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December 2005

A Model for IT Industry Success in Developing Countries: A Study of Thailand

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Abstract

This study presents an IT industry success model for developing countries. It adapts Ein-dor, Myers and Raman's (1997) model, which is primarily focused on small-developed countries. The adapted framework is then applied in a study of IT industry in a developing country - Thailand. We found IT-related foreign direct investment to be vital to IT industry success in Thailand. Unlike findings from earlier studies on small-developed countries, geographical location and to a lesser extent government investment promotion policies are also important to IT industry success in a developing country. These findings support the view that there are differences in the factors that affect IT industry success in developed and developing countries.

Keywords: IT industry success, developing countries, Thailand, Foreign direct investment

1. INTRODUCTION

A stream of research exists that explores a country's information technology (IT) industry success. For example, Ein-dor, Myers and Raman (1997) described and studied the IT industries in Israel, Singapore and New Zealand. The authors developed and tested a model describing the factors affecting IT industry success. In another study, Finland and New Zealand were examined (Watson and Myers 2001). These studies conclude that government policy in promoting IT production/use, as well as the level of research & development, and the existence of an education system that produces IT literate graduates, are key factors that contribute to IT industry success in these countries.

However, the theoretical model used in these studies was developed with a focus on small-developed countries. For instance, Ein-dor, Myers and Raman's conceptual framework was grounded in the work of Grossman and Helpman (1992), with a focus on small-developed countries - New Zealand, Israel and Singapore. Watson and Myers (Watson and Myers 2001) adapted this model with a focus on small-developed countries – Finland and New Zealand.

We contend that the factors that contribute to IT industry success in developing countries are likely to differ somewhat to those that play a role in small-developed countries. For instance, developing countries face inadequate sustainable sources of funding (Davison et al. 2000) and are likely unable to fund the level of research and development required for IT industry success as identified by the earlier studies. At the same time, many developing countries depend highly on foreign-direct investments to sustain economic growth (Masuyama et al. 2001) and as such we can expect such investments to have a strong impact on success of IT in these countries.

This study therefore presents an alternative IT industry success model for developing countries. It adapts Ein-dor, Myers and Raman's (1997) model in developing such a conceptual framework. Using the adapted framework, this study investigates IT industry success in a developing country - Thailand. Thailand was chosen as the subject of this study due to the country being in a position that is highly challenged by the changes required in the Information Technology era. Thailand has been performing well in economic growth during the Industrial Technology era. The country is one of only three developing countries that are counted among eight "High-Performing Asian Economies" (WorldBank 2002). The rapid growth of Thailand was underpinned by Foreign Investment encouraged by cheap labor costs (Jomo 2001; Kamaruding 1994). However, as its economy is expanding, increasing labor costs can be expected. Thailand will no longer have a comparative advantage in low-wage labor and, thus, will lose this advantage to new comers such as China and Vietnam (Kamaruding 1994; Masuyama et al. 2001). Thailand needs to seek other competitive advantages. To some extent, it needs to be able to adopt and employ technology in order to confront the changing environment.

This paper begins by discussing the literature on IT industry success, in particular Ein-dor et al's (1997) model and related studies. We then introduce our model of factors affecting IT industry success in developing countries. The research methodology, results and discussion are then presented. Finally, the conclusion follows.

2. PRIOR RESEARCH ON IT INDUSTRY SUCCESS

IT industry in this study is defined as all industries that fall into a range of upstream to downstream of IT industry value chain – from hardware production to software and services.

Ein-dor et al (1997) developed a framework that focuses mainly on small-developed countries and IT industry success is measured by the value of IT sales and IT exports. The model, presented in Figure 1, is largely based on the macro-economic model of Grossman and Helpman (1992).

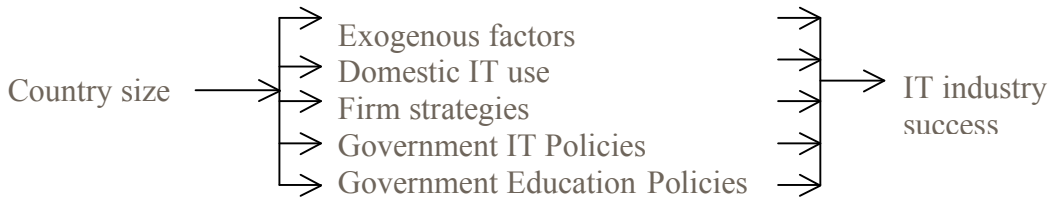

Figure 1: Ein-dor, Myers and Rahman's Model of Factors Affecting IT Industry Success (Ein-dor et al. 1997)

Factors in this model are categorized into control variables, dependent variable, and exogenous and endogenous mediating factors. Control variables determine the countries to be included in the study – eg. country size (Ein-dor et al. 1997). IT industry success is a dependent variable in this model. It determines the degree to which the country is successful in the IT industry. The exogenous mediating factors are those factors that we have less or no control over and normally are accepted as given (eg. geographical location), while more control and influence can be placed on endogenous mediating factors through firms or government (eg. firm strategies and government IT policies) (Ein-dor et al. 1997). This model was used to assess the IT industry in three small-developed countries, namely Israel, Singapore and New Zealand. The research found that the dominant factor that seems to influence success of IT industries is government policies in promoting IT industries, supporting R&D and in providing appropriate, trained labour. Watson and Myers (2001) subsequently developed a similar framework for studying IT industry success in small-developed countries by adapting Ein-dor et al's (Ein-dor

et al. 1997) model. The only difference between these two models is that instead of firm strategies, level of R&D was introduced to the model. This adapted model was used to compare Finland and New Zealand. The authors argue that level of R&D provides a better explanation to the model.

3.0 A FRAMEWORK FOR DEVELOPING COUNTRIES

Similarly, this study has adapted Ein-dor et al's original model (Ein-dor et al. 1997). However, the purpose of developing the model is to explain IT industry success in developing countries rather than small developed countries. The model employs a similar rationale as the previous model – that country size and economic development impact on IT industry success through exogenous and endogenous mediating factors. This study further includes political stability as a control variable. The rationale of including this control variable is discussed later in the paper. Moreover, in this study, the five mediating factors are, in part, believed to influence the level of IT-related Foreign Direct Investment (FDI) into the host country. In other words, these mediating factors are expected to have both direct and indirect (through IT-related FDI) effects on IT industry success in developing countries. We assume that these factors, together with IT-related FDI, will explain IT industry success in developing countries. The model is presented in Figure 2.

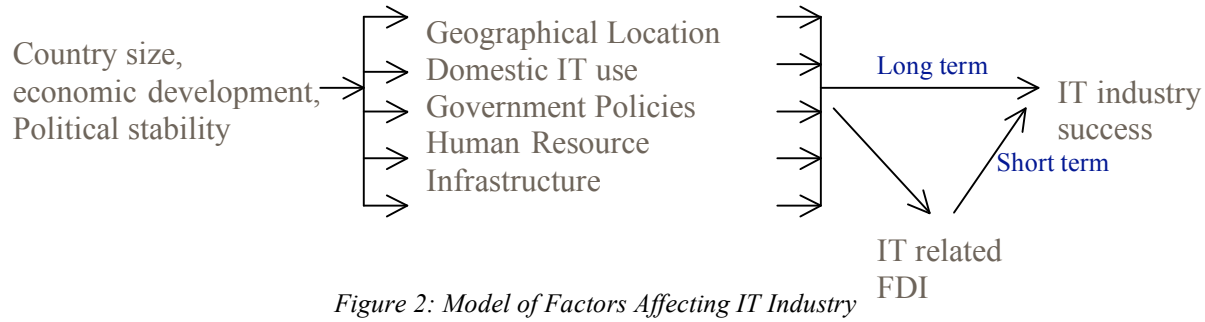

Figure 2: Model of Factors Affecting IT Industry Successin Developing Countries (adapted from Ein-dor et al. 1997)

A number of changes have been made to the original model (Ein-dor et al. 1997). Firstly, firm strategy factor is excluded from the model. This factor has been found not to contribute to IT industries developments in prior research (Ein-dor et al. 1997) and was also dropped in the Watson and Myer's (2001) study. Different types of companies in different countries may have different strategies. Therefore, it is hard to measure whether one is superior to the others. Secondly, the level of R&D is considered part of government policies. We expect that developing countries have considerably less funding on R&D than those developed economies and is largely dependent on government IT policies (Davison et al. 2000). Thirdly, the government education policy factor becomes part of, the newly introduced, Human Resource factor in order to emphasize the importance of human capital as an input to IT industry growth in developing countries. Fourthly, technology infrastructure, which used to be part of domestic IT use, is one of the factors in the model and it is assumed to be significant to the development of the IT industry. Unlike developed countries, developing countries face the problem of inadequate infrastructure which can discourage private sectors to take risks in their investments (Kraemer et al. 1993). Therefore infrastructure is expected to influence the development of the IT industry in developing countries. Lastly, investment from IT related foreign companies is included as one of the factors in this new model. Generally, developing countries lack resources, such as industry technological resources, IT human resources and capital, which facilitate growth in IT. Inflows from foreign firms can provide these fundamental elements to developing countries (Perkins 2001).

In addition, political stability is considered an additional control variable in the context of developing countries. According to Katz (1988), the transition to an Information Society in developed countries can be described by variables in economics; on the contrary, in developing countries, politics is the decisive variable influencing the transition to an Information Society. Furthermore, political stability influences the private sector's decisions whether to invest in a high risk industry like IT in a particular country (Kraemer et al. 1993). Political environment was considered as part of the environment factors that influence Technology policies and IT production in Kraemer and Dedrick's (1993) study. In our study, we consider that political stability may impact IT development in developing countries. As a result, Thailand was selected for study because of its political stability.

4.0 RESEARCH METHODOLOGY

The research methodology involved collecting secondary data. This approach is consistent with previous studies on IT industry success (Ein-dor et al. 1997; Watson et al. 2001), but data was colleted over a five-year period (ie. 1997-2002) as opposed to a 2 year period. The unit of analysis was Thailand's IT industry. Thailand is one of a number of developing countries that has high exports of IT products. This study adopted Ein-dor et al's (1997) main criteria for indicating IT industry success - the production and the export of IT products. Prior to the process of data collection, operationalization of concepts into measurable groups of elements was established, based on previous research (Ein-dor et al. 1997). This served to reduce the abstraction of concepts of the research and defines necessary data for analysis.

Variable groups	Variables	Operationalizations
1. Controlled variables	Country size	Population Area
	General economic development	GDP per capita
	Political stability	Political stability
2. Dependent variables	IT industry success measures	IT product sales & contribution to GDP Locally developed IT products IT industry exports Stock market listings
3.Exogenous mediating factors	Geographical location	IT market proximity
4.Endogenous mediating factors	Domestic IT use	IT spending relative to GDP Number of computers installed Use of telecommunications Use of Internet
	Government IT policies	Priority of IT development Level of R&D support Investment promotion policy Tax incentives Trade policy
	Human resource	Education policy General education levels IT manpower Labour cost
	Infrastructure	Physical Infrastructure Quality of electric power system Quality of transportation Information Infrastructure No. of telephone mainlines No. of mobile phones Internet access cost No. of Internet hosts
	IT related foreign direct investment	IT industry ownership FDI net inflows FDI as % of gross capital formation

Table 1: Operationalization of Variables (adapted from Ein-dor et al 1997)

From this table, "table shells" were created to represent the array of data that needed to be collected for each variable. Data collection consisted of locating data to fill the "table shells". The analytic strategy employed in this study was similar to Yin's (see Yin 1984) 'explanation-building' strategy. This strategy helped focus attention on data that provided evidences to analyze the relationships identified in Figure 2. The analysis was based on the presumption that Thailand had developed a successful IT industry as it fulfilled the key indicators of IT industry success established by Ein-dor et al (Ein-dor et al. 1997). Data were then analyzed to establish whether there are evidences to support the relationships. Multiple sources of data were used in this study, including: (i) published journal articles and books such as World Electronics data and World Development Indicators; (ii) newspapers; (iii) research conducted by independent research institutes such as the Centre for Research on Information Technology and Organizations (CRITO); (iv) research conducted by Thai universities eg. Thammasat University; (iv) government organizations such as Software Park Thailand, National Electronics and Computer Technology Centre, Association of Thai Computer Industry (ATCI), Board of Investment Thailand (BOI); (v) research and reports from Internet web sites; (vi) an interview and subsequent correspondence with the General Secretary of ATCI, Thailand.

5.0 RESULTS AND ANALYSIS

5.1 Control Variable: Country Characteristics

Thailand used to be known as 'Siam' until 1949 when it was officially proclaimed 'Thailand', which means the land of freedom. It is the only country in the region that has never been colonized by the English and French, unlike its neighbors Myanmar, Malaysia, Laos etc. Table 2 presents some statistics on Thailand's size and economic development.

Country Size and Economic Development	**Thailand**
Population (million s)	61.2 (a)
Population rank	19/227 (a)
Surface Area (sq. km)	513,115 (c)
Population Density (persons/ sq. km)	119.3 (a)
Per-capita GNP (US$)	3390
GDP (million US$)	122,300 (c)
Per-capita GDP (US$)	2,018 (c)
Per-capita GDP Rank	56/116 (d)

Table 2: Country Size and Economic Development (adapted from Ein-dor et al 1997)

Sources: World Development Indicators database, April 2002; Centre for Economic and Policy Research
note : (a) = yr 2002, (b) = yr 2001, (c) = yr 2000, (d) = 1999, (e) = 1998, (f) =1997

Thailand is considered to have a relatively stable government. This can be seen from the country often being chosen to be the regional base for foreign companies (Public Relation Department 2000). Moreover, the stable political situation, strong social foundation and sound macro-economic policies are the factors that influence the impressive economic growth of the eight high performing east Asian countries, which include Thailand, proclaimed as the East Asia miracle (Lunsche 1997).

5.2 Dependent Variable - IT Industry Success

Thailand's IT industry can be considered successful, led by the success of its hardware industry. Table 3 illustrates this based on criteria established in previous studies of IT industry success in small developed countries.

IT Industry Success	Thailand
IT industry sales (US $ million)	9,200 (e)
IT industry as percentage of GDP	11(e)
IT production:	
Hardware (US $ millions)	8,369(e)
Software (US $ millions)	199.5 (c)
IT exports:	
Hardware (US $ millions)	8,263 (e)
Software (US $ millions)	less than 12 (a)
Total	8,275
High Technology Exports (US $ millions)	13,999(d)
High Technology Exports/Manufactured exports	32% (d)

Table 3: IT Industry Success (adapted from Ein-dor et al 1997)

Sources: World development report 2000/2001, US Department of Commerce: International Trade Administration, Yearbook of World Electronics Data, World Development Indicator 2001, The Stock Exchange Thailand, Ministry of Commerce: Department of Commercial Registration, General Secretary of Association of Thai Computer Industry.

Note: (a)= yr 2002, (b)= yr 2001, (c)= yr 2000, (d)= yr 1999, (e)= yr 1998, (f)= yr 1997

According to Table 3, in 1998 IT industry sales were 9,200 million US dollars, which accounted for 11 percent of GDP (ATCI 2001; Reed Electronics Research 2000). Of this, foreign and domestic markets accounted for approximately 90 and 10 percent respectively. The level of exports from Thailand's IT industry, most specifically the hardware industry, is impressive when compared with other developing countries. In 1998, the value of hardware exports was reported to be as high as 8,263 million US dollars (Reed Electronics Research 2000). Thailand ranks seventh among the world's major computer and parts exporters (Yearbook of World Electronic Data 2000 Vol. 2). The percentage contribution of high technology exports in Thailand is impressive. It surpassed many developed countries; for instance, Finland and New Zealand have a contribution of high technology exports to total manufactured exports in 1997 of only 26 percent and 11 percent, respectively (Watson and Myers 2001). Moreover, the number of local companies that are able to be listed on the stock market also indicates the maturity and success of IT industry (Ein-dor et al. 1997).

5.3 Mediating Factors

In this study, there are six mediating factors, with the last factor, IT related foreign direct investment, expected to be influenced by the first five mediating factors (geographical location, domestic IT use, government policies and regulations, information infrastructure and human resource); each having IT industry success as a consequence.

5.3.1 Geographical Location

In Ein-dor et al (1997), geographical location, although important, is considered to not affect IT industry success in small developed countries. In this study, the factor is reconsidered to find out whether the previous conclusion applies also to developing countries. The data on geographical location are presented in Table 4.

Location Related Factors	Thailand
Geographical Location	

Physical Location	Middle of Southeast Asia mainland	
Neighbouring countries	Myanmar, Laos, Vietnam, Cambodia, Malaysia	
IT Market Proximity:		
	Distance	Trade
Europe	Far	Middle
North America	Far	High
Asia and Pacific	Close	Most

Table 4: Location Related Factors (adapted from Ein-dor et al 1997)

Location → Hardware Industry: Favourable geographical location is a common characteristic found in most of the countries that have a successful hardware industry (Dedrick et al. 1995). Given that Thailand is situated in the middle of mainland South East Asia, with the availability of three modes of international transportation (air, ground and sea), its location is conducive to the conduct of international trade. Thailand takes advantage of its location by engaging in substantial trade exchange with ASEAN countries, East Asia such as Japan, Hong Kong and China as well as the USA, Netherlands and United Kingdom (Tiralap 1997). The evidence of Thailand's IT market's proximity and its heavy trade activity with neighboring countries show that its location has supported IT industry success in Thailand. Therefore, it may be concluded that geographical location is one of the factors explaining Thailand's hardware industry success.

Location → FDI → Hardware Industry: There are many reasons why MNCs choose Thailand as a production base for hardware industries. One reason is its IT market proximity; providing access to China and the rest of the region (Trade partners UK 2000). In addition, the integration of the ASEAN countries make Thailand and the other member countries more favorable production bases, due to a large, and growing, potential IT market with free trade in IT goods and services (Severino 2000). Thailand and Malaysia have been chosen as production bases for HDD sub-assembly (Kraemer et al. 1996) as they offer low cost labor and are close to a more mature industry in Singapore, where HDD components and parts are mainly shipped for final assembly (CSN & Associates 2001). Thailand's geographical location therefore could be one of the factors supporting the choice of the country as a production base for MNCs. Consequently, if the presumption of FDI influencing IT industry success is true, location also has an indirect impact on the IT industry's success in attracting FDI.

5.3.2 Domestic IT Use

To measure the country's use of IT the composite of sub-variables (national IT spending, the number of computers installed and the volume of national telecommunication use) established by Ein-dor et al (1997) is adapted and applied to this study. A summary of these data is presented in Table 5.

Domest c IT Use	Tha land
Internet users/100people	12.74(a)
IT spend ng	
Total IT Spend ng (US $ m ll ons)	1,511 (a)
IT spend ng as a percentage of GDP	1.2 (a)
ICT expend ture as percentage of GDP	2.13 (d)
Personal Computers per 100 persons	3.795 (a)
Telecommun cat ons Revenues (US $ m ll ons)	64,781(f)
Telecommun cat on revenues per cap ta (US $)	1067 (f)

Table 5: Domestic IT Use (adapted from Ein-dor et al (Ein-dor et al. 1997)

Sources: National Information Technology Committee Secretariat (NITC), The World Competitiveness Yearbook, US Department of Commerce: International Trade Administration, World Development Indicator 2001, The Association of Thai Computer Industry (ATCI), National Electronics and Computer Technology Centre (NECTEC)
note : (a) = yr 2002, (b) = yr 2001, (c) = yr 2000, (d) = 1999, (e) = 1998, (f) =1997

Domestic IT use in Thailand, although reasonably high when compared with other developing countries, is not outstanding. In fact, it is relatively low when compared with IT use in developed countries. Therefore, as with previous research on small developed countries, domestic IT use does not appear to be significant enough to influence IT industry success in a developing country either. Moreover, foreign companies that invested in Thailand seems to focus on external markets rather than the domestic market (Jansen 1997). Although there are some foreign software companies, for example IBM, Oracle and Microsoft, which target the domestic market (like government and large scale companies), this does not seems to explain IT industry success, which is dominated by the hardware industry. As a result, domestic IT use does not directly or indirectly impact IT industry in Thailand.

5.3.3 Government Policies

Thailand's in the midst of their second national IT plan, called IT 2010. Most of the projects thus far focus on building an IT society; such as SchoolNet Thailand launched for the purpose of increasing students' opportunity to learn (Kiattananan et al. 1998). Only a few are directly aimed at the development of the IT industry. Thailand's national IT policies seem to be introspective; with a main focus on development inside the country, and lacking an outward focus (Corbitt 1999).

Thailand's expenditure on R&D is relatively low. Its total public expenditure on university research is claimed to be less than that of a large engineering department in a US university (TDRI cited in Abdulsomad 1994). In 2001, the government's total R&D expenditure accounted for 0.17 percent of GDP and the amount of R&D expenditure on Science and Technology accounted for 0.05 percent of GDP (NECTEC 2002). The low number of scientists and engineers in R&D and the number of patents also reflect less effective government support for R&D. The number of scientists and engineers in R&D per million people in Thailand is only 103 persons, which is surprisingly low when considered together with the value of its export of high technology products. However, the Thai government do provide a range of benefits, such as income tax exemption, import duties reduction and a free entry permission of expatriate experts and technicians, to foreign investors in a number of industries including, the computer hardware industry (Kraemer et al. 2001). Thailand' trade policy and its participation in international trade agreements is another facilitator that supports the growth of its IT industry. The list of IT products receiving reduced tax ranges from finished goods (e.g.

computers) to components and peripherals (e.g. integrated circuits). Table 6 presents the IT industry related government policies.

Government Pol c es	**Tha land**
IT policies	
IT Strategy	Yes
Type of Promotion of IT Use	National IT policy
Type of Promotion of IT Development	National IT policy
IT priority	
IT Use Priority	High
IT Development Priority	High
Government IT Organisations	
Number of Policy Setting Organisations	
Number of Advisory Organisations	2
Research and Development	
Extent of R&D	
Gross Domestic Expenditure on R&D (US $ millions)	47 (d)
R&D expenditure as a percentage of GNI(987 - 997)	0. 3
Scientists and Engineers in R&D/million people	03 (e)
Performance of R&D	
Percentage of R&D Performed by the Private Sector	29 (d)
Percentage of R&D Performed by the Public Sector	7 (d)

Table 6: Government Policies (adapted from Ein-dor et al 1997)

Sources: The World Competitiveness Yearbook 2001, World development indicators 2002
note : (a) = yr 2002, (b) = yr 2001, (c) = yr 2000, (d) = 1999, (e) = 1998, (f) =1997

In summary, government policy through the support of R&D seems to be the least effective among the four types of policies and seem to have limited contribution to the success of the IT industry in Thailand. Moreover, even though government IT policies have shown a heavy commitment by the government to the importance of the use and development of IT, these policies were initiated less than ten years ago. Therefore, they may not be significant enough to entirely explain the success of the industry. On the other hand, investment promotion policy and trade policy do appear to have contributed to the growth of the IT industry by welcoming foreign companies and encouraging local companies to invest in the industry. We conclude that government policies, to some extent, have contributed to Thai IT industry development, however, there are still some steps (e.g. R&D promotion) that the government could take in order to achieve a higher level of success. In addition, Thailand has had considerable success in attracting foreign direct investments from MNCs, suggesting that government policy has had some impact on investment on IT-related FDI.

5.3.4 Human Resources

According to UNESCO (1999), Thailand's percentage of public expenditure on education per Gross National Product (GNP) is 4.8. Even though the percentage of public expenditure on education is not as high as in developed countries like Finland and New Zealand (7.5 and 7.3, respectively), it is higher than some developed countries, for example Japan, Korea and Singapore (3.6, 3.7 and 3.0, respectively). The education sector receives high priority from the

government. In 2000, 25 percent of the government's budget was spent on the education sector (ITU 2002). The number of IT graduates in Thailand is increasing steadily, with an average growth of 19 percent during 1992 to 1998 (Pantasen et al. 2001). In 1998 there were 24,867 IT professionals in Thailand, among whom 42.8 percent had a bachelor degree or higher (Pantasen et al. 2001). The total number of IT workers in both the public and private sectors is 77,816 persons in 2001 (Pantasen et al. 2001). Of this number, approximately 20,000 persons are software professionals (SWP cited in NECTEC 2002). Although there seems to be a shortage, the quality and cost of Thailand's labor is often cited as a factor that attracts foreign investment into the hardware industry (BOI 2002a; Doner et al. 1998; Strategis 2003). Table 7 presents the results for human resources in Thailand.

Human Resources	**Thailand**
Ethnic gr*ups	) aj*rity: Thai) in*rity: Chinese, Malays, La*
Official languages	Thai
Life expectancy	69.4 c$
Infant) *rtality/%000 live births	28 ($
Literacy	
a(ult	9' % ($
y*uth	98.' % ($
Nu) ber *f IT relate(fiel(enr*l) ents*	8,6%0 b$
Nu) ber *f IT Relate(Gra(uates **	24,867 e$
Value a((e(per w*rker in) anufacturing $ per year '9' -'99$	%0,946
Lab*ur c*st per w*rker in) anufacturing $ per year '9' -'99$	2,70'
E(ucati*n P*licies	
T*tal E(ucati*n Expen(iture as percentage *f GNP	4.8 g$
T*tal E(ucati*n Expen(iture as percentage *f g*vern) ent expen(it ure	2' .4 ($
Sch**l E(ucati*n	
Nu) ber *f c*) puter installe(in E(ucati*n th*usan(s$	272 a$
Sch**l Internet Access Percentage	%3.' a$
Tertiary E(ucati*n	
Nu) ber *f stu(ents enr*lle(in Tertiary E(ucati*n	%' 22,%42 '97/'98$
Gr*ss enr*l) ent rati* in tertiary e(ucati*n	22% g$
Science an(engineering stu(ents/t*tal tertiary stu(ents %987 -%997$	%8%

Table 7: Human Resources (adapted from Ein-dor et al (Ein-dor et al. 1997)

Sources: The World Competitiveness Yearbook 2001, UNESCO Statistical Yearbook 1999, World Development Indicators 2001, NITC (2001)
*this number is calculated from the report of Thai public universities under Ministry of University Affair (2001) which does not include universities that are not under the ministry
**this number is included graduates at lower, higher and bachelor degree from both private and public university in 1998
Note: (a)= yr 2002, (b)= yr 2001, (c)= yr 2000, (d)= yr 1999, (e)= yr 1998, (f)= yr 1997, (g)= yr 1996

5.3.5 Infrastructure

Although Thailand is considered a developing country, both the country's existing general and telecommunication infrastructure are relatively developed. A summary of data on Thailand's infrastructure is presented in Table 8.

Infrastructure	Thailand
Telecommunication Infrastructure	
Telephone ma nl nes per 100 people	9.2 (c)
Wa t ng l st (thousands)	415.2 (c)
Mob le phones per 100 persons	5.0 (c)
Secure Technology Assets (Secure Servers)	116
Telecommun cat on nvestment as % of GDP	0.71
Annual Telecommun cat on nvestment (US $ m ll on)	6,158 (f)
F ve years nvestment n Telecommun cat on (US $ m ll on)	2,025.70 (e)
Internet Hosts per 100 people	0.065 (c)
Monthly off -peak Internet access charge	
Serv ce prov der charge ($)	9 (b)
Telephone call charge ($)	0.75 (b)
Cost of local call $ per 3 m nutes	0.07 (b)
Outgo ng traff c m nutes per subscr ber	64 (c)
Cost of call to US. $ per 3 m nutes	2.50 (d)
General Infrastructure	
Electric power	
Consumpt on per cap ta kwh	1,352 (d)
Transm ss on and d str but on losses % of output	8 (d)
Qual ty of h ghways rank (of 75 countr es)	14 (d)
Qual ty of port fac l t es and waterways rank (of 75 countr es)	35 (d)
Qual ty of a r transport rank (of 75 countr es)	29 (d)

Table 8: Infrastructure (adapted from Ein-dor et al 1997)

Sources: World Development Report 2000/2001, US Department of Commerce: ITA, World Development Indicators 2002, International Telecommunication Union: Yearbook of Statistics, World Economic Forum: The Global Information Technology Report 2001-2002
Note: (a)= yr 2002, (b)= yr 2001, (c)= yr 2000, (d)= yr 1999, (e)= yr 1998, (f)= yr 1997

For telecommunication infrastructure, the country provides both satellite and submarine/terrestrial cable network links throughout the country and with the rest of the world (Paul Budde Communication Pty Ltd 2003). The country seems to be one of the region's leading adopters of technology, however, there are problems to be solved in respect of service quality, network utilization and the telecommunication regulatory regime (Thajchayapong et al. 1997). According to the National IT Committee, the country does not currently require further significant investment in infrastructure as the existing fibre-optic network is only operating at ten percent of capacity. The limited access to the Internet and its high cost (compared with the cost of living) could be a factor that is impeding the adoption and development of IT. On the other hand, the reliable infrastructure does satisfy foreign investors and contributes to their decision to invest in the country.

5.3.6 IT related Foreign Direct Investment

Thailand's fast growing economy is claimed to be significantly driven by FDI (Jansen 1997; Rasiah 2001). This FDI and economic growth have been found to have a positive correlation (Perkins 2001). The impact of FDI on Thailand's exports was considerable and resulted in the country's fast growing economy (Jansen 1997). FDI inflows into Thailand have increased more than 15 fold between 1980 and 1997 (World Bank cited in Perkins 2001). The World Bank

(cited in Perkins 2001) also reported that Thailand received among the largest inflows of FDI of any developing country. Thailand ranks sixth in the top ten largest recipients of FDI among developing countries from 1988 to 1992, following China, Singapore, Mexico, Malaysia and Argentina (United Nations cited in Dumois 1997). During this period Thailand received USD 9,500 million of FDI inflow. Table 9 below illustrates the extent of FDI in Thailand.

Foreign Direct Investment	Thailand
Software Industry Ownership	
Percentage of Thai company	51
Percentage of Foreign company	28
Percentage of Joint venture	21
Electronics Industry Ownership	
Percentage of Thai company	16
Percentage of Foreign company	45
Percentage of Joint venture	39
FDI, net inflows (US $ millions)	6,213(d)
Gross Foreign Direct Investment as percentage of PPP GDP	1.8(d)

Table 9: IT related Foreign Investment

Sources: World Bank country profile, World development indicator 2001, Board of Investment Thailand
note : (a) = yr 2002, (b) = yr 2001, (c) = yr 2000, (d) = 1999, (e) = 1998, (f) =1997

FDI underpinned the double-digit growth in Thailand during 1987-1990 (Jansen 1997) and appears to be a significant factor contributing to the hardware industry's success. The growth of hardware production and exports appears to have a positive correlation with FDI inflows into the country. Moreover, the majority ownership by foreign firms and joint ventures in the hardware industry illustrates the domination of FDI in that sector. We conclude that FDI is a factor that impacts IT industry success in Thailand and that geographical factors, government policies, human resources and infrastructure have indirect impact on IT industry success in Thailand through FDI. In contrast, the effect of FDI on the software industry has not resulted in high production or exports by this industry. This is probably due to the foreign software companies' investments in Thailand being focused only on serving the domestic demand, rather than using Thailand as a production base like the hardware industry.

6.0 DISCUSSION

This study found differences in the factors that affect IT industry success in developed countries as compared to a developing country. It reflects that countries with different levels of economic development (developed versus developing countries) may be affected by different factors or may be affected by the same factors in differing ways. A summary of the study's findings is presented in Table 10 below.

Factor	Direct effect to IT industry	Indirect effect to IT industry	Literature supporting the relationships
1. Location related factor	Location ⊁ IT industry Supported Connected to mainland Southeast Asia Close to major trade partners	Location ⊁ FDI ⊁ IT industry Supported Provides access to ASEAN Close to investors eg. Japan, Singapore and Taiwan	Dedrick et al (1995), Mansell (1999)
2. Domestic IT use	Domestic IT use ⊁ IT industry Not Supported Larger external market	Domestic IT use ⊁ FDI ⊁ IT industry Not Supported Export oriented FDI	Ein-dor et al (1997), Watson and Myers (2001)
3.Government Policies	Government policies ⊁ IT industry Weak Support Successful Investment promotion policy Relatively late issued IT policies Low R&D support	Government policies ⊁ FDI ⊁ IT industry Supported Successful Investment promotion policy Trade policy	Ein-dor et al (1997), Watson and Myers (2001), Kraemer and Dedrick (1997), Tallon and Kraemer (1995)
4. Human Resource	Human Resource ⊁ IT industry Not Supported Shortage of IT personal	Human Resource ⊁ FDI ⊁ IT industry Supported Good for foreign investors when comparing cost with quality	Kraemer and Dedrick (1997), Mansell (1999)
5. Infrastructure	Infrastructure ⊁ IT industry Weak Support Lack of universal access of Internet and High cost	Infrastructure ⊁FDI ⊁ IT industry Supported Reliable infrastructure	Kraemer and Dedrick (1997)
6. IT related FDI	FDI ⊁ IT industry Supported Hardware industry is leading by foreign companies		Kraemer and Dedrick (1997), Tallon and Kraemer (1995), Dedrick et al (1995)

Table 10: Summary of Findings and Supporting Literature

6.1 Challenges for Thailand's IT Industry Development

In order to develop the country's capability, Thailand should learn from developed countries. Factors that affect IT industry success in developed countries should be placed as the first priority for development. Even though Thailand's IT industry can be classified as successful based upon the criteria of Ein-dor et al's (1997) framework, the diffusion of IT in the country is low and it is concentrated in the populations of the big cities. Thailand's experience has been different from Singapore's where, although that country's IT industry also relies heavily on MNCs, it has been able to develop its human resources, infrastructure and policies to embrace technology.

There are two challenges for Thailand. Firstly, to achieve sustainable hardware industry success, the country needs to support more R&D into the more sophisticated aspects of the IT industry, such as fabrication and design. As stated earlier, Thailand is now facing competition for its position in the hardware industry's value chain. Many companies in the industry are engaging in assembling by utilizing the country low-cost labor. However, this advantage is not sustainable as a country's labor costs tend to increase along with the growth of economic development. In order to shift to the more sophisticated manufacturing tasks, the government needs to encourage and support the private sector's R&D. The Finnish government, for example, stimulated R&D in private companies by providing tax incentives for R&D expenditures (Watson and Myers 2001). More recently, the Thai government has taken some

action on R&D via TMEC, to drive the industry toward fabrication and design tasks (Leemawattana 2001). Nonetheless, this has to be supported by increasing the number of well-educated professionals in the fields of IT, science and engineering. In addition, the government should support the emergence of indigenous firms. Until now, the government appears to have been less interventionist and this has limited IT firms to certain portions of the IT industry value chain. Foreign companies have largely driven the industry. The support of the government to increase the number of indigenous firms that engage in manufacturing of sophisticated products, such as IC design and wafer fabrication (upstream industry), could help to nurture the existing MNCs or indigenous firms that engage in IC packaging and PCB manufacturing (middle stream industry) (Leemawattana 2001).

Secondly, to be successful in the software industry, Thailand needs to provide universal access to telecommunication, for instance by increasing teledensity (found to be significant to software industry production (Kraemer et al. 1993)), and lowering Internet access costs. In addition, both the quantity and the quality of IT workers need to be improved to support the growth of the industry.

6.2 Implications for Future Research

This study examined IT industry success in Thailand. The framework used in this study needs to be tested in other developing countries to ensure the generalizability of the theory and also to achieve the iterative nature of explanation-building analysis. A comparison among countries could then be drawn, using the level of economic development as a control variable. Some of the factors adopted from previous studies, do not appear to impact IT industry success in developing countries, for example domestic IT use. This factor may be excluded from the model in the future.

Furthermore, the affect of FDI on IT industry success may not be limited only to developing countries. Future research may also wish to consider FDI as a factor that may contribute to IT industry success in developed countries. In fact, the flows of FDI among developed countries themselves are higher than those available to developing countries. FDI in IT-related industries of developed countries may be investigated. Ireland is one of example of a developed country that has achieved success in its IT industry by encouraging heavy investment from foreign companies (see Tallon et al. 1999).

7.0 CONCLUSION

The aim of this research was to examine the IT industry in a developing country – Thailand, to establish the factors that underlie its success.

From our analysis, we found that the investment of foreign companies into the IT industry is significant to the Thai IT industry, especially the hardware sector. This seems to be the key factor explaining how a developing country like Thailand became one of the world leaders in IT hardware exports. FDI provides elements needed for IT industry development that, in general, developing countries seem to lack (e.g. advanced technology, capital and skilled human resources). In addition, four out of five other factors, being geographical location, government policies, human resources and infrastructure, are found to have positive relationships with IT related to FDI. To some extent, government policies seem to contribute to IT industry success by attracting investment into the country and, to a lesser extent, by the direct promotion of IT, but they fail to support the industry via spending on R&D.

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