external knowledge flows is the catalyst for innovation which composed of seven components (suppliers, clients, competitors, universities, research institutions, specialized journals and meetings). The absorptive capacities are the internal R&D expenses, staff R&D department, training for R&D personnel, and the ratio of scientist and researchers to total employees. The model looks simple but is difficult to implement in most construction firms due to the unavailability of R&D departments in most construction companies.

The model by Liao (2009) presents a sociotechnical system framework for finance and manufacturing industries. With 362 valid questionnaires from manufacturers and financial industries in Taiwan, they examined the relationships between *absorptive capacity*, *knowledge acquisition* and *innovation capability*

using statistical analysis. They pointed out that in order to grasp the sources of a firm's absorptive capacity, one should concentrate on 'how the communications between the firm and the external environment are organised'. This could also include the 'nature of the know-how and experience within the organisation'. The study is in line with the ideas of Nieto and Quevedo (2005) which stated that it is vital to consider factors such as communication, level of know-how, diversity and strategic positioning as important components of absorptive capacities. This model is more suitable for contractors to benchmark their physical productivity performance with other organisations. The concept behind the model looks simple and straightforward, but has been criticised due to the lacks of clarity on how to measure the absorptive capacity, and hence is not recommended for construction organisations.

Table 1: The measurements of absorptive capacity in technology transfer (TT)

Industry	Manufacturing	Construction	Manufacturing	Finance & Manufacturing	Manufacturing
Country	Finland, Russia, & USA	Malaysia	Spain	Taiwan	Malaysia
Author	Minbaeva et al. (2003)	Abu Bakar (2004)	Escribano et al., (2008)	Liao (2009)	Sazali et al., (2009)
Sample	Questionnaires -168 subsidiaries company Respondents: 1) General Managers (GM)/ Deputy GM 2) HR Managers	Questionnaires -42 Malaysian local contractors	Questionnaires - 4000 firms	Questionnaires -362 responses - 2 industries; 1) Manufacturing 2) Financial	Questionnaires -128 JV companies
Measurement	Measures by: 1)Employees' ability • Performance Appraisal • Employees' training 2) Employees' motivation • Performance based compensation • Merit based promotion 3)Control Variables • Subsidiary/company age • Subsidiary/Company size • Share of expatriates • Strategic mission	Measured by: Independent variables 1) Financial (profitability) - Difference between total annual revenue and total annual cost 2) Capacity - Net assets 3) Capability - The 8 stages of development to indicate the level of capability of company Sub-variables 1) The experience in TT project 2) The number of TT projects undertaken 3) Ownership 4) Resource factors - Management resource - Technical resources - The company's net assets 5) The TT programme - Mode of transfer - The training cost - Training duration - Involvement of local contractors - The transfer program (e.g., on the job training, full time courses, part time courses, in house operation manuals) 6) Technology as Knowledge - The general business technology - The industry specific technology - The system specific technology - The firm specific technology - The technology as an on-going problem solving capability	Measures by: 1) Innovation performance - Percentage of total annual sales (turnover company) 2) External knowledge flows 3) Absorptive Capacity - The internal R&D expenses - Staff R&D department - Firm provides training for its R&D personnel - The ratio of scientist and researchers to total employees	Measured by: 1) The links between the firm and the surrounding environment 2) The level of knowledge and experience of the organization 3) The diversity and overlapping of knowledge structure 4) The strategic posture for measuring AC	Measured by: 1) Academic background 2) Technical capacity 3) Educational programs 4) Financial support for new ideas 5) Overseas training opportunities 6) Commitment in terms of personnel and resources (physical, financial and logistic)

Sazali et al. (2009) propose a model of absorptive capacity using the quantitative analytical approach. The model was tested based on empirical data gathered from 128 joint venture manufacturing companies. They identified six important variables which include: academic background, technical capacity, educational programmes, financial support, overseas training opportunities, and commitment. In their study, absorptive capacity is regarded as one of the critical elements of TT projects. The strength of this model is that it is easy to understand and comprehensive, taking into consideration of technology recipients' viewpoint.

Given the above, most of the models, if not all; are stressing on measuring the absorptive capacity of TT by identifying the technology transfer phases. Not withstand the common focus on absorptive capacity for firms; the results of the studies are depended upon the perspectives of each individual industry. In all the studies, the absorptive capacity model developed by Minbaeva et al. (2003) seems to provide a complete measurement of absorptive capacity process. With the exception of the model developed by Abu Bakar, the models developed by Escribano et al. (2008), Liao (2009) and Sazali et al. (2009), on the other hand, are comprehensive and yet simple to understand. A detail analysis show that those variables emerged from these

models is applicable for the construction industry. Hence, these models could be used as a guideline, in developing a model for measuring absorptive capacity in TT projects for construction organisations.

4. Propose Conceptual Framework

Figure 1 proposes a conceptual framework for measuring absorptive capacity in construction organisations. This has been developed based on integrating the various form of literature search and the understanding of the information gathered by the various models established by Minbaeva et al. (2003; 2004); Escribano, (2008); Liao, (2009) and Sazali et al. (2009) tailored to the context of the construction industry.

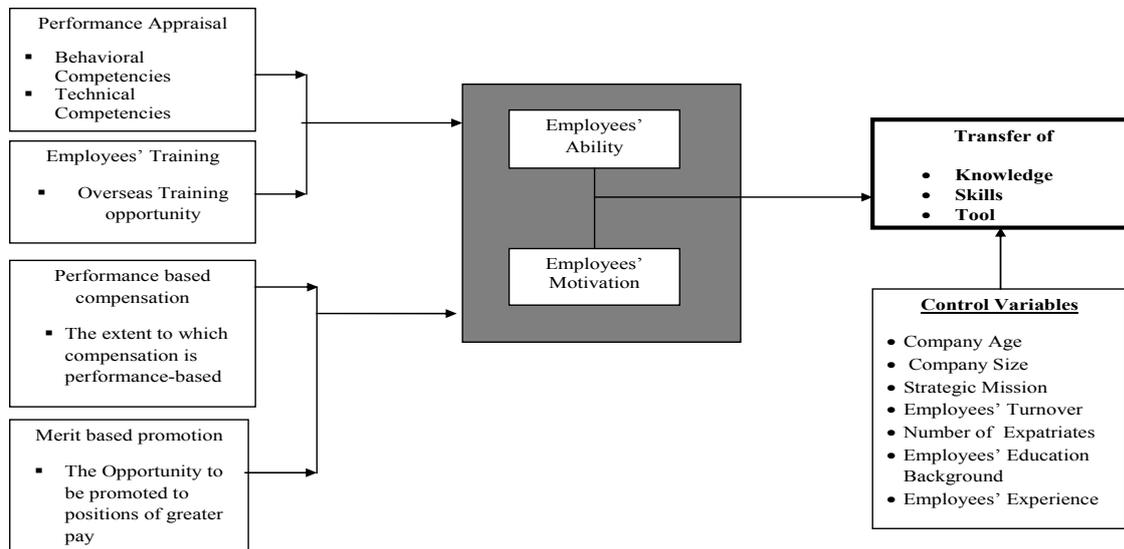


Figure 1: Conceptual framework of absorptive capacity in Technology Transfer (Source: Minbaeva et al. 2003; Liao, 2008; Escribano et al. 2009; Sazali et al. 2009)

Fundamentally, the proposed framework for measuring absorptive capacity in TT projects starts with the understanding of two main components: *the employees' ability* and *motivation*. This strategy is in line with the notion of Minbaeva et al. (2003), indicating that absorptive capacity are measured via the employees' ability and motivation. To measure the employees' ability, the critical variables included are *performance appraisal* and *employees' training*. Performance appraisal systems provide employees with feedback on their performance and competencies to meet the needs of the firm. An integrated part of most performance appraisal systems is also the establishment of firm's objectives and targets for the self-development and training of employees. There is also extensive evidence that investment in employees' training enhances the human capital of the firm, leading to positive relationship between employees' training and organisational performance (Delaney and Huselid, 1996; Koch and McGrath, 1996 cited in Minbaeva et al. 2003).

In spite of employees' ability, employees' motivation is another important variable to be measured. Huselid (1995) identified that the effectiveness of highly skilled employees will be limited if they are not motivated to perform. This means that human resource management (HRM) practices may influence individual or staff performances by providing incentives that elicit appropriate behaviors. Such incentive systems include *performance based compensation* and *merit based promotion*. Both of these variables could help employees to overcome invisible barriers to their career growth (Huselid, 1995 cited in Minbaeva et al. 2003). This is in line with the opinion of Pfeffer, (1994); Lepak and Snell, (1999) indicating that promotion is a strong motivation for employees to work harder for all firms and organisations.

The outcomes of employee's ability and motivation would influence the measurement on the absorptive capacity of TT in the form of knowledge, skills and tools into organisations via construction projects. Knowledge, skills and tools could be transferred and shared among employees and extensive intra-organisational communication is likely to contribute to employees' motivation. The process of measuring the absorptive capacity is supported by seven *control variables* which ought to be accounted. These are: company's age, size, strategic mission, and turnover, number of expatriates, employees' education

background, and experiences. Foss and Pedersen (2002) reckon that older companies tend to be more independent and able to absorb more TT compared to the new companies.

Company's age is measured as the number of years the company has operated in the country, while company's size is measured as the total number of employees in the company. The strategic mission of the company usually describe as 'vision' of the company's future state. This mission will normally have been formed by the board of directors, or major strategists within the company and will usually be encompassed within some form of mission statement. To measure the strategic mission is usually based on the accomplishment of the mission statement (Takim, 2005). Meanwhile, in the context of HRM, employees' turnover is the rate at which an employer gains and losses employees. High employees' turnover can be harmful to a company's productivity if skilled workers often leave and the worker population contains a high percentage of novice workers.

The services of expatriates in the companies, could act as vehicles in which their knowledge, skill and experiences will be transferred to the respective employees. To a certain extent, the higher number of expatriates in a company, the more knowledge may be transferred. (Downes and Thomas, 2000; Bonache and Brewster, 2001 cited in Minbaeva et al. 2003). Finally, employees' education background and experience are measured by the level of knowledge and experience of the organisation. This formula followed the work of Drucker and Ferdinand (1993) stating that the procedure of acquiring and identifying knowledge through the experience and reconciliation in an organisation will assist administrative and technology transfer and technological innovation. Moreover, TT must rely on a base of common knowledge which comes from both inside and outside the organisation (Liao et al. 2009). Hence, an organisation's ability to absorb external knowledge, i.e. its absorptive capacity is closely related to knowledge acquisition.

Given the above, the framework for measuring of absorptive capacity in construction's organisations emphasising the employees' ability and motivation which are strongly supported by performance appraisal, employees' training, performance-based compensation and merit based promotion. The outcomes of TT in the form of knowledge, skills and tools is then reinforced by control variables (company age, size, strategic mission, and turnover, number of expatriates, employees' education background, and experiences). The impacts of TT on organisational performance however, could be measured via the level of absorptive capacity of the firms based on the proposed framework. More extensive empirical research works on measuring absorptive capacity based on the proposed framework are required to enhance for future findings. Considering these variables, a further empirical research in the form of case studies and semi semi-structured interviews of the six (6) international companies, involving in international projects, are currently being collected in order to tackle the overall aim and objectives of the research. A document analysis methodology would be useful for data elicitation prior to reaching any final conclusion. These processes are underway and the outcomes of the empirical research will be reported in the future.

5. Conclusion

Many frameworks that have been developed to measure the absorptive capacity are found to be more theoretically based rather than empirically proven. Realizing this, the paper attempts to develop a framework of absorptive capacity in technology transfer (TT) in construction organisation based on the experience learned from United State of America, Finland, Spain, Taiwan, and Malaysia. It highlighted two remarkable points: employees' ability and motivation which are measured through performance appraisal, employees' training, performance-based compensation, and merit based promotion. The goal of TT is the level of absorptive capacity in the form of form of knowledge, skills and tools via construction projects into organization. TT is supported by seven control variables (i.e., company age, size, strategic mission, and employees' turnover, number of expatriates, employees' education background, and experiences) which are also measured and accounted to capture results of absorptive capacity of TT within organisations. Firms are required to pay high attention on absorptive capacity of TT via construction projects from the initial stage of projects implementation. Firms with high absorptive capacity of TT at the early project stage are claimed to produce a better technological capabilities among employees.

Therefore, to acquire a successful absorptive capacity of TT in any organisation, it is important to consider the level of absorptive capacity and technological capabilities, the competency of local stakeholders/practitioner, the organisational and managerial cultures, the role and structure, the needs and

expectation of the organisations itself. In considering of these variables, a further empirical research is needed.

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

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