Technology Strategy and Performance: A study of Information Technology Service Providers from Selected Asian Countries.

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ABSTRACT

The provision of information technology (IT) services to support a wide range of information and communication technology (ICT) products has experienced rapid growth in recent years, particularly in less developed countries in Asia. This paper develops a conceptual model to test the impacts of the technology strategy of IT service providers on two measures of performance based on the experience of a sample of 98 IT firms form Korea, China, Thailand and the Philippines. It is found that technology strategy related to the adoption and diffusion of technology contributes positively to both performance measures. While the technology capabilities of firms, both internal and external, are important for financial performance, internal technological capabilities are more effective for the firm's response to market changes. The technology competence of employees reflected by their education levels and the availability of in-house training are also found to be crucial for financial performance. The overall results suggest that technology strategy contributes significantly towards the performance of IT service providers but the impacts of different strategies on the financial and strategic performance of firms vary markedly.

KEY WORDS: TECHNOLOGY STRATEGY, SERVICE PROVIDERS, ICT, ASIA

1.0 INTRODUCTION

The contribution of technology to the performance of enterprises has attracted renewed attention from scholars over the last two decades given that today technology permeates almost every aspect of our lives. The last two decades have also experienced revolutionary innovations and rapid diffusion of information and communication technologies (ICT). And, together with increased globalization, the widespread adoption of the Internet and computer networks as the platform for electronic commerce (e-commerce) are changing the way firms compete in the

marketplace. Thus, a major issue for enterprises is related to the extent to which developments in information and communication technologies can enhance their performance. Although there are compelling theoretical arguments to suggest that differences in the performance of firms can be traced to difference in technological attributes, there is, however, little empirical support for what is almost considered conventional wisdom (Brynjolfsson and Yang, 1996).

The overall objective of this paper is to investigate the link between firms technology strategy and their performance with a particular focus on IT service providers from selected countries in Asia. More specifically, the paper assesses the extent to which technology strategy at the firm level contribute towards firm performance.

The focus on selected Asian IT service providers is prompted by the fact that this is an emerging and rapidly growing sector which remains under investigated despite the heavy reliance of many Asian economies on this sector. The ICT sector comprises both services and service embedded products such as computers, software development, systems engineering and, data communications and information appliances. Growth in world exports of ICT has been consistently higher than the average growth in manufactured exports throughout much of the last two decades (UNCTAD 2000). For example, according to the most recent data available, ICT exports increased by almost 5 folds from US$ 364 billion in 1990 to more than US$ 1.5 trillion in 2003 (UNCTAD 2006), while merchandise exports (excluding ICT products) increased at an annual rate of 10 percent during the same period . The ICT categories which have experienced the fastest growth include service embedded products such as computers and peripherals, computer parts and components, transistors and semiconductors and telecommunications equipment. Growth in the ICT industry in recent years has shifted from the traditional areas of IT manufacturing to more specialised areas focusing on the provision of a wide range of pure services to the ICT sector, including software development and a broad range of IT supported business services such as Business Process Outsourcing (BPO). The global IT services market is estimated to be worth between US$ 800 bil (Gartner, 2005) and US$ 917 bil (EITO 2005) with the USA (38%), Europe (33%) and Japan (14%) being the three major players (EITO 2005). According to McKinsey (2005), IT services will increasingly be outsourced to offshore locations, in particular to less developed economies in Asia, and by 2008 will employ an estimated 4 million people overseas.

Thus, this paper fills an important gap in the literature by contributing towards our understanding of the IT services sector in selected less developed Asian economies.

2.0 CONCEPTUAL MODEL AND HYPOTHESES

2.1 Technology Strategy

Broadly defined as 'know-how' or knowledge that improves our understanding about how to do things (Capon and Glazer, 1987), technology can be classified into one of the following three types; namely, product, process and management technologies. Although the benefits of advanced technologies are not immediately quantifiable, evidence suggests that the value created by innovation manifested in new ideas, business concepts, processes or products, can enable an innovating firm to pre-empt competition while rendering established rivals' positions obsolete (Hamel, 2000). It is widely believed that those who routinely perform minor innovations are more likely to be more competitive than those who do not, and those who are competing at the forefront of the technological frontier are more likely to lead the competition than those with no technological capabilities to speak of (Read, 2000). Hence in recent years, the management of technology has become the focus of attention of many enterprises, particularly among technology intensive firms and has given rise to the term technology strategy.

While a generic definition of the term is still lacking in the literature, technology strategy is generally understood to comprise a consistent pattern of decisions and actions relating to resource commitment for the development, appropriation, diffusion, and maintenance of technology set out to achieve certain organisational goals (Helfat and Rasbitschek, 2000). A technology strategy underpins the technological orientation of the firm, which involves the incorporation of technological development into a firm's corporate development agenda (Mytelka, 1999). Recent thinking about innovation suggests that success in today's competitive global environment not only requires firms to cultivate these technologies but also calls for a need to employ them strategically in the various functional areas of the firm's activities in order to enhance their overall performance.

The literature highlights three important elements of a technology strategy. Overall, the technology strategy of a particular firm involves (1) the internal development and/or external acquisition of technology (Freeman, 1974), (2) the adoption and diffusion of appropriate technology (Francisco et al., 1995), and (3) developing human resource capabilities to allow the integration of technology with other resources and capabilities of the organisation (Helfat and Rasbitschek, 2000; Mytelka, 1999; Powell and Dent-Micallef, 1997).

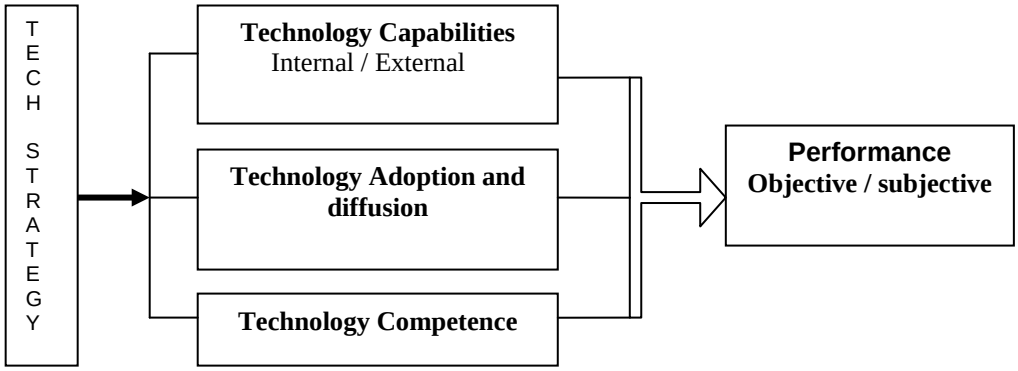
2.2 Performance

From the perspective of the firm, its performance is reflected in either financial or strategic measures. The vast majority of the literature has a tendency to view the performance of the firm from a financial standpoint. This is understandable to the extent that financial measures are readily available for research purposes. Financial measures have the advantage of being objective and include a broad range of sales and profit-related measures at either the corporate or product level (Cavusgil and Zou, 1994). However, the use of objective measures of performance is also known to have yielded inconsistent research findings (Zou and Stan, 1998) particularly in cross-national studies where significant variations in export market orientation are likely to be found (Clark et al., 1999; Doyle et al., 1988). This has led to a growing number of research using non-financial indicators of performance such as market responsiveness, operational efficiency, quality management techniques or competitive positioning in export markets (Clark et al., 1999; Cavusgil and Zou, 1994; Christensen et al., 1987; Leonidou and Katsikeas, 1996; Tesar and Moini, 1998). While non-financial measures can be operationalised in either objective or subjective terms, in most studies they have been associated with the latter. This is because strategic components are notoriously difficult to gauge in an objective manner and advocates of the subjective approach contend that a firm's own interpretation of its export performance is likely to be influenced by its organisational characteristics and managerial behaviour. Hence, the extent to which a firm's goals and objectives are achieved, from a manager's perspective, is a strong indicator of its success (Cavusgil and Zou, 1994; Evangelista, 1994).

Following the discussion above, a conceptual framework of the relationship between a firm's technology strategy and its performance is shown in Figure 1. For the purpose

of this study, three variables are used to capture the firm's technology strategy: (1) *Technology capabilities* refer to both internal and external strategies of the firm to develop its technological capabilities and base (2) *Technology adoption and diffusion* refer to the extent of technology adoption and diffusion within the organisation and (3) *Technology competence* refers to firm's strategy for developing technologically competent employees so that technology is fully integrated with other resources within the organisation. The model in Figure 1 posits that the firm's strategies for the development of its technology capabilities, the adoption and diffusion of appropriate technologies and the maintenance of a technologically competent workforce constitute the firm's main technology strategy orientation. Together these factors have the potential of having a major influence on the firm's overall performance.

Figure 1: A Conceptual Model of Technology Strategy and Performance



2.3 Hypotheses

2.3.1 Technology Capabilities: Internal / external

Typically firms face the choice of either developing a substitute or genuine technology in-house, out-sourcing the operation to external suppliers, or acquiring the technology from suppliers (Kraemer and Dedrick, 2000). Among these alternatives, in-house R&D has frequently been cited as a prerequisite to competitiveness. Generally measured in terms of R&D intensity, the scale of in-house R&D activities can be a relevant indicator of a firm's stock of technological capabilities by virtue of its significant contribution to the firm's knowledge stock (Neely and Hii, 1998). The ability to perform R&D not only contributes directly to the development of new products and processes, but also plays an important role in the adoption of

technologies developed outside the firm. Several studies have also found a positive relationship between export performance at either the firm or industry levels and R&D (Bleaney and Wakelin, 1999; Holzmuller and Kasper, 1998; Kumar and Siddharthan, 1994; Neely and Hii, 1998; Roper and Love, 2001). And, with reference to Asian firms in general, the majority of firms still rely heavily on technology transfer although the development of in-house R&D competencies has often been suggested to be a key element of late-comer strategy by East Asian firms (Ernst and O'Conner, 1989, 1992; Lall, 2001; Hobday, 1995; Mathews and Cho, 2000; Mytelka, 1999). Nevertheless, to the extent that in-house R&D represents an important technology strategy, R&D investments are expected to contribute positively to the performance of firms.

Within the context of technology strategy, innovation is viewed not just as an outcome of internal research and development (R&D), but also as a mechanism that builds on interactions with users, suppliers, public research organisations, government bodies and other external agents that are linked to the firm through either market or non-market transactions (Kraemer and Dedrick, 2000). Thus, the performance of the firm hinges not only on its own skills and competencies, but also on the support it receives from the external environment in which it operates (Maarten de Vet, 1993) and its ability to access knowledge from outside.

The most well-documented linkage relationships are those between buyers and sellers of capital goods, between users and producers of technologies, between firms with common or complementary technologies, and sourcing arrangements of multinational enterprises (MNEs) (UNCTAD, 1996). Many such linkages involve a collective learning process through which information exchange, technology sharing and coordinated investments can be facilitated. The growing importance of network linkages reflects the increasingly multi-disciplinary nature of technological innovation, which requires the integration of different knowledge inputs from a diversity of sources (Kaounides, 1999). Such linkage relationships occur because the market for truly tacit knowledge does not exist, and inherent differences in the skills and competencies of firms make it infeasible for a firm to capture the benefits of knowledge spill overs on its own (Madhok, 1997). Hence the following hypotheses:

H1a: Strategies to enhance the internal technological capabilities of IT service providers contribute positively to their performance.

H1b: Strategies to enhance the external technological capabilities of IT service providers contribute positively to their performance.

2.3.2 Technology adoption and diffusion

The processes by which firms adopt and diffuse technologies within their organisations are attracting increasing research attention. All too often, the rate and breadth of the adoption and diffusion of advanced technologies play at least an important, if not more important role than the ability to carry out innovation (OCED, 1996). In particular, the adoption and diffusion of advanced manufacturing and process technologies has frequently been cited as a key element of latecomer strategy among East Asian firms (Ernst and O'Conner, 1992; Hobday, 1995; Mathews and Cho, 2000; Mytelka, 1999). For firms with little technological competencies to begin with, the adoption of new product and process technologies often represents a fast-track entry into a certain technology field, particularly when the technologies in question can be bought in open markets and given sufficient time and effort to absorb the technologies (Neely and Hii, 1998). Whereas for established firms, the adoption of new, incompatible technologies can be a source of double-loop learning through which the rigidities associated with a pre-existing knowledge base can be overcome (Smith et al., 1996).

Technological orientation within firms also tends to be context-specific in the sense that the learning costs, risks, duration and organisational capability requirements for adoption vary according to industry context, extent of external linkages and nature of technologies (Lall, 2001). In the case of IT firms, the adoption and diffusion of technology can potentially have a revolutionary impact on not just the organisation of production processes of a firm, but also on its logistical and coordination functions both internally and externally with customers, suppliers and network partners (Chadee and Kumar, 2001). Despite much controversy continues to exist about whether the productivity payoff associated with the adoption of IT at both the national and firm levels is overstated (Brynjolfsson and Yang, 1996), the fact that technology offers opportunities for firms to overcome information barriers should not be overlooked (Powell and Dent-Micallef, 1997). For example, through more

efficient, real-time information and database management, IT holds enormous potential for enhancing the information processing capacity of firms, and thus their absorptive and transformative capacities (Cohen and Levinthal, 1990; Garud and Nayyar, 1994). This in turn can greatly improve a firm's strategic flexibility, market responsiveness, operational efficiency, quality management techniques and ultimately financial performance (Ernst and O'Conner, 1992). As East Asian IT firms are moving into more complex and knowledge-intensive activities like design, marketing and R&D while becoming more integrated into the global IT industry, the need for the adoption and diffusion of more sophisticated IT and network capabilities will only be higher in order for firms to remain competitive. For the purpose of this study, we consider two specific areas where the adoption and diffusion of technology can result in improved performance. These include the adoption of technology for internal logistical and coordination functions and the diffusion of technology for wider marketing related activities. Efficiency in each of these areas is considered to be critical for the overall performance of technologically oriented firm. Hence the following hypotheses:

H2a: Technology adoption strategies for logistical and coordination functions by IT service providers contribute positively to their performance.

H2b: Technology diffusion strategies for marketing related activities by IT service providers contribute positively to their performance.

2.3.3 Technology Competence

Although the adoption of new and / or generic technologies per se may not necessarily confer a source of competitive advantage to a firm, its values can stem from its potential to enhance other resources and capabilities, which in turn can lead to improved performance when the selected technologies are integrated into its value chain, routines and systems (Francisco et al., 1995). Among these resources and capabilities, the quality of human resources has received the most research attention as they bring together more frequently the requirements essential for creating competitive advantages (Kostopoulos et al., 2002). Recent research repeatedly points to the need to integrate a firm's technological competencies with its human resources

to tap into the tacit knowledge of employees (Powell and Dent-Micallef, 1997). The extent to which the potential value of a particular technology can be realised hinges much on the competencies of individuals (Francisco et al., 1995). In this regard, an educated labour force has been found to be more likely to contribute towards performance than an uneducated one (Ref here). This is because in today's technologically oriented world, even the most basic functions in an organisation would likely require some elementary literacy and numeracy competence. And, in IT sector formal technical education is quickly becoming a prerequisite for employment. However, although formal higher education has been linked to performance, for IT firms it is not a sufficient condition. This is because experiential knowledge has also been found to be important in explaining performance, particularly in certain types of jobs where developing the necessary skills depends on the tacitness of knowledge and technology embedded in them. In the case of IT firms, skills and competencies with high experiential knowledge gained from in-house, on the job training particularly when the skills in question embody substantial process and system-dependent technologies may constitute a unique source of competitive advantage. In this regard, IT service providers which provide in-house, on the job training and development programs are more likely to have technologically competent employees and as such would experience overall superior performance. Hence:

H3a: Formal higher education of employees contributes positively to the performance of IT service providers.

H3b: In house and on the job training of employees contribute positively to the performance of IT service providers.

3.0 METHOD, DATA, MODEL ESTIMATION AND RESULTS

The data for analytical purposes come from a large scale survey of ICT firms from four Asian countries, namely China, South Korea, Thailand and the Philippines undertaken by the Asian Development Bank. The firms under consideration were randomly selected from a list of ICT firms operating in each of these countries provided by the Chamber of Commerce of each country. A comprehensive questionnaire was developed and pilot tested before being mailed to approximately

500 companies. The questionnaires were administered into the respective local languages and were addressed to the person in charge of information and communication technology department or to the chief financial officer (CFO) of the organisation. Following the initial mail out and subsequent telephone follow-up by field staff, a total of approximately 320 questionnaires were returned. In the questionnaire, firms were asked to briefly describe the nature of their business and based on this information 98 firms were identified as IT service providers which were retained for the purpose of this study.

An analysis of the sample characteristics in Table 1 shows the number of responses for the various countries to be more or less equally distributed. The majority of firms under consideration are between 3 and 10 years old with 35 percent older than 10 years suggesting that they are experienced and well established. Firms in the ICT sector also tend to be large, with 42 % reporting having more than 500 employees. This is not unusual as many IT service providers in Asia tend to be labour intensive. For example, it is not uncommon for typical IT service providers such as Call Centres or Business Process Organisations (BPOs) to have several thousand front line employees. However, the size of firms in the sample does not match their assets with 56 % having assets of less than $10 million while only 14 % have assets of more than $ 50 million. This is, again, as expected because the larger firms tend to focus on labour intensive low value services while only few firms focus on high value activities requiring sophisticated and expensive technology.

Table 1: Profile of Sample Firms (N=98)

Variables	Frequency	Precent of Valid Total
Firm Location		
China	23	23.4%
Korea	33	33.6%
Thailand	18	18.3%
Philippines	24	24.5%
Age of Firm		
Less Than 3 Years	18	18.3%
3-10 years	45	45.9%
More Than 10 Years	35	35.7%
Firm Size		
Number of Employees		
Less Than 100	27	27.5%
101 – 500	29	29.5%
More Than 501	42	42.8%

Value of Assets		
Less Than $10 Millions	56	57.1%
$10 – 50 Millions	28	28.5%
$50 Millions or above	14	14.3%

3.1 Measurement

In the questionnaire, respondents were asked to rate various technology strategies and performance items related to their organisations, mostly based on a 5 point Likert-type bipolar scale. Table 2 summarises the independent and explanatory variables together with their measurement scales, reliability estimates and scale anchors where relevant.

3.1.1 The Dependent Variable

Performance: A variety of measures have been used to evaluate performance at the firm level including economic measures such as sales, sales growth, profitability; sales per employee and export intensity (Cavusgil & Zhou, 1994; Evangelista, 1994). Subjective measures such as management's evaluations and perceptions of export activities (Aaby & Slater, 1989; Cavusgil, 1990), and satisfaction with export activities (Evangelista, 1994) have also been utilized in previous research. Although the subjective measures of performance are increasingly taken into account, the most commonly used measurement of performance is still expressed in objective terms (Brown & Yau, 1995; Cavusgil & Zhou, 1994).

In this paper, two measures of performance are used. The first is an objective financial measure and relates to growth in sales revenue coded as 1= 0 - 15% annual growth; 2 = 16 - 30% and 3 > 31% growth in sales revenue. The second is a subjective self evaluation measure related to the extent to which the firm is able to respond effectively to changes in market and client needs. We believe that because the ICT sector, as most technology sectors, face constant and rapid change, in order to survive, firms have to constantly upgrade their technologies in order not to be left behind. Thus, being able to respond quickly and effectively to changes in both market and customer needs become a critical indicator of performance. Managers were asked to rate their ability in responding to changes in market and customer needs on a 5-point Likert scale where 1 = performed below expectation, …, 5 = performed beyond

expectation. The 5 point Likert scale were subsequently recoded and collapsed into 3 point scales (1 = below expectation; 2 = as expected; 3 = above expectation) for the purposes of model estimation as this yielded greater degrees of freedom.

3.1.2 The Explanatory Variables:

Technology Adoption and diffusion: Strategies for the adoption and diffusion of technology within the firm was operationalized by two factors; namely ADOP and DIF respectively, extracted from a list of items subjected to a principal component analysis with varimax rotation. ADOP refers to strategies for the adoption of technology for logistical and internal coordination activities while DIF refers to strategies for the diffusion of technology in marketing related activities based on perceived assessment of the respondents. More specifically, they were asked to rate the importance for their firm to adopt and diffuse technology in various functional areas of the company on a 5-point Likert-type scale. Seven items reflective of two factors were retained based on factor loading of 0.55 or more and Cronbach's Alpha score of 0.60 or above to ensure reliability (see table 2).

Technology Capabilities: Two variables were used to capture the firm's strategy for developing its technology capabilities in order to enhance its competitiveness. The first variable (IRND) relates to the firm's strategy for internal development of technology through in house research and development activities and is captured by the level of spending on R&D as a proportion of total sales. This measure has been used widely in the literature to capture firm's technology strategy. The second variable (XRND) relates to the firms strategy for sourcing technology from external sources and was measured as the average score of three items based on a principal component analysis; namely the extent to which the firm: (a) actively engages with external bodies for product design, (b) cooperates with others in the industry for R&D information management and (c) networks for R&D purposes (see table 2). These three items were retained based on their factor loadings and Cronbach's Alpha score.

Technology Competence: Two variables are used to capture the technical competence of employees in the organisation. The first (EDU) measures the proportion of staff in the firm with formal technical education at the post secondary level. The second

(IHJT) measures the availability of in house, on the job training within the organisation where 1 = in house training is available and 0 = in house training is not available.

Control variables: Three control variables are introduced into the analysis. Firm size (SIZE) is captured by two 0-1 dummy variables to account for three different firms size categories, namely small (SIZE1: asset < $10 million), medium (SIZE2: asset between 10-50 million dollars) and large (SIZE3: asset>$50 million). The age of the firm is also thought to be an important element reflected in its performance as well established firms are more likely to have well established networks and consequently are more likely to perform better. Two 0-1 dummy variables are included to account for 3 age groups (AGE1: firms less than 3 years; AGE2: 3-10 years old; and AGE3: greater than 10 years old). Finally, a set of 0 – 1 country dummy variables are also included to account for differences in national innovation systems (NIS) associated with different countries (Lundvall, 1992). Increasingly, the performance of firms is viewed as based on a societal arrangement in which the interplay of a host of firm-specific and location-bounded determinants within a NIS can interact to speed up the learning process and spur innovation (Esser et al., 1996). Thus, to capture any national differences in NIS, we include three 0-1 dummy variables to differentiate between the four countries under consideration in this study (Korea, China, Philippines, and Thailand).

3.2 Model Estimation and Discussion of Results

Following the discussion above, the effects of technology strategy on performance as depicted in Figure 2 is specified as follows:

$$\begin{aligned} PER_i = \quad & \alpha_i + \beta_1 ADOP + \beta_2 DIF + \beta_3 XRND + \beta_4 IRND + \beta_5 EDU + \beta_6 IHJT + \\ & \beta_7 SIZE1 + \beta_8 SIZE2 + \beta_9 AGE1 \quad \beta_{10} AGE2 + \\ & \beta_{11} KOR + \beta_{12} PHIL + \beta_{13} CHINA + \varepsilon_i \end{aligned} \qquad (1)$$

Where $\beta_1, \ldots, \beta_{13}$ are the regression coefficients to be estimated and ε_i is the error term. The averages of items pertaining to factors extracted (ADOP, DIF and XRND) were used to form the variables for regression analysis. The dependent and explanatory variables are summarised in table 2.

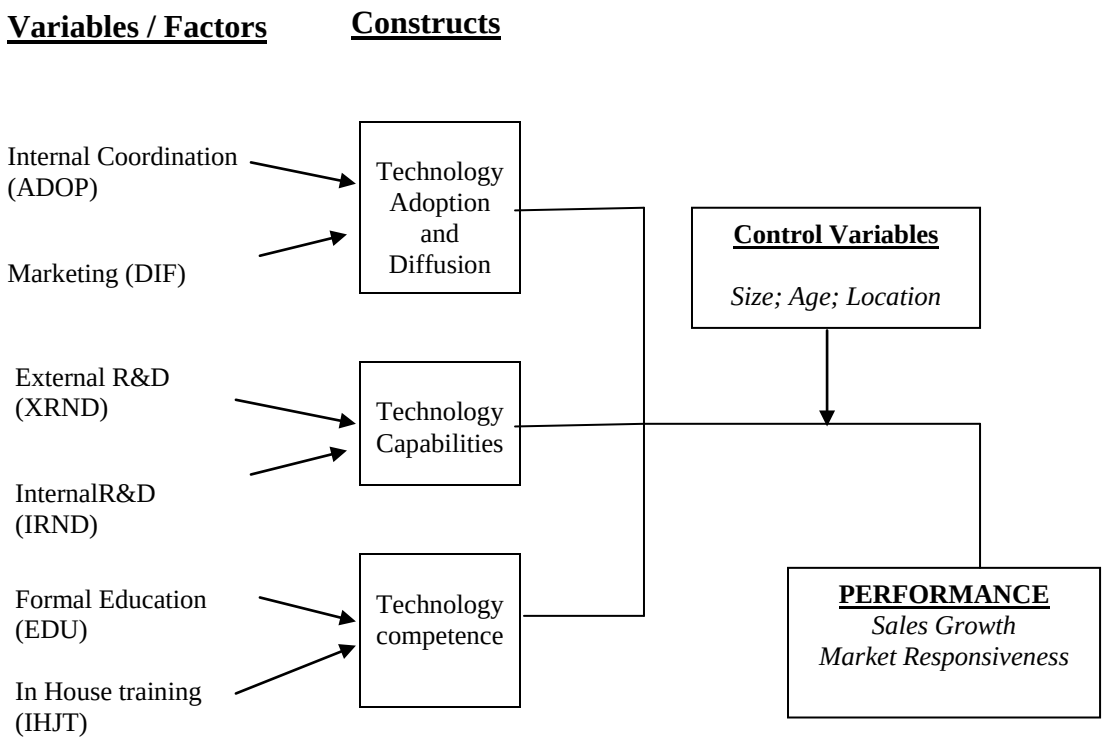
Table 2: Operational Measures of Dependent and Explanatory variables

Explanatory Variables / Factors		Factor Loading	Eigenvalues	% of Var. Explained	Cumulative Var. Explained	α
Factor: Adoption IT for	(ADOP)		3.90	43.36	43.36	0.81
Internal Communication		0.78				
Human Resource Management		0.68				
Production Process Management		0.84				
Service Scheduling		0.78				
Factor: Diffusion of IT for:	(DIF)		1.30	30.43	73.79	0.82
Supplier coordination		0.64				
Client base Management		0.91				
Client Marketing		0.87				
Factor: EXTERNAL R&D for:	(XRND)		2.11	62.32	62..32	0.61
Product Design		0.82				
Information Management		0.83				
Networking		0.79				
OTHER EXPLANATORY VARIABLES						
In house on the job training	(IHJT)	Yes = 1 and No = 0				
Higher education availability	(EDU)	Yes = 1 and No = 0				
Internal R&D	(IRND)	R&D expenditure as % of sales				
Firm Age	(AGE)	Two 0-1 dummy variables (AGE1 and AGE2)				
SIZE	(SIZE)	Two 0-1 dummy variables for medium (SIZEM) and large (SIZEL) firms				
Country dummy		Three 0-1 dummy variables for: Korea (KOR), China (CHINA) and Philippines (PHIL)				
DEPENDENT VAIABLES (PER)						
Objective: Growth in Sales Revenue		1= 0-15 % ; 2= 16-30% and 3> 31%				
Subjective: Market Responsiveness		Anchored by 1= below expectation; 2=as expected and 3 above expectation				

Given the categorical nature of the two dependent variables under consideration, we use multinomial logistic regression techniques (Mc Fadden, 1974) available in Statistical Analysis System (SAS) to obtain the maximum likelihood estimates of the parameters of equation 1. Logit type models assume the effects of the independent variable to be linear in the logarithm of the odds ratio of the dependent variable; i.e. logit (P) = Log [P / 1-P] = $\alpha + \beta'X$; where P = Pr (Y = 1/X) is the response

probability to be modelled and α is the intercept. The estimated β coefficient[1] shows the effects of a change in the explanatory variable on the logarithm of the odds that a particular performance level will be achieved.

Figure 2: Operational Model of Technology Strategy and Performance



The estimated coefficients, chi square statistics and associated performance statistics for the two models are summarised in Table 3**.** Judging by the respective model fit statistics, both models appear to perform reasonably well. More specifically, the chi-square statistics and their likelihood ratios for both models are statistically significant at the sub 0.10 p-value range. In terms of their predictive abilities, both models have concordant values well over 75%, suggesting a high association between predicted and actual probabilities.

The three main technology strategy variables, namely technology adoption and diffusion, technology capabilities and HR technical competence, have the expected signs and all but two are significant in Model 2. Technology strategy for adoption,

[1] *Bi in equation (1) measures the effects of a change in the independent variable on the ln [Pi/ (1-Pi)]. The amount of the increase in probability depends on the original probability and the initial values of all the independent variables and their coefficients. For a more detailed interpretation of logistic regression results, see Gujarati, 1988.*

diffusion and internal R&D activities are all significant in both models. Technology strategy for external R&D activities is significant in explaining sales revenues but does not necessarily make the firm more responsive to market and customer changes. This can be explained by the fact that because firms have less control on external sources of R&D than internal R&D, the firm is less likely to rely on external sources of R&D to respond quickly and effectively to changes in market conditions.

Table 3: Summary of Logistic Regression Results

	Model 1 (N=98) Growth in Sales Revenues		**Model 2 (N=98) Market Responsiveness**	
Variable	Coef.	Wald Chi-Square	Coef.	Wald Chi-Square
Intercept1	-6.1	0.72	7.9	11.8****
Intercept2	-4.9	0.06	10.4	18.4****
ADOP	0.48	4.54***	0.97	5.6***
DIF	0.14	2.99**	0.63	2.7*
IRND	0.87	3.42**	0.003	3.2**
XRND	5.07	3.20**	1.9	1.25
EDU	0.02	2.87**	0.004	0.02
IHJT	0.51	2.6**	-0.60	6.10***
AGE1	-2.66	12.8****	-0.96	3.50**
AGE2	-4.74	13.8****	0.14	0.05
SIZE1 (small)	1.57	4.5***	-2.07	2.7*
SIZE3 (large)	3.95	15.6****	0.15	0.09
Country dummy				
Korea	0.44	0.19	-0.02	0.01
China	-0.73	0.53	-0.75	1.17
Thailand	-0.37	0.15	0.12	0.03
Performance statistics				
Likelihood ratio	X^2 = 81.6 ****		X^2 = 37.6 ****	
% Concordant	92		79	
Wald chi-SQ	34.5****		29.1***	
-2Log L	17.9		173	

Regarding the firm's technology strategy with respect to its human resource technical competence, the results show that while both formal educational and in house-on the job training are important for sales performance, only in house - on the jog training is significant in explaining market responsiveness. This suggests that in

house – on the job training provides employees with more relevant skills to deal effectively with changes in the market place. Overall, the positive coefficient confirms what is almost considered as conventional wisdom in new growth theories that human capital accumulation is a key determinant of productivity growth (UNCTAD, 1996) and is fundamental to technological capability building (Lall, 2001).

Regarding age and size, the results broadly suggest that older firms perform better with sales than with market responsiveness while larger firms perform better with sales but do not respond as quickly and effectively as smaller ones. Interestingly, the country dummy variables are not significant in either of the two models suggesting that firms in the different countries do not behave and perform differently. This is surprising given the vast literature on the critical role of National Innovation Systems (NIS) on the international competitiveness of enterprises in general.

4.0 CONCLUSION

This paper sets out to investigate how the technology strategy of IT service providers impact on their performance. A firm's technology strategy is defined as the firm's deliberate commitment and willingness to proactively develop and acquire relevant technologies, utilise these technologies widely in the organisation and consistently upgrade its employees to ensure that technologies are fully embraced within the organisation. From this perspective, the paper identifies three elements of technology strategy; namely the development of technology, the adoption and diffusion of technology within the organisation and the support of technology by technologically competent employees. Given the rapid growth of the IT industry in Asia and accompanying unprecedented growth of IT service providers in this region, this paper adds to our understanding of the behaviour and performance of IT firms from this region.

Generally, the findings confirm that IT service providers can enhance their performance through the adoption of technology for logistical and coordination functions as well as the diffusion of technology widely for marketing activities. Achieving a certain level of automation and computerisation in these areas can potentially give IT service providers an edge in competition in terms of sales and market responsiveness. In particular, linking itself electronically to its technology

suppliers and various information channels and networking with external bodies can improve a firm's knowledge base while reducing cycle time in R&D and product design. Thus, firms should pay attention not only to their internal R&D but also to external sources where collaboration with others can be of benefit to the organisation in terms of sourcing ideas and knowledge to benefit the organisation.

Several recent studies have pointed out that in many Asian economies there is a lack of inducements or incentives for the adoption and diffusion of technologies (Ernst and O'Conner, 1989, 1992; Hobday, 1995, 2000; Hong and Yun, 2000; Kraemer and Dedrick, 2000; Lall, 1996, 2001; Mytelka, 1999; World Bank, 2000). This can be particularly harmful to economic growth in countries where the majority of firms are small and medium size and cannot afford the initial investment required to adopt and diffuse technology. Thus, in such instances, from a public policy perspective, the government can enhance the performance of firms by facilitating the adoption and diffusion of advanced technologies.

The study also confirms that the technology competence of employees is critical for the performance of IT firms. Both the quality of employees as reflected through their levels of formal education and their training on the job contribute positively to sales. However on the job training is more effective for firms to respond to market and customer change suggesting that in-house on the job training is more relevant for identifying and resolving problems specifically related to the task at hand. Thus, IT service providers which provide in house and on the job training are likely to be more flexible and responsive and also perform better.

This paper has made several contributions to the literature by shedding light on various aspects of performance of Asian IT service providers. At the level of the firm, decision makers need to employ technology strategically by focusing on the functional areas where the impacts can be the greatest on their performance; particularly when firms have to allocate limited financial resources strategically. At the institution level, governments need to devote more attention in developing the technological competence of domestic human capital by assisting small and medium size enterprises implement in-house on the job training programs. Such programs have been shown to have a direct impact on performance, particularly on their responsiveness to changes in market conditions. Small firms, in particular, do not usually have in-house expertise necessary to put in place in house training programs

and most of the time do not have the necessary financial resources to fully support such programs on their own.

As with any research, this paper has several limitations. The first relates to the difficulty in capturing the effect of technology strategy on firm performance given the time and path-dependent nature of the technical learning process. In this respect, R&D spending, for example, is a rather crude measure of technology as it only captures one of the many aspects of knowledge-intensive activities and performance implications at a specific time. The development of a more systemic measurement scheme is warranted if one is to discern the pattern of different types of technological development within firms particularly for cross country comparative purposes. Additionally, a longitudinal approach may be more appropriate for measuring the learning process underlying technological development given the dynamic nature of knowledge development and technical learning.

Another limitation of the present study relates to the measurement of the extent to which employees are technologically competent. In the absence of a better measure, we use the proportion of employees with formal higher education and the availability of in house training in this study. While both measured have been used extensively in the literature, they are still far from adequate in capturing the level of competence and the effectiveness of in house training programs. A firm may have in house training programs but participation rate from employees is low and as such would not necessarily be an effective strategy. Similarly, an advanced qualification does not necessarily reflect the competence of an employee. Thus, an opportunity exists for researchers to contribute to this important area by developing a more appropriate measure to capture the technology competence of employees within an organisation.

Another limitation of the study is that the data set on which the analysis is based was drawn from a large scale survey of ITC firms in general. The paper is based on a sub sample of firms which identified either their entire business or part of their businesses as IT service providers. Thus, the provision of IT services among some of the firms in the sample may only constitute a minor aspect of their business and therefore the performance indicators may relate more to other non service aspects of their business. There was no reliable way to identify the extent to which firms in the sample were involved in IT service provision. It would be constructive for future

research to focus specifically on firms where IT service provision constitutes their core business.

One surprising and unexpected result of this study is that there were no significant country differences to explain the performance of firms under consideration. This may be related to the structure of the industry under consideration and the nature of competition in the industry which force firms to behave and performs more or less similarly regardless of their country location. However, given the vast literature on the importance of National Systems of Innovations (NIS) on the competitiveness of enterprises, more research is warranted to investigate how country factors influence the competitive advantage of firms and their performance. Along similar lines, another research avenue would be to investigate the role of the government in enhancing the competitive advantage of IT service providers, particularly in less developed countries.

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