THAILAND'S HARD DISK DRIVE COMPETITIVENESS ANALYSIS

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ABSTRACT

The hard disk drive (HDD) industry has been concentrated in Asia, especially in Southeast Asia. The competition in the HDD industry is aggressive. Many countries try to be the world's number one HDD manufacturer. Thailand, the largest HDD producer, has been chosen from most of the main leading HDD companies to establish production bases. It is necessary to evaluate and compare Thailand's competitiveness with other nations.

This thesis used both of quantitative and qualitative analysis. Due to the limitation of available data, two well-known indicators have been conducted in this thesis. Both indicators which are the Manufacturing Production Index (MPI) and the Revealed Comparative Advantage Index (RCA) are able to measure competitiveness of any country at the disaggregated product group level. Countries that are identified as the important players in the HDD industry are the base of HDD manufacturer in ASIA and have the investments from multinational enterprises. The five countries that have those characteristics are Singapore, Thailand, Malaysia, the Philippines, and China.

The results show that Thailand and China have a strong performance in the HDD industry, while Singapore and the Philippines with a decline in RCA indices are vulnerable as the HDD producers. Malaysia also has an ability to maintain its competitive advantage. The value of HDD export shows that Malaysia is not a major threat to other nations. The limitation of quantitative analysis is that it does not explain how Thailand and China gain their competitive advantages. To understand them more precisely, we identified the four determinants of Thailand and China's HDD industry by using diamond model and also added the government as a fifth determinant. From the analysis, China has a significant advantage in the size of domestic market, while Thailand has some critical issues that need to be improved. The HDD's downstream industry does not exist in Thailand. The R&D funding from its government is low. To enhance its competitiveness, it needs a government national policy for the HDD industry and the promotion plan for encouraging the growth of foreign direct investment (FDI).

KEY WORDS: HARD DISK DRIVE INDUSTRY / COMPETITIVENESS ANALYSIS / REVEALED COMPARATIVE ADVANTAGE INDEX / DIAMOND MODEL

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การวิเคราะห์ความสามารถทางการแข่งขันของอุตสาหกรรมฮาร์ดดิสก์ไดร์ฟในประเทศไทย
THAILAND'S HARD DISK DRIVE COMPETITIVENESS ANALYSIS

ธารทิพย์ เปรื่องชนะ 5036714 EGIE/M

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บทคัดย่อ

อุตสาหกรรมฮาร์ดดิสก์ไดร์ฟเป็นเป็นอุตสาหกรรมที่มีการแข่งขันสูงและได้มีการขยายฐานการผลิตไปยังหลายประเทศ โดยเฉพาะในแถบเอเชียตะวันออกเฉียงใต้ หลายประเทศต่างก็ผลักดันตัวเองให้เป็นฐานการผลิตฮาร์ดดิกส์ไดร์ฟอันดับต้นๆของโลก ประเทศไทยก็เป็นหนึ่งในนั้นเช่นกัน ปัจจุบันประเทศไทยเป็นฐานการผลิตอันดับหนึ่งของอุตสาหกรรมฮาร์ดดิกส์ไดร์ฟ ดังนั้นจึงเป็นเรื่องสำคัญที่ประเทศไทยควรจะประเมินความสามารถทางการแข่งขันของตัวเองเปรียบเทียบกับประเทศอื่นๆ

วิทยานิพนธ์ฉบับนี้ได้นำเอาวิธีการประเมินความสามารถทางการแข่งขันทั้งเชิงปริมาณและเชิงคุณภาพเข้ามาประยุกต์ใช้ จากการเก็บข้อมูลทำให้สามารถเลือกดัชนีเชิงปริมาณที่มีความเหมาะสมกับข้อมูลที่มีอยู่อย่างจำกัด 2 ดัชนีด้วยกัน 1) ดัชนีผลผลิตอุตสาหกรรม (MPI) และ 2) ดัชนีความได้เปรียบโดยเปรียบเทียบ (RCA) นอกจากนั้นแล้ววิทยานิพรธ์ฉบับนี้ได้นำเอาวิธีการวิเคราะห์เชิงคุณภาพด้วยแบบจำลองเพชรมาทำการประเมินหาปัจจัยแวดล้อมในประเทศที่มีผลต่อความสามารถทางการแข่งขัน

โดยจากผลการคำนวณพบว่าทั้งประเทศไทยและประเทศจีนต่างก็มีศักยภาพในการแข่งขันสูงในอุตสาหกรรมนี้ ในขณะที่สิงคโปร์และฟิลิปปินส์แสดงให้เห็นถึงแนวโน้มของการผลิตและส่งออกฮาร์ดดิกส์ไดร์ฟที่ลดลง ส่วนมาเลเซียก็มีศักยภาพในการรักษาขีดความสามารถทางการแข่งขัน แต่ผลจากดัชนีทั้งสองของมาเลซียแสดงให้เห็นว่ายังเป็นประเทศที่มีบทบาทสำคัญยังไม่มากนัก การประเมินเชิงคุณภาพด้วยแบบจำลองเพชรสามารถวิเคราะห์ได้ว่าจุดอ่อนที่สำคัญของไทยคือการวิจัยและพัฒนาที่ยังขาดการสนับสนุนจากภาครัฐ และนโยบายระยะยาวของรัฐบาลที่จะส่งเสริมอุตสาหกรรมฮาร์ดดิกส์ไดร์ฟ ในขณะที่จีนมีจุดแข็งคือมีอุตสาหกรรมปลายน้ำของอุตสาหกรรมฮาร์ดดิสก์ไดร์ฟตั้งอยู่เป็นจำนวนมากในประเทศจีน ในขณะที่ประเทศไทยยังไม่มีตลาดภายในประเทศเลย

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CHAPTER I
INTRODUCTION

This chapter will outline why this thesis is important and should be conducted. A brief review and introduction of the thesis question is described in the background section. The content in this chapter also included the specific purposes, scope of the study and what this thesis is attempting to find out.

1.1 Background and Problems statement

The electrical and electronics industry has been a major contribution to Thailand's economic growth. Figure 1.1 shows export value of electrical and electronics industry in Thailand from 2002-2008. The exports value in these two industries is growing, especially in electronics industry. During 2008 the electric and electronics industry has accounted respectively for 9.99 and 16.45 percent of Thailand's total exports. Many industries have suffered from global economic recession in 2008, however those problem are now passed for the electronics industry. An increase in demand in March 2009 for electronics sector shows sign of recovery and the main product that has played an important role in the economic growth of electronics industry is the hard disk drive (HDD). The statistics data in 2010 from ministry of commerce, Thailand show that the top product that has a largest proportion is computer and its component product group. The HDD is one of the significant products in this group.

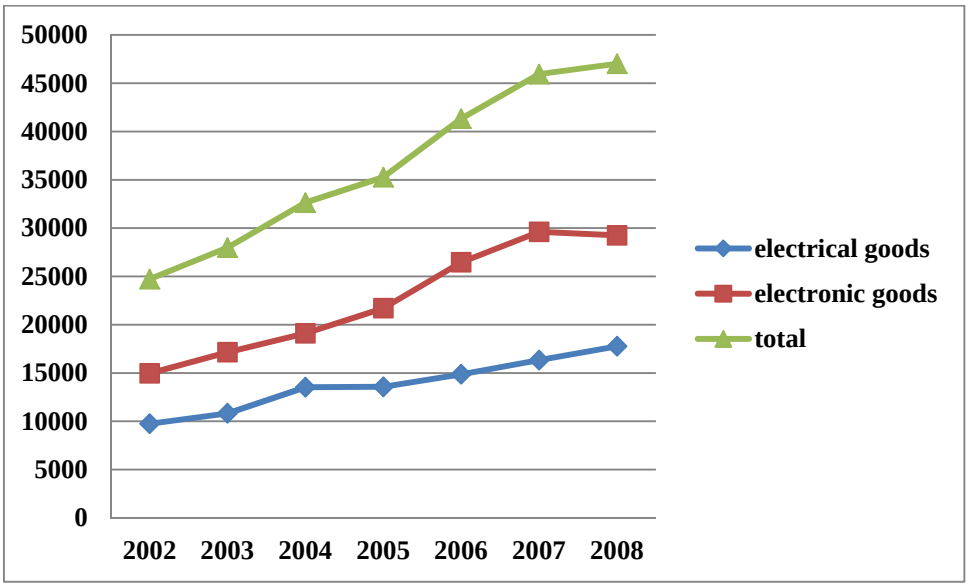

Figure 1.1

Thailand's export value of electrical and electronics industry (Million USD)

Source: Electrical and electronics institute

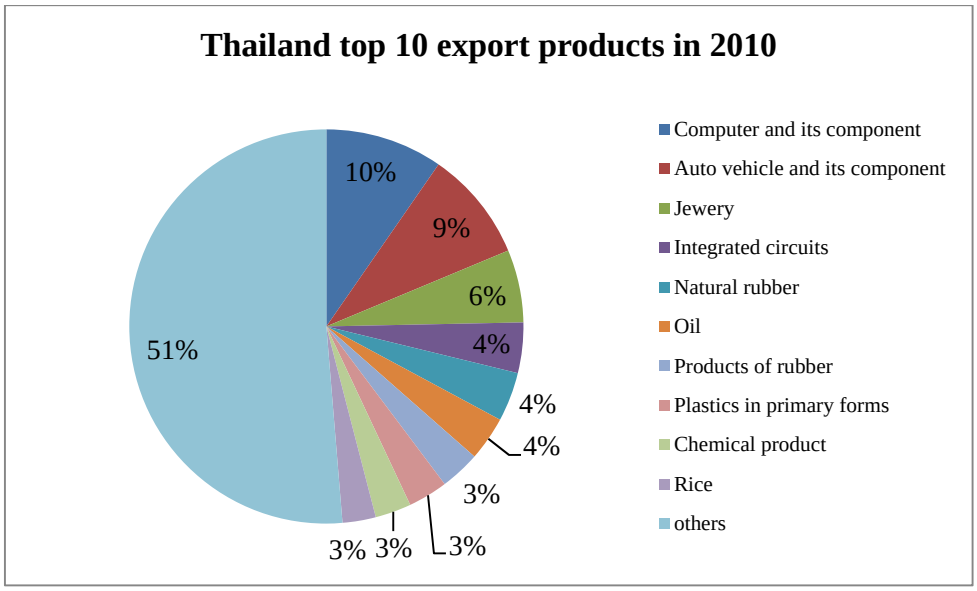

Figure 1.2

The proportion of Thailand top ten export products

Source: Ministry of commerce Thailand

Thailand is now one of the world's largest HDD exporters and manufacturers. All of The main leading HDD companies established production bases in Thailand: Seagate, Western digital, Hitachi global storage technology and Toshiba (Formerly Fujitsu), except Samsung. Figure 3 shows that the growth of Thailand's production in the HDD is rapidly increasing from 22,830 thousand of unit in 1999 to 246.985 thousand of units in 2008. According to Piewthongngam and Vijitnopparat (2009), Thailand has gained a huge benefit from this industry. Their study shows that the effects from the HDD cluster in 2007 to Thai labor are 2.4 hundred billion baht for the income and 10,000 jobs for the employment. Thailand government has acknowledged the important of this sector. Thus, hard disk drive institute (HDDI) was established by the government to support and strengthen the HDD Industry in Thailand. The goal of HDDI is to enhance international competitiveness and promote Thailand as the world number one HDD manufacturer through the next decade

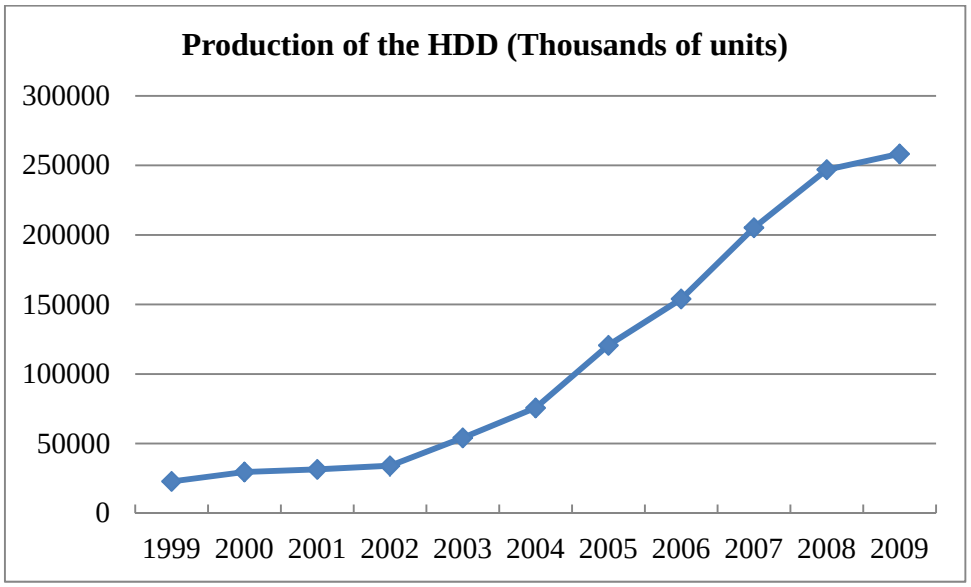

Figure 1.3

Thailand's production of hard disk drive (Thousands of units)

Source: Bank of Thailand (2010)

The competition in the HDD industry is growing more and more aggressive. Not only Thailand attempt to maintain and enhance competitiveness, but China, Singapore and Malaysia are also become the important players in this industry.

Therefore, Thailand should be aware of its competitors and analyze the current competitive situation of the HDD industry. The research from Thai farmers research center (2003) revealed that China is a major threat to Thailand. Being one of the most important based electronics manufacturers and providing low labor cost are the main advantages of China. Some of HDD companies have already expanded their investment to China (e.g. Hitachi global storage technology, Seagate formerly Maxtor). If Thailand lack of obvious policy and continuous improvement, soon or later Thailand will lose its competitive advantage to other nations. In addressing these issues, it is necessary to understand and compare competitive factors between key players in this industry

It is generally difficult to measure competitiveness of a specific industry in a nation level. Methods that employ to investigate competitive performance can categorize in two groups (Shafaei, 2008). First group is using a quantitative method which is focused on ranking the competitive of nations accordingly by using economic indicator and statistics. Studies in second category are using a qualitative method that explores the effect of each factor which based on the determinants in order to gain an in-depth understanding. The quantitative indicators can be defined as a measure of quantity while the qualitative indicators can be defined as a people's judgment and a perception about subject (CIDA, 1996:9). In the first category, qualitative data is needed to analyze competitiveness. As a result, it does not indicate how those nations have comparative advantage or disadvantage. In order to compare competitive advantage between nations the proposed approaches in this thesis will be based on both categories.

The structure of this thesis is divided in 6 chapters. Chapter 2 presents the main theoretical background and the related literature review to the HDD industry. Chapter 3 discusses the thesis methodology. The results of quantitative analysis and qualitative analysis are accordingly discussed in chapter 4 and chapter 5. The summary of the main findings are in final chapter.

1.2 Objectives

1.2.1 To assess and compare the competitiveness performance of the major role countries in the hard disk drive industry.

1.3 Scope of Work

1.3.1 The thesis will be focused on the major role countries in the hard disk drive industry. The country that is the production base of HDD manufacture and the main exporters of HDD will be considered as the major roles country.

CHAPTER II
THEORETICAL FRAMEWORK AND LITERATURE REVIEW

This chapter will describe the theoretical framework and a review of literature that are related to this study. First topic is an overview of existing literatures which give the definitions of competitiveness. The second part is the theory of the indicators that are related to competitiveness measurement at Nation/Industry level. A review of the researches that applied this theory is also included. In the final part is some reviews from the previous studies on the HDD industry.

2.1 The definitions of "Competitiveness"

The term competitiveness has been illustrated in several reports and articles. The used of this term often refer to three levels: 1.Microeconomic (i.e. firms) 2.Mesoeconomics (i.e. target industry/sector) 3.Macroeconomics (i.e. nations, regions). The following are the definitions of competitiveness given by institutes.

IMD (2009: 2): "How nations and businesses are managing the totality of their competencies to achieve greater prosperity". Competitiveness is not just about growth or economic performance but should take into consideration the "soft factors" of competitiveness, such as the environment, quality of life, technology, knowledge, etc.

OECD (1996: 20): "the ability of companies, industries, regions, nations or supranational regions to generate, while being and remaining exposed to international competition, relatively high factor income and factor employment levels on a sustainable basis".

WEF (2009: 4): "the set of institutions, policies, and factors that determine the level of productivity of a country". More-competitive economies tend to be able to produce higher levels of income for their citizens.

Many researchers also studied on competitiveness.

Waheeduzzaman and Ryans (1996) (cited in Sagheer, Yadav and Deshmukh, 2009): "Competitiveness is the degree to which a nation under free and fair market conditions produce goods and services that meet the test of international markets while maintaining or expanding real incomes"

Zinnes, Eilat and Sachs (2001) defined competitiveness as the set of causes of broad total factor productivity (TFP). Causes of growth in TFP would include institutional changes that strengthen property rights, increase the flexibility of goods and factor markets, improve the quality and productivity of government goods and services delivery, and raise the quality of government policy.

Porter (1998) stated that competitiveness is determined by the productivity with which a nation uses its human, capital, and natural resources. Productivity sets a nation's or region's standard of living (wages, returns to capital, returns to natural resource endowments)

According to Thailand's government organizations, the definitions of competitiveness have been addressed in some of reports.

Office of economic and social development board of Thailand use concept of competitiveness from both of Porter (1998) and OECD (1996) as a framework of Thailand's competitiveness development (Competitiveness newsletter, 2009).

Fiscal policy office of Thailand identified national competitiveness as a capability of a national economy to operate ensuring an increasing welfare of its citizens as its factor productivity sustainably growing. This capability is realized through maintaining an environment for its companies and other institutions to create utilize and sell goods and services meeting the requirements of global competition and changing social norms. Achieving competitiveness requires factors from government, technology, economics and human resource. Thus, the study of competitiveness is a competitiveness guide map and compass that will help us to understand our weakness and strengths of our country. (Macroeconomic analysis briefing, 2009)

This thesis will use the concept from Fiscal policy office of Thailand to analyze the competitiveness of the HDD industry at Nation level.

2.2 National competitiveness analysis at industry/product level

The summaries of the data that are needed to calculate each indicator and the previous studies from Thai government agencies are illustrated in table 2.3 and table 2.4.

2.2.1 Total Factor Productivity (TFP)

TFP measures the efficiency of the utilization of both capital and human resources. It is also regarded as a measure of the degree of technological advancement associated with economic growth.

$$TFP = \frac{Y}{L^{\alpha}K^{\beta}}$$

TFP is an index of the aggregate state of technology. Since TFP is not a pure number, it carries no interesting information in itself. But changes in the number indicate shifts in the relation between measured aggregate inputs and outputs and *in this aggregate model* these changes are assumed to be caused by changes in technology or changes in efficiency and/or in the scale of operations of firms (Richard G. Lipsey and Kenneth Carlaw, 2001). The growth rate of TFP is then calculated as an arithmetic index generated by taking time derivatives of both sides of the TFP expression:

$$\Delta TFP = \frac{\Delta Y}{Y} - \alpha\frac{\Delta L}{L} - \beta\frac{\Delta K}{K}$$

Explanation of symbols:

Y = total output ($),

L = labor input (People),

K = capital ($),

While α,β are the shares of output/income accruing to labor and capital. That is:

$$\alpha = \frac{wL}{Y} \; and \; \beta = \frac{\pi}{Y}$$

These shares imply that:

$$\frac{wL}{Y} + \frac{\pi}{Y} = 1$$

Where w is wage paid to labor and π is total profits.

Higher TFP growth indicates efficient utilization and management of resources, materials and inputs necessary for the production of goods and services.

At the national level, TFP growth reflects the portion of the growth in the Gross Domestic Product (GDP) that is not explained by the growth in inputs such as employment, capital investment and natural resources.

At the firm level, TFP growth implies the upgrading of skilled and technical manpower, application of technology and creation of new technologies, adoption of best management practices and developing corporate culture and work ethics (Malaysia Productivity Corporation, 2008).

2.2.2 Revealed Comparative Advantage (RCA)

In evaluating competitive advantage in the exportation of individual industries of a country, the indicator that most commonly used and has gained wide acceptance is the Revealed Comparative Advantage index. RCA shows whether a country has gained its market share in a product in the international (Shafaeddin, 2004). The idea of this indicator was introduced and developed by Balassa (1965):

$$RCA_{ij} = (X_{ij}/X_{it}) \,/\, (X_{wj}/X_{wt})$$

Explanation of symbols:

X = exports ($),

Subscripts i = country i,

j = industry j,

w = world,

t = all industries

where, X_{ij} represents the exports of industry j of country i, X_{it} represents total exports of country i, X_{wj} represents the world exports of industry j and X_{wt} represents total world exports.

To assessing the export performances of a product, if the value of RCA is greater than 1(RCA>1), it implies that country i has a comparative advantage in the production in industry j and if the value is not exceed 1, it implies that country i has a comparative disadvantage in the production in industry j.

The advantage of this indicator is that changes and trends in the RCA index over time indicate increasing or losing comparative advantage. In addition, it also eases of use and calculation due to limited and readily available data (Liu, 2007). However, it also has shortcoming in lack of insight explanations of its value. For example, it does not clarify whether a country has advantage in production or assembly operation of a product and it does not provide any evidence that extension of market share result from comparative advantage or subsidizing export, dumping, etc. (Shafaeddin, 2004)

2.2.2.1 The approach of Revealed Comparative Advantage (RCA) in competitiveness

The method of RCA has been employed and revised by many researchers. The following studies are the researches that have focused on assessing competitiveness of each industry/segment and also comparing with another country at national level, especially in developing country. Shafaeddin (2004) determined the effects of China's entry to WTO on selected developing countries in Asia, Latin America and Africa. Various issues have been considered in this paper: wages, competition and complementary effects. Due to the available data, this research applied RCA to exports and imports by using data that classified in STIC 3-digit level over period from 1992-1998. In the case of Thailand, member of Association of Southeast Asian Nations (ASEAN), the impacts from China's accession to WTO are clothing, miscellaneous household equipment and electric machinery. As a consequence of increasing domestic value added, China is improving competitiveness in technology/skill intensive products of interest the ASEAN.

Similar to Coxhead (2007), the paper examined the effects of China' growth on Southeast Asia and discussed about the curse of natural resource wealth. The main argument of this paper is SE Asian economies is under challenge from a combination of global and domestic condition which are the growth of China in world market and the quality of institutions for environmental management respectively. SE Asia, natural resource-rich region and low-skill manufacturing, need to improve policy for resource management. Especially Vietnam and Indonesia, which exports are most depend on natural resources and agriculture. In contrast, Malaysia and Thailand are having good exports performance in medium-tech manufactures. Not

only using RCA index in exports performance of products, but Seyoum (2007) also measured developing countries' competitive performance by focused on services industries. Besides the original formulation, another two modified indices of RCA also used to determine comparative advantage and in order to evaluate the consistency of RCA, three statistical tests: cardinal measure, ordinal measure and dichotomous measure are approached. The study concluded that most of developing countries have comparative disadvantage in financial and business services but do have comparative advantage in travel and transportation services. Recommendations for these countries are they have to provide good infrastructure and the government should work with private sector in order to enhance their competitiveness.

Another set of studies are applying revealed comparative advantage to compare competitiveness between two countries. For example, Wu and Zhou (2006) focused on bilateral trade between China and India. They investigated the composition of trade, trade intensity, intra-industry trade and comparative advantages by using export and import data from 1992, 1997 and 2003 that organized in standard international trade classification system (SITC). In order to evaluate which commodity group that China and India are competing with each other, RCA values have been computed. The results show that China and India have a potential to increase their bilateral trade by improving their competitiveness in some commodities and should consider in signing a free trade agreement.

A recent study, James and Ramstetter (2008) revealed that both Thailand and Indonesia's manufacturing industry have shifted from light to machinery industry. This is because multinational enterprises (MNEs) are becoming more significant contributions to these two counties. Thailand and Indonesia's exports of office and computing machinery and electric machinery have grown rapidly, according to the revealed comparative advantage index in those categories. Unlike textile and apparel industries, the indices showed that Thailand is vulnerable in exports these products while Indonesia still have advantage in apparel industry. The important of tariffs policy was also addressed in this paper by analyzing the impacts from their policy regimes.

Besides comparing between nations, RCA is also used to determine the export performance of a country. Lee (1995) investigated the

competitiveness in Korea's exports to point out the products that have been gaining comparative advantage. The data that was calculated from 1965-1992 at five-year benchmarks was the exports data in two and three digits SITC categories. The evaluation of RCA trends showed that the major export of Korea has been shifted from light-industry products (e.g. clothing, textile) to heavy or medium industry products (e.g. trailers, nonmotor vehicle). Korea can maintain some products in labor-intensive industries, because of the specialization in their products (e.g. footwear, travel goods and handbags). Other researchers, Vaidya, Bennett and Liu (2007) contributed to answer the question: Is China's manufacturing sector becoming more high-tech? First, they classified the three-digit level STIC product groups in to three categories: High-tech, Medium-tech and Low-tech and assessed export performances in four levels: in1987-2005 by calculating RCA. Second, assessment of changes in RCA alongside with growth of world exports over the same period gave an insight understanding. Finally, in order to investigate china's competitiveness more precisely, they plotted trade balance against RCA indices and calculated their correlation. As a result, this paper concluded that China is gaining more specialization in high-tech product groups, especially in automatic data processing and telecommunications equipment. Further, doing more research at film level is required to enhancing the competitive capabilities.

2.2.3 Manufacturing Production Index (MPI)

The definition of MPI is a measure of change in the volume of production of a fixed set of products of all selected producer units (BOT, 2000). The Laspeyres method is used to aggregate the indices. The value-added weights are applied to each product.

$$I^t = \frac{\frac{\sum_{i=1}^{n} Q_i^t \times W_i^0}{Q_i^0}}{\sum_{i=1}^{n} W_i^0} \times 100$$

Where I^t = Manufacturing production index at time t

Q_i^t = production quantity of product i at time t (piece)

Q_i^0 = production quantity of product i at base year (piece)

W_i^0 = Value-added weight of production i at base year

i = industry 1, 2,…, n

Bank of Thailand (BOT) has been calculating MPI and monthly reporting to the public. The objective is to use the MPI as an indicator of a production output in the short term and also forecast the future projection of the production. Only producers that are in the forefront of each industry are chosen due to limitation of manpower (19 industrial groups (76 products) accounting for 75.7 % of year 2000 manufacturing sector's value-added). Data are collected in unit of productions if applicable. The rest are calculated indirectly through proxy data, such as export volumes.

In order to calculate the MPI of the single industry (or product), the weight in the formula is eliminated:

$$I^t = \frac{Q_i^t}{Q_i^0} \times 100$$

Where Q_i^t = production quantity of product i at time t (piece)

Q_i^0 = production quantity of product i at base year (piece)

2.2.4 Capacity Utilization

Capacity Utilization is the portion between real production output and the maximum capacity. It shows that whether or not the installed equipment/machine was fully used.

$$U^t = \frac{\frac{\sum_{i=1}^{n} Q_i^t \times W_i^0}{C_i^t}}{\sum_{i=1}^{n} W_i^0} \times 100$$

Where U^t = Capacity utilization at time t

Q_i^t = production quantity of product i at time t (piece)

C_i^t = capacity of product i at time t (piece)

W_i^0 = Value-added weight of production i at base year

i = industry 1, 2,…, n

If the capacity utilization is more than 80 percent, it implies that the capacity is nearly full. If the capacity utilization is under 50 percent, it implies that those industries have low production capability and under break-even point. In order to calculate the capacity utilization of the single industry (or product), the weight in the formula is eliminated:

$$U^t = \frac{Q_i^t}{C_i^t} \times 100$$

Where Q_i^t = production quantity of product i at time t

C_i^t = capacity of product i at time t

The value of capacity utilization can be used to analyze the industry ability to handle the industry's high volume of its expansion in the future

2.2.5 Thailand Competitiveness Matrix (TCM)

Office of the national economic and social development board has developed the matrix based on BCG Matrix and GE / Mckinsey Matrix to evaluate the industry. The assessment from the matrix will help to making a future 4 years (2005-2008) strategic planning for Thailand's economic. This matrix is called "Thailand Competitiveness Matrix".

TCM has been analyzing based on two composite indicator groups which are:

1. Competitiveness Composite: this composite is a group of competitiveness indicators in a different perspective such as production aspect, competitive aspect, related and supporting factors.
2. Attractiveness Composite: this composite is a group of indicators that affect the industry growth such as the size of world market, the growth of world market, effects of social and environment factors.

The study employed the quantitative indicator to evaluate TCM. They used Revealed Comparative Advantage (RCA), Thailand export compound annual growth rate and import content to represent the competitiveness composite.

Table 2.1 The summary of the TCM's competitiveness composite

Competitiveness composite	Calculation	Implication
RCA_2003	(Export value of product/Total Export value) ÷ (World export value of product/Total world export value)	higher RCA => more competitive
Thailand export CAGR*_1998-2003	(Export value of product_2003/Export value of product_1998)$^{(1/\text{number of year})}$ -1	higher export growth => more competitive
Import content_2000	(Import value/Export value)×100	higher import content => less competitive

*Compound annual growth rate

Table 2.2 The summary of the TCM's Attractiveness composite

Attractiveness composite	Calculation	Implication
World demand_2003	(World import value of product/Total world import value) ×100	higher demand => more attractive
World demand CAGR*_1998-2003	(World import value of product_2003/World import value of product_1998)$^{(1/\text{number of year})}$ -1	higher demand growth => more attractive
Local demand_2000	(Local import value of product/Total local import value) ×100	Higher local demand => more attractive
% Operating surplus_2000	(Operating surplus value/Value added) ×100	Higher operating surplus => more attractive

*Compound annual growth rate

For attractiveness composite, they used world demand, world demand compound annual growth rate, local demand and percentage of operating surplus. The

result from TCM will be divided into 6 categories: Star, Opportunity, New wave, Falling star, Question mark and Trouble.

From their study as shown in figure 2.1, the HDD industry which is in the electronics group has been categorized as a potential industry. Potential industry group means that the HDD industry has a high competitiveness index and high attractiveness index.

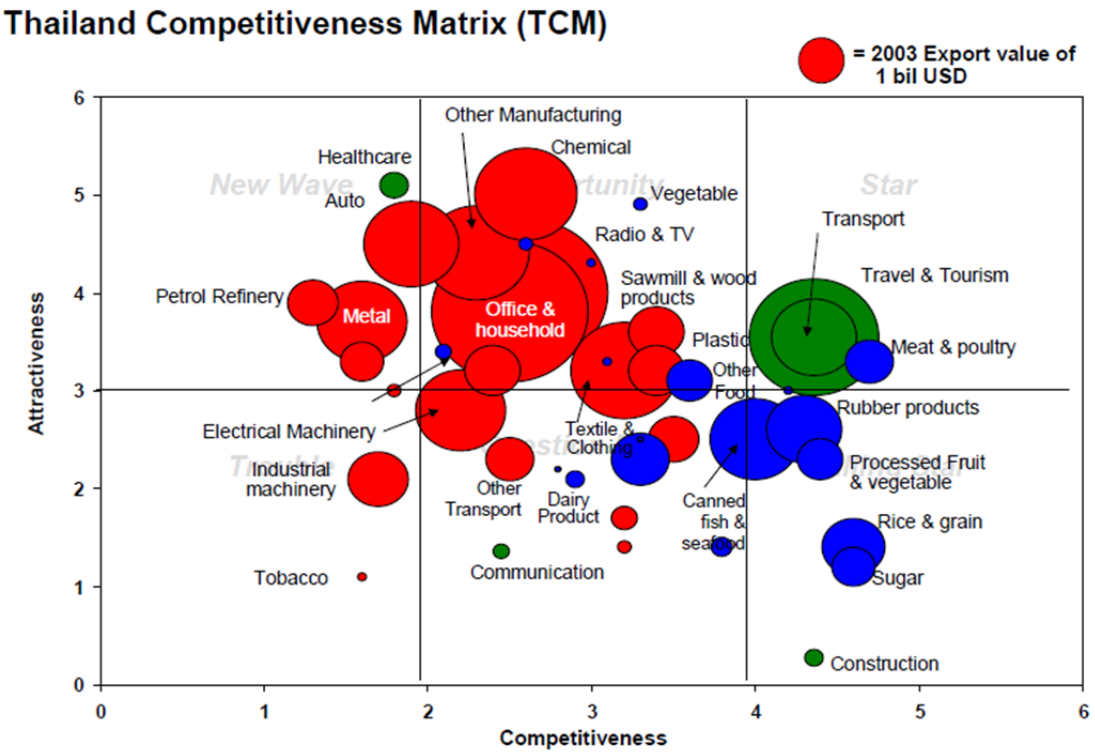

Figure 2.1

Thailand competitiveness matrix (TCM)

Source: Office of the national economic and social development board (2005)

2.2.6 Porter's diamond model

To explore the sources of competitive advantage in particular industry, it is really important to understand and investigate the elements of microeconomic business environment. Providing good quality business environment, the important factor, can offer a basis for successful production in industry. The four elements of competitive context or the diamond model was described in *The competitive Advantage of Nations* the book which written by Michael E.Porter (1990). Each part of diamond influences

on a nation's success of international competitive advantage. Thus, Porter's diamond model is considered as an effective methodology to analyze the competitive advantage of a national industry or an enterprise (Zhao and Zuo, 2009).

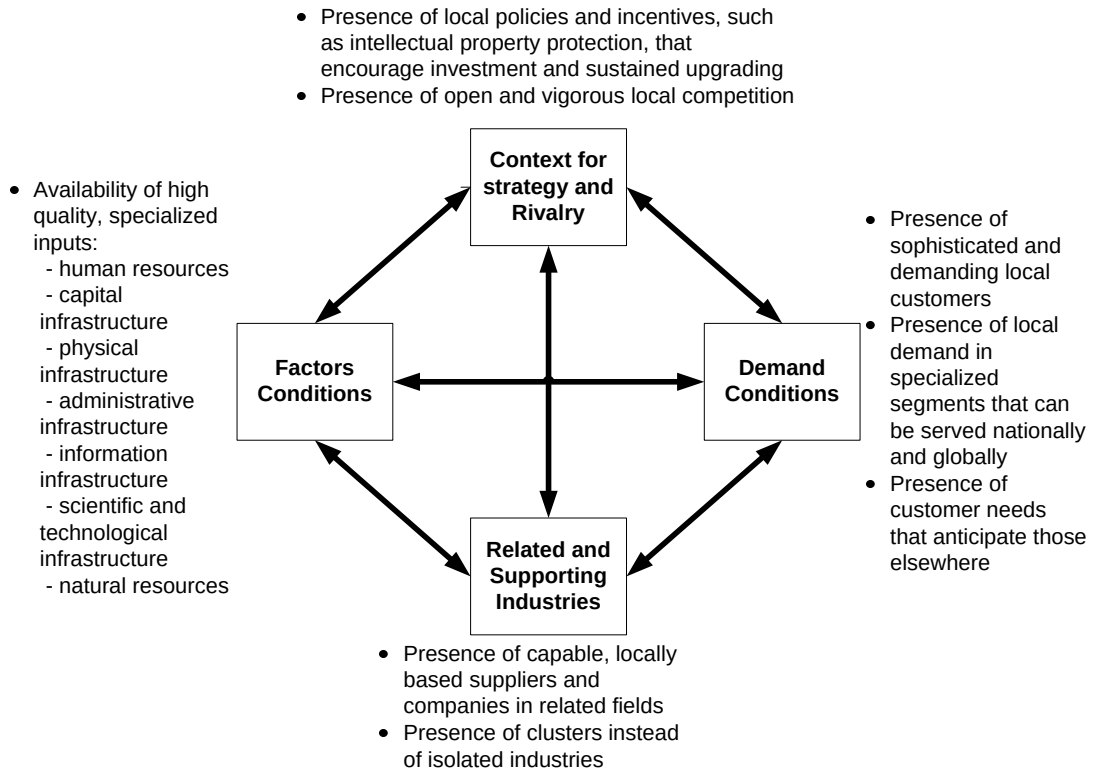

Figure 2.2
The four determinants in diamond model
Source: Porter and Kramer (2002)

The four interrelated elements that shape up the diamond are factors condition, demand conditions, context for strategy and rivalry and related and supporting industries. There are also two external determinants of national advantage, Government and chance, other two external determinants, also affect each and every point of the four major components.

2.2.6.1 Factor Conditions

This determinant refers to the quality inputs of production that are necessary to compete in a given industry. Porter classified the determinant into difference aspects: human resources, capital infrastructure, physical infrastructure, administrative infrastructure, information infrastructure, scientific and technological infrastructure and natural resources. These factors can be distinguished between basic factor conditions and advanced factor conditions. For example, unskilled labor is considered as basic factors while skilled human resource is considered as advanced factor.

2.2.6.2 Demand Conditions

In economics of scale, the size of local demand may be important but the presence of quality of domestic demand is more crucial. Demanding customers will stimulate the industry to enhance their competitiveness in the products or services. In order to response the customers, the industry have to constantly improve itself. As the industry is accomplished to deal with the sophisticated and specialized local demand, the industry will be able to serve the international demand either.

2.2.6.3 Context for strategy and Rivalry

This determinant is usually analyzed from the government policies and rules that continuously promote investment and encourage an open and vigorous competition in the industry. Porter and Kramer (2002) suggested that policies or incentives in a nation that protect intellectual property, open local markets to trade, and reduce corruption make a location a more attractive place to do business. In addition, more domestic rivalry will cause the business environment that creates more intense the competition.

2.2.6.4 Related and Supporting Industries

The presence of high-quality suppliers and related industries within nation can enhance productivity in industry. Because of globalization, raw materials are now largely sourced from different countries. However, it is not as efficient as sourcing services, capital goods and technology from suppliers within nation. The vertical and horizontal linkages across industries and institutions are the most important to competition. According to Porter (1998), those linkages are defined

as a cluster's boundaries. Clusters are geographic concentrations of interconnected companies and institutions in a particular field (Porter, 1998: 78). Therefore, being part of a cluster offers much more benefits than being isolated industry.

As mentioned earlier, competition depends on productivity which is affected from every determinant in diamond model. It is necessary to analyze the four elements carefully. Porter and Kramer (2002) suggested that weakness in any part of diamond can lead to the failure in competitiveness of a nation or region.

2.2.6.5 The approach of Porter's diamond model in competitiveness

A review of the literature reveals that Porter's diamond model has been employed in firm-industry-nation level competitiveness (Sagheer, Yadav and Deshmukh, 2009). The examples of researchers who studied competitiveness at nation level are Chobanyan and Leigh (2006) and Kovačič (2007). Chobanyan and Leigh (2006) applied diamond model to analyze the competitive advantage of Armenia. As a result from defining Armenia's diamond, the recommendations have been made to enhance Armenian industries' competitive advantage. Similarly, Kovačič (2007) who studied on competitiveness of nation used both of quantitative and qualitative analysis to evaluate competitiveness of a small open economy like Slovenia.

At the industry level, diamond framework also applied in the following papers. Since 2002, Taiwan has gained a highest important role in export thin film transistor liquid crystal display (TFT-LCD), second only to Korea. To understand the issues behind this success, Chang (2005) employed diamond model based on six determinants to identify competitive advantage in this industry. For the factor endowments, the action that Taiwan has to do is attentive to the requirements of intellectual property rights which are the most important resource. Another critical factor that contributed the development of this industry is the local demand in this industry which is coming from notebook PCs and LCD monitors manufacturing. In addition, not only downstream customers, a reliable local supply in Taiwan also enhances the competitiveness. The intensity of local rivalry also enables the industry to improve their ability, in order to competing with Japan and Korea. While the government has been supported in subsidize universities and institutes to do R&D, the drafted a 5-year plan has been launched to help this industry surpass Korea. Moreover,

the rapid change technology has resulted in the replacement of CRT TVs. The trend that is likely to happen within a few years, will definitely lead the high demand of LCD TVs.

Zhoa and Zuo (2009) analyzed the performance of China's wind power industry. Because of the vital role of China's government in the electric power industry, other than the four elements the paper also included government as a fifth determinant. As well as technology and chance, there are also considered as an important factor in the model. All seven determinants were carefully analyzed. First, they investigated in factor condition. It showed that China has a plenty wind resource along the southeastern coastal areas. In contrast, generation costs and the on-grid power price is much more expensive that conventional power price. There are programs and project that have been launched to promote the commercialization. Second, because of the power price and generation cost, demand condition is not stable. The government is still working on this issue, while the statistics showed that China is becoming a largest wind power-generating country in Asia. Firm strategy, structure and rivalry, the third factor, showed that domestics and joint-venture manufactures are gaining a higher role in market share. Another two determinants related and support industry and government, also were identified. Overall, wind power industry has a great potential to grow. The most important issues that need attention are the price of this power and Chinese government's policy, in order to help this industry compete with coal-fired power.

Besides evaluate competitiveness at nation level, diamond model also applied at the firm level. Porter and Kramer (2002) explained the benefits from philanthropic investment by using diamond model to analyze the effects from philanthropy to company's competitive. It is important to understand the connection between charitable contribution and the company's business. Therefore, company will know where companies should give to and how their contributions create greatest benefits to social and economic impact.

Diamond model has been criticized from many researchers that Porter's home-based diamond model is not applicable well with small and open economy (Chobanyan, Leigh, 2006; Liu and Hsu, 2009). Those researchers argued that Porter fails to incorporate the effects of multinational activities in his model

(Moon, Rugman and Verbeke, 1998: 137) therefore, Moon et al. (1995) proposed a new approach: the generalized double diamond model. Several studies that employed generalized double diamond model as a theoretical framework are the research by Moon, Rugman and Verbeke (1998), Liu and Hsu (2009) and Jin and Moon (2006).

Moon, Rugman and Verbeke (1998) aimed to test the validity of diamond model and generalized double diamond model. They evaluated the global competitiveness of Korea and Singapore by calculated competitiveness index in both of domestic and international factor conditions. For example, data that represent factor conditions are wages in manufacturing and scientists and technicians per 1000 persons. The visualized shapes of double diamond model showed that Korea has more competitive than Singapore in domestic determinants while Singapore has more competitive than Korea when considered domestics and internationals determinants.

Similar to Liu and Hsu (2009) who studied on competitiveness of Taiwan and Korea used data based on quantitative data. The four elements have been evaluated in value, for example the paper analyzed factor condition from average labor force participation, average researchers per 1,000 employments, average exports of goods, average inbound FDI per capita. They had to collect these data from many sources and calculated data to competitiveness index. Then, they compared each determinant's competitive index between those two countries. They stated that this paper is the first study that applied a generalized double diamond model approach to analyze and to compare the competitiveness of the economies of both Taiwan and Korea.

While those researchers used data based on quantitative by focusing on macroeconomic level, Jin and Moon (2006) employed generalized double diamond model and used data based on qualitative data by focusing on individual industry. The main objective of Jin and Moon (2006) is to identify the competitive factors in Korea's apparel industry. They gathered data from the literature review on the successful firms and the interviewed from the practitioners in this industry. To summarized, the basic factors no longer contribute to competitive advantage, such as, labor costs, local supplier's availability. Korea's apparel industry needs to focus on the more advanced factors, such as skilled-labor, related and supporting industry in front-end. Moreover, the studied concluded that the most important key issue of Korea's

apparel industry is internationalization. For example, Korea should hire foreign designers to cooperate with local designers, create the global brands to the international market.

On the other hand, Öz (2002) argued that the diamond model successfully works in a developing country. In his paper, he aimed to identify the sources of competitive advantage in selected industries of Turkey. Five Turkish industry case studies are glass industry, construction industry, leather industry, automobile industry and flat steel industry. In order to prove that diamond model works with developing country, the paper compared the results by using diamond model with the current competitiveness situation of those industries. For example, automobile industry in Turkey is uncompetitive and the results from diamond model also reveal that all determinants are low on competitive advantage in this industry.

The literature reviews which are mentioned above are the researches that approach either RCA index or diamond model. The following paper is the research that used both of two methods. Shafaei (2008) analyzed the textile industry in Iran by applying diamond model to assessing at a firm level and calculating RCA index to assessing at a nation level. In order to evaluate five elements (included government) of diamond model, face-to-face interview and questionnaire were used to collecting data from four major Iranian synthetic fiber-manufacturing companies. The results showed that the average competitiveness of the four companies in all determinants is significantly low, especially demand condition. Besides employing diamond model, this paper also checked the validity of results by using exports value and RCA index to comparing between nations.

2.3 Previous study on Thailand's competitiveness at the industry-nation level

2.3.1 The case study of automotive industry

Besides HDD industry, automotive industry also has an important role as a contributor to the Thai economy. The nature of automotive industry is similar to HDD

industry. For example, there are direct investments made by all of the world's largest companies to locate their manufacturing facilities involvement in both of industries. In the context of supply chain, their upstream supporting industries which are located both domestic and international are rely on high-technology such as electronic part, precision part, metal part, plastic part, etc.

Teams from the office of the national economic and social development board, the Sasin graduate institute for business administration of Chulalongkorn university, and prof. Michael E.Porter of Harvard university (2003) applied diamond model as a tool to assessing five strategic industries in Thailand: tourism, automotive, fashion, food, and software. According to their findings on automotive industry, the factors that affect on the expansion of MNEs are the size of the domestic and nearby markets and the quality of the business environment (i.e. the presence of a large pool of capable locally-based suppliers, a productive workforce, political stability, an open trade policy, and strong upstream supporting industries). Another issue that Thailand has to take in action is upgrading the competitiveness of local suppliers. The problems on this issue are involved with the productivity, the capability, and the upstream supporting industries. The suggestions for the relevant institutes in automotive industry are concerned about their roles that are focused on policy development instead of cluster collaboration.

The federations of Thai industry (2008) also studied on the competitiveness of automotive industry by comparing between Thailand and Vietnam. The methods that used in this study to evaluate competitiveness are RCA index, constant market share analysis, SWOT analysis and diamond model. They analyzed the industry which is disaggregated into three product groups: car, motorcycle, and part and component. Since Vietnam accessed to WTO, the results showed that Thailand still has comparative advantage more than Vietnam in automotive industry. Vietnam has a potential in a future to develop competitiveness in this industry, especially in motorcycle due to plenty of resources and cheap labor cost. The recommendations have been made to Thai governor that research and development, human resource, supporting institutes and automotive database are the issues which need to improve.

2.3.2 The case study of electric and electronics industry

Electrical and electronic institute (2007) has been studying competitiveness in electrical and electronics industry since 2003. The study compared competitiveness between Thailand, South Korea, China and Vietnam by calculating RCA index and identifying the determinants in diamond model. In addition, in their latest study in 2007 they also included logistics and supply chain management to evaluate the performance of this industry. The product groups that were focused from this study are 1) electric appliance: air conditioner, refrigerator, and washing machine 2) electronics appliance: television 3) parts and components: motor, compressor, integrated circuit, and printed circuit board assembly. As a result from their study in diamond model, China has the most competitive advantages among four countries. Only three issues that China need to concern are trade liberalization from its trade partners, the low quality of local suppliers and lack of intellectual property rights. Moreover, evidences from calculating RCA index in world market, US market, EU market and Japan market showed that China is the big threat in every product group. Although Thailand is increasing competitive advantage from 2002 to 2006 in some of product groups, changes in market share is declining. This study suggested that Thailand should improve their research and development (R&D) and incentive policy to attract more FDI. The concept of cluster is also point out that this industry should collaborate and support each other to establish this industry into a cluster.

Table 2.3
The summary of needed data in each indicator

Indicator \ Data		Total Income (USD/ Year)	Number of labor	Average wage (USD)	Capital assets (USD)	Export Value (USD/ Year)	Total Export Value (USD/ Year)	Production (Piece/ Year)	Total capacity (Piece/ Year)	Resource import Value (USD/ year)	Total World Import Value (USD/Year)	Total sales in country (USD/ Year)	Total Profit ÷ Value added (%)
TFP, TFP Growth		✓	✓	✓	✓								
RCA						✓	✓						
MPI								✓					
Capacity Utilization								✓	✓				
Thailand Competitiveness Matrix	Competitiveness Composite												
	1. RCA					✓	✓						
	2. export CAGR*					✓							
	3. import content					✓				✓			
	Attractiveness Composite												
	1. world demand										✓		
	2. world demand CGAR*										✓		
	3. local demand											✓	
	4. percentage of operating surplus												✓

* Compound annual growth rate

Table 2.4 The summary of the studies/reports from the government departments that adopt these indicators

Indicator	**Released**	**Scope**	**Responsibility government department**
TFP/TFP Growth	2001	Macroeconomic	Bank of Thailand
	2005	Macroeconomic focused on the national economic and social development plan	Office of the National Economic and Social Development Board
	2006	10 manufacturing groups	The office of industrial economics, Ministry of industry Thailand
	2006	The services sector	A Joint Project of The National Economic and Social Development Board and the World Bank
RCA	2007	5 groups of foods and processed foods	Office of agriculture economics
	2007	Automotive industry	The Federation of Thai Industries and the Thailand research fund
	2009	73 industry groups (HS code 2 digits)	The office of industrial economics, Ministry of industry Thailand
	2009	Refrigerator, Television, Air conditioner and microwave	Electrical and Electronics Institute
MPI	Monthly report	53 products (ISIC 4 digits)	The office of industrial economics, Ministry of industry Thailand
Capacity Utilization	Monthly report	53 products (ISIC 4 digits)	The office of industrial economics, Ministry of industry Thailand
TCM	2004	Groups of industry (HS classification)	Office of the National Economic and Social Development Board
Diamond model	2002	Phuket tourism	Office of the National Economic and Social Development Board
	2002	Black tiger shrimp industry	Office of the National Economic and Social Development Board
	2003	5 clusters: automotive, software, food, fashion and tourism	Christian H. M. Ketels, PhD, Institute for Strategy and Competitiveness, Harvard Business School by Office of the National Economic and Social Development Board
	2007	Automotive industry	The Federation of Thai Industries and the Thailand research fund

CHAPTER III
METHODOLOGY

The content in this chapter will give a thorough description of the thesis methodology. Stages of study which divided into four stages will explain how to collect the necessary data and the analytical procedure that this thesis will use to draw a conclusion.

3.1 Stage 1: Preliminary analysis

The first stage is to understand the overall competitiveness of the HDD industry in each country by using the quantitative indicators. This stage is divided into 3 steps.

3.1.1 Define the key player in the HDD industry

In the past 10 years, Asia is the region that has been expanded by the HDD industry. Most of the HDD production is from this region, thus this thesis will only focus on the countries located in Asia. The key players in the HDD industry must be identified before comparing competitiveness. Countries that are classified as the key players must have similar HDD industry characteristics to that of Thailand. These similarities are 1) their countries must be manufacturers in the HDD industry not just distributors 2) the investment in those countries from the HDD manufacturer has to come from multinational enterprises (MNEs) such as Seagate, Western digital, Hitachi global storage technology, Toshiba and Samsung.

As mentioned above, the important players have to be identified. In order to analyze this issue, the study of the HDD industry in ASIA has been done by a literature review and collecting data from the practitioners of the HDD industry. The countries that are classified as the key players in the HDD industry are Thailand, China, Malaysia, Singapore and the Philippines.

3.1.2 Select the quantitative indicators

We have to collecting reliability and validity secondary data from many sources. Due to the limitation of available data, we cannot calculate every proposed indicator. There are only two proposed approach indicators from chapter 2 than can compute for all country. First indicator is the RCA index and second indicator is the MPI index. In order to calculate MPI index, the export volumes will represent the production output (Q).

Table 3.1 The summary of available data

Available data	Year	Source
HDD export value of each country (USD)	1998-2009	UN comtrade/ HS code: 847170
Total export value of each country (USD)	1998-2009	UN comtrade/ HS code: 847170
HDD export value of world (USD)	1998-2009	UN comtrade/ HS code: 847170
Total export value of world (USD)	1998-2009	UN comtrade/ HS code: 847170
Export quantity of each country (piece)*	1999-2009	Global trade atlas sited from department of export promotion, Thailand/ HS code: 847170
MPI of Thailand's HDD industry	1999-current year (Based year=1999)	The office of industrial economics, Thailand/ISIC code: 300020
MPI of Malaysia's HDD industry	2003-2009 (Based year=2005)	Department of statistics, Malaysia/ISIC code: 30002
Capacity Utilization of Thailand	1999-current year	The office of industrial economics, Thailand/ISIC code: 300020

*Export quantity of Thailand is collected mixed between ton and piece unit, While Philippines is collected in ton unit.

Exports data and production quantity of the HDD from each country are needed to compute the RCA index and the MPI index. This thesis will use data from United Nations Commodity Trade Statistics Database (UN comtrade) and The Global Trade Atlas that are organized in harmonized commodity description and coding system (HS) in six-digit level. These two sources provide an online trade data system.

It allows users to view world trade flows for products of interest using the latest import/export data from the official sources of more than 70 countries. According to Thai custom department, HS in six digit level is international common use.

HS code 847170 is defined as an automatic data processing machines and units thereof; magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, not elsewhere specified or included and HS code 84717020 is defined as a hard disk drive. In fact, HS in eight-digit level is more specific to the HDD but Thailand and some other countries have just started to develop and collect data at 8-digit level in 2007. Hence, Thailand's HDD exports data is not available back from 2006. In order to assessing the trend of RCA index over period, the thesis has to use HS code at 6-digit level which is 847170 instead of 8-digit level.

3.1.3 Analyze the results from the index

The third step is data analysis. After we have got all the data we need the next step is to calculate and analyze them. The changes in trend of the RCA index and the MPI index over period can interpret whether the country is increasing or losing comparative advantage. Analyzing RCA index with trade balance is also the good way to explain the competitiveness of the country.

3.2 Stage 2: In-depth analysis

The limitation of quantitative analysis is that it does not explain how those countries have comparative advantage. The best way to measure national competitiveness is the combination of statistical data and qualitative data (Kovačič, 2007). In this stage we will select the other 2 main countries beside Thailand that have a relatively high competitive advantage in the HDD industry. The countries that have been selected will be based on the results from stage 1. The other reason that this thesis studies only two countries (included Thailand) is because it is hard to gather data and analyze every key countries in the limited resources.

To understand competitive advantage more precisely, we will identify the four elements of Thailand's HDD industry by using diamond model. Each determinant

in this model has to investigate by literature review and the interviewees. Hence, the structured interviews with the experts in HDD industry is needed to collect the qualitative data. The questionnaire that use in the structured interviews is developed by the following steps:

3.2.1 Questionnaire design

The questionnaire is developed to directly address the objectives of the study. The content of the questions will be design by based on each determinant in the diamond model. Other than those determinants in the diamond model, the role of government is also important to the HDD industry. This thesis will also include government as a fifth factor. Thus, the questions of the interview form will be categorized into 5 groups which are factors condition, demand conditions, context for strategy and rivalry, related and supporting industries and government. Each factor has to adjust with the HDD industry.

3.2.1.1 Factor conditions:

1) Physical infrastructure: transportation factor, industrial estate management factor and public utility factor.

2) Information infrastructure: the availability and accessibility of the information.

3) Human resources: the availability, the skill and knowledge and the cost of labor.

4) Capital/ Research funding resource: the availability and accessibility of the funding.

3.2.1.2 Related and supporting industries:

1) Locally-based suppliers: the availability and the variety of the HDD suppliers, the quality of the HDD suppliers

2) Presences of clusters: the availability of the related and supporting organization, the linkage between those organizations.

3.2.1.3 Demand conditions: the volume and the existence of demand in each country.

3.2.1.4 Context for firm and strategy rivalry: A local context and rules that encourage investment and sustained upgrading (e.g., Intellectual property protection).

3.2.1.5 Government: the stable of government and the policy from government.

3.2.2 Develop the question wording

The questions must be clearly understood by the interviewees. To ensure the understanding of the wording of questions, each question will be constructed carefully. The clarity and simplicity of wordings is the most important to concern.

3.2.3 Revise questionnaire

In order to assess the content validity of questionnaire, the draft questionnaire will be reviewed by the practitioner in the HDD industry and the expert from academic institution. After the draft questionnaire is approved by those reviewers, the fixed format questions will be conducted in the interview.

3.2.4 Interview all of the HDD manufacturer companies in Thailand

The experienced employees from Seagate, Western digital, Hitachi global storage technology and Toshiba have been interviewed by using the questionnaire. The perspective of each interviewee has to be related to those determinants in the diamond model. Therefore, we have selected the interviewees who work in these following fields: logistics, human resource, engineering and purchasing.

3.3 Stage 3: Discussion and Conclusion

We have to understand the results deeply to evaluate and compare competitiveness of each country, particularly among the important key players. The factors in diamond model that affect on achieving international competitiveness success in HDD industry will be identified. Furthermore, examination of critical issues of Thailand's HDD industry that are urgent to take in action will be addressed. The final stage is to summarize all the findings from this thesis. In order to achieving in the

purposes of this thesis, we will conclude our results. The value of this thesis is not only as a guide to policy-makers but also as a model of competitive analysis for other industry.

CHAPTER IV
COMPETITIVENESS ANALYSIS WITH QUANTITATIVE INDICATOR

As mentioned in chapter 3, the thesis will gather secondary data to understand the overall of HDD industry and its nature. The first section will give an overview of the HDD industry. The information and history about the HDD industry of each key player country will be described in the next section. At the first analysis stage, the RCA index and MPI index are using to evaluate competitiveness of Thailand, China, Malaysia, Singapore and Philippines.

4.1 An overview of hard disk drive industry

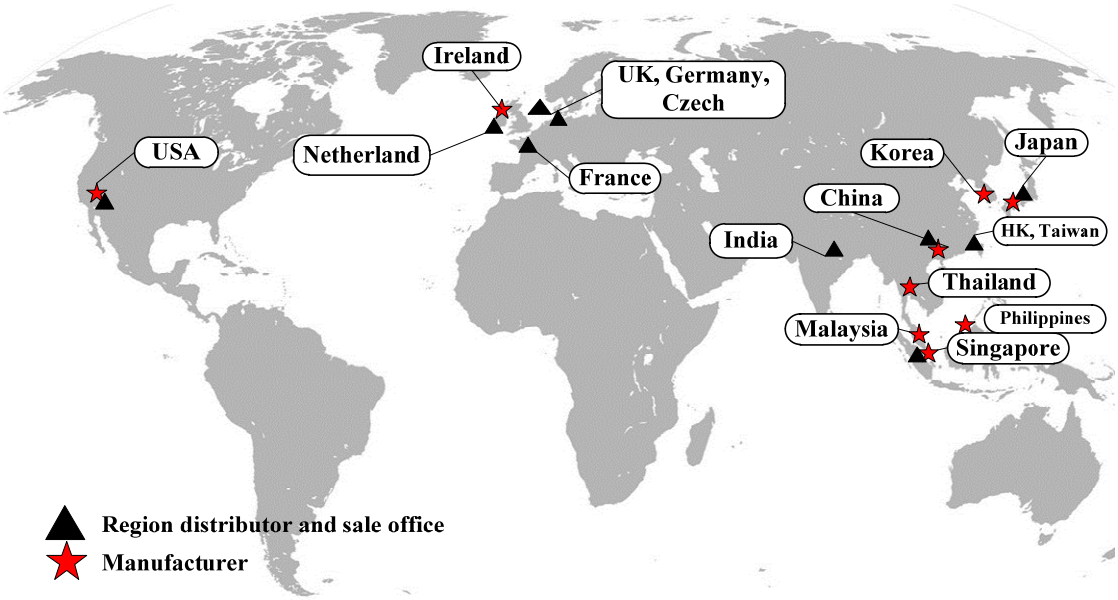

Figure 4.1

The geographic concentration of the HDD industry

Hard disk drive, storage device, has been introduced in 1965 by IBM. At first the main purpose of HDD is to use in computer. Now HDD not just supplies to computer industry but also expand the technology into many devices (e.g. camcorder, mobile phone, game console, etc.). More than 40 years that HDD has been producing to the global. Because many factors affect on this industry such as economic recession, the number of HDD companies has been changing to the five companies which are Seagate, Western digital, Hitachi global storage technology, Samsung and Toshiba. All of those companies established the research and development centers and sale offices in USA which is the world's largest consumer electronics market.

The hard disk drive industry has become one of the most globalized in modern industry. In analyzing the competitiveness of the HDD industry in any nation there is an issue that needs to be concerned before assessing its competitiveness. That issue is about whether the country is the base of the HDD manufacturer or only being the distributor of HDD. As shown in figure 6, there are the HDD manufacturers and distributors all over the world. The manufacturing has been concentrated in Asia, especially in Southeast Asia. Since 1981, the HDD companies have decided to expand their manufacturer to Southeast Asian region. Singapore is the initial country in SE Asia that has been picked by the HDD manufacturer. Since then, Singapore has played the most important role in producing HDD for the world. Later the investment came to Thailand as a second place in 1983 two years after the first entry of the HDD maker in SE Asia and to Malaysia and Philippines in 1988. Eventually SE Asia has a share of the global production of HDD unit more that 70% in 1995 (McKendrick and Hicken, 1997)

The top 20 countries that have the high value of HDD exports are shown in table 5. The thesis uses disaggregate product data classified by the Harmonized System code at 8-digit level (as mentioned in chapter 3). World custom organization developed and set the HS code in 6 digits which were internationally used. While the HS code at 8-digit level is defined differences because individual countries may extend a HS code to eight or ten digits. Thus, HS code at 8-digit of each country has to investigate before collecting those data.

As a result, the thesis use data from world trade atlas which is the reliable source from ministry of commerce. Table 5 shows the major countries that export

HDD and their exports value. China has the highest exports value which is 7000 US million dollars and second place is Singapore. Surprisingly, Netherland and Hong Kong have surpassed Thailand which has an exports value in the fifth place. To address this issue, all ranked countries have to categorize in two groups. First group is the country that has a HDD manufacturer and second group is the country that only has a sale office or distribution.

From reviewing a literature and collecting data from the practitioners in HDD industry, China, Singapore, Netherland, Thailand, Korea, USA, Ireland, Malaysia and Philippines are in the first group. The other countries have been categorized in the second groups. Netherland is also the distributor for EU region. Hong Kong is the hub that HDD from elsewhere has to pass before transfer to China.

Table 4.1 Top 20 countries that export HDD in 2009 (US dollars)

HS code 847170	**2007**	**2008**	**2009**	**Average**
China	11617262102	11708044418	10635083161	11320129894
Thailand	10204900127	11789277373	10466523059	10820233520
Hong Kong	4015252738	5238974694	5083769085	4779332172
Singapore	6477425515	6549290858	4881608681	5969441685
Netherlands	6135470270	5389787485	4584939633	5370065796
United States	4591468772	4472935659	4188953100	4417785844
Malaysia	2368702578	2684619241	2884911812	2646077877
Germany	2119252386	2142576340	2229879965	2163902897
South Korea	2618935822	2246652308	1711288819	2192292316
Ireland	1583318282	1024879800	1187635896	1265277993
Czech Republic	1075826701	1406668659	1162826651	1215107337
Philippines	2082554117	1651394470	1105990954	1613313180
United Kingdom	1444154105	1292646870	1101605431	1279468802
Hungary	1361167533	1430372069	1005438524	1265659375
Mexico	767276771	911158520	958710329	879048540
Taiwan	627116479	735179291	954627837	772307869
Austria	327272877	750062762	531880459	536405366
France	686520723	581940018	455350646	574603795.7
Japan	649748347	519047886	389902061	519566098

Source: Global trade atlas (sourced from Ministry of commerce, Thailand)

4.2 An overview of HDD activities in each country

The history of the HDD industry in each country is described in Appendix B and also summarized in figure 4.2 and figure 4.3.

4.2.1 Singapore

A decade ago Singapore was a number one producer in the HDD industry. Singapore has been shifting from the main HDD manufacturing to the HDD research/logistics center and the solid state drive (SSD) manufacturing.

There are three HDD companies currently operating in Singapore which are Seagate, Hitachi global storage, Western digital. The Seagate's facilities in Singapore are research center located in Science Park and media manufacturing located in Woodlands (the Seagate's HDD plant at Ang Mo Kio was closed in 2010). Hitachi global storage set the manufacturing plant at Kaki Bukit and the Asia pacific logistics center in Singapore. Hard disk drive maker Western Digital has just entered to Singapore by acquiring Hoya's Singapore media operation in 2010.

4.2.2 Thailand

Thailand is now the largest HDD manufacturing in the world. Four companies are producing the HDD in Thailand which are Seagate, Hitachi global storage, Western digital and Toshiba. On the other hand, there is no any research center neither logistics/distribution center located in Thailand. The first entry of the HDD industry was Seagate in 1983 as a head stack assembly plant at Pathumthani which is now operating by Fabrinet company. The current locations of the HDD plants are scattered all over the country (e.g. Pathumthani, Ayuthaya, Prachinburi, Nakorn-Ratchasima).

4.2.3 Malaysia

Seagate, Western digital and Hitachi global storage are operating their business in Malaysia. But there is only one HDD manufacturing plant in Malaysia owned by Western digital which is located in Selangor. The other facilities are mainly producing media/slider fabrication for the HDD. The locations of those plants are

located in Penang, Johor Bahru and Sarawak. The followings are some information about those cities:

Petaling Jaya has been commonly known as the most developed non-capital city in Malaysia. It is a Malaysian city originally developed as a satellite township for Kuala Lumpur comprising mostly residential and some industrial areas. It is located in the Petaling district of Selangor.

Penang had cemented its position as the “Silicon Valley of the East” by attracting top electrical and electronic companies due to factors such as ready availability of human talent, effective supply chain management, strong intellectual property protection, good governance and creativity and innovation in science and technology.

Johor Bahru is an important industrial, logistical, and commercial center. Its major industries include electronics, resource and petrochemical refinery, and shipbuilding. The Johor Bahru Central Business District is located at the southern tip of the metropolitan area. Johor Bahru access to the national expressway system is possible via the North-South Expressway. The Johor-Singapore Causeway links the city to Singapore with a six-lane road and a railway line terminating at the Southern Integrated Gateway, constructed in 2008. The Malaysia-Singapore Second Link, located west of the metropolitan area, was constructed in 1997 to alleviate congestion on the Causeway. It is linked directly to the Second Link Expressway, Johor Bahru Parkway, Johor Bahru Railway Station, and the North-South Expressway. Johor Bahru connects to regional and international centers: The Senai International Airport, located north-west of the metropolitan area, serves regional and national airlines. It is one of AirAsia's hub airports. To the west of the metropolitan area, in Nusajaya, is the Port of Tanjung Pelepas, which currently ranks as Malaysia's biggest transshipment hub. In addition, Singapore's seaports and airport also serve Johor Bahru's transportation or logistics needs, as they are less than an hour's drive from the city.

Since the 1980s, Sarawak has started to diversify and transform its economy into a more industrialized one. It is now playing a significant role in shaping the economic expansion of the state. As the largest state in Malaysia, Sarawak aims to be a fully developed state along with the rest of the country by 2020. Sarawak has

identified four sectors as key sources of growth: manufacturing, commercial agriculture, construction, services sectors

4.2.4 Philippines

Two of the HDD manufacturers own by Japanese company are operating in Philippines. The entry of those Japanese HDD majors was accompanied by the relocation of a number of Japanese supplier companies between 1994 and 1996 (e.g. the entry of Nidec in 1995). In the early 90's, Seagate also build a plant in Philippines but doesn't have a chance to open it because of the economic recession.

4.2.5 China

There are three major HDD companies that invested manufacturing operation in China which are Seagate, Hitachi global storage technology, and Samsung. The beginning of the HDD industry in China started in 1995 by Seagate. Since opening in 1995 the plant has earned the distinction of top foreign company by export value in the Wuxi and Suzhou, Jiangsu Province. Wuxi and Suzhou are found in the southern part of Jiangsu Province in one of China's fastest growing economic regions known as the Golden Triangle. The cities are located south of the Yangtze delta, between Nanjing and Shanghai on China's southeast coast and bordering Lake Taihu. Since 1993 the manufacturing in this province has gaining an attraction from electronics industry. Moreover, Jiangsu has the highest intensity in population and also has a third highest in gross domestic product (GDP) of China.

Hitachi global storage technology has a HDD manufacturing plant in, another spot in economic zone, Guangdong. Guangdong is one of the economic zones which is called "Pam pearl river delta". This province is mainly focus on light industry such as clothes, toys, etc. Comparing in the same product, the productivity from Guangdong accounted over 50% of country's total production. However, there is a sign of shifting from light industry to machinery and hi-tech industry. In the past few years, Guangdong has received foreign direct investment (FDI) from electronics industry from multinational enterprises (e.g. V-Tech, Gold Peak, Johnson Electrics, Hutchison, Hopewell, IBM, Intel, Hitachi, Samsung, Nokia, Sony, and General Electric).

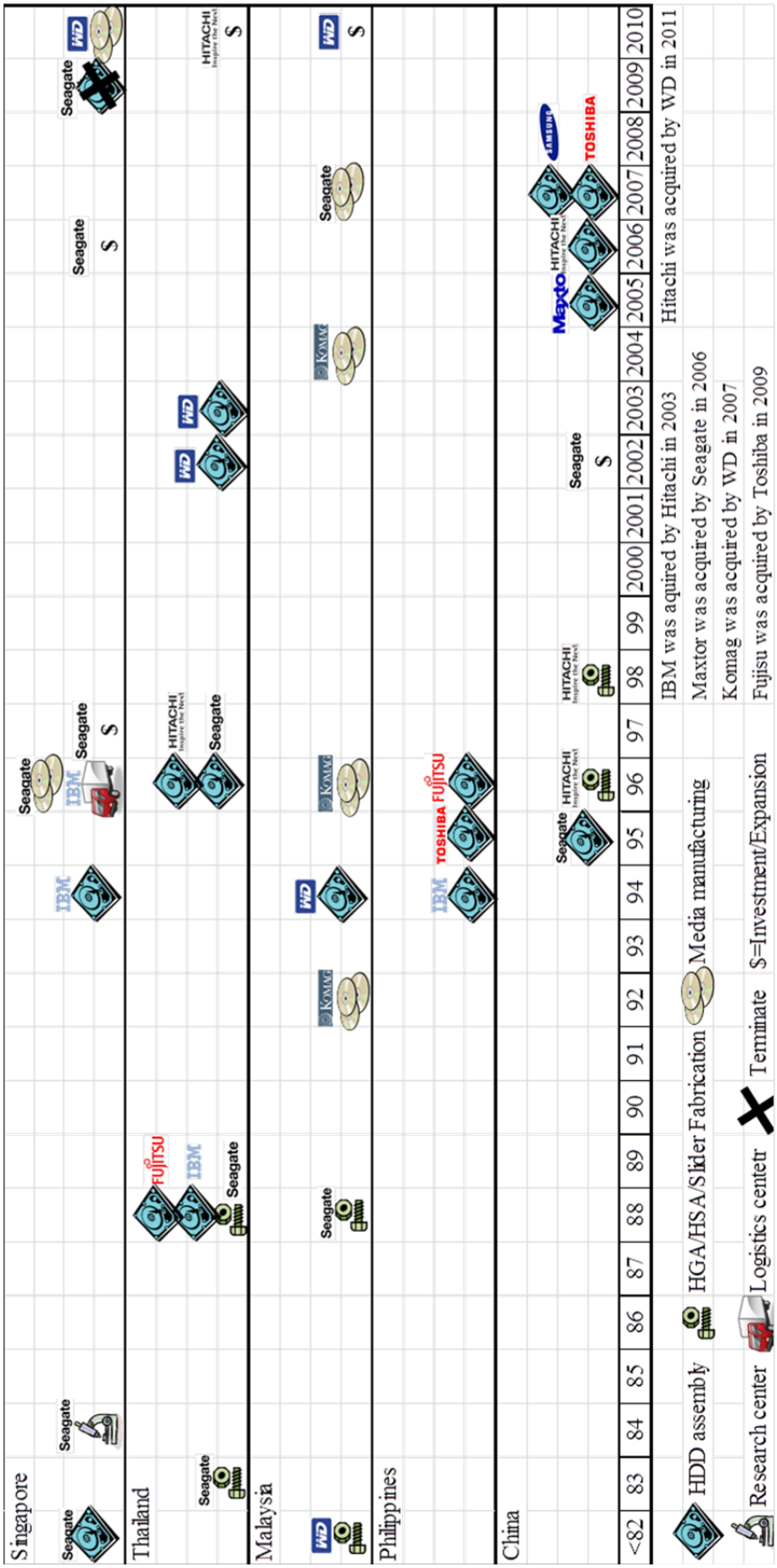

Figure 4.2

The activities of the HDD companies in Singapore, Thailand, Malaysia, Philippines and China

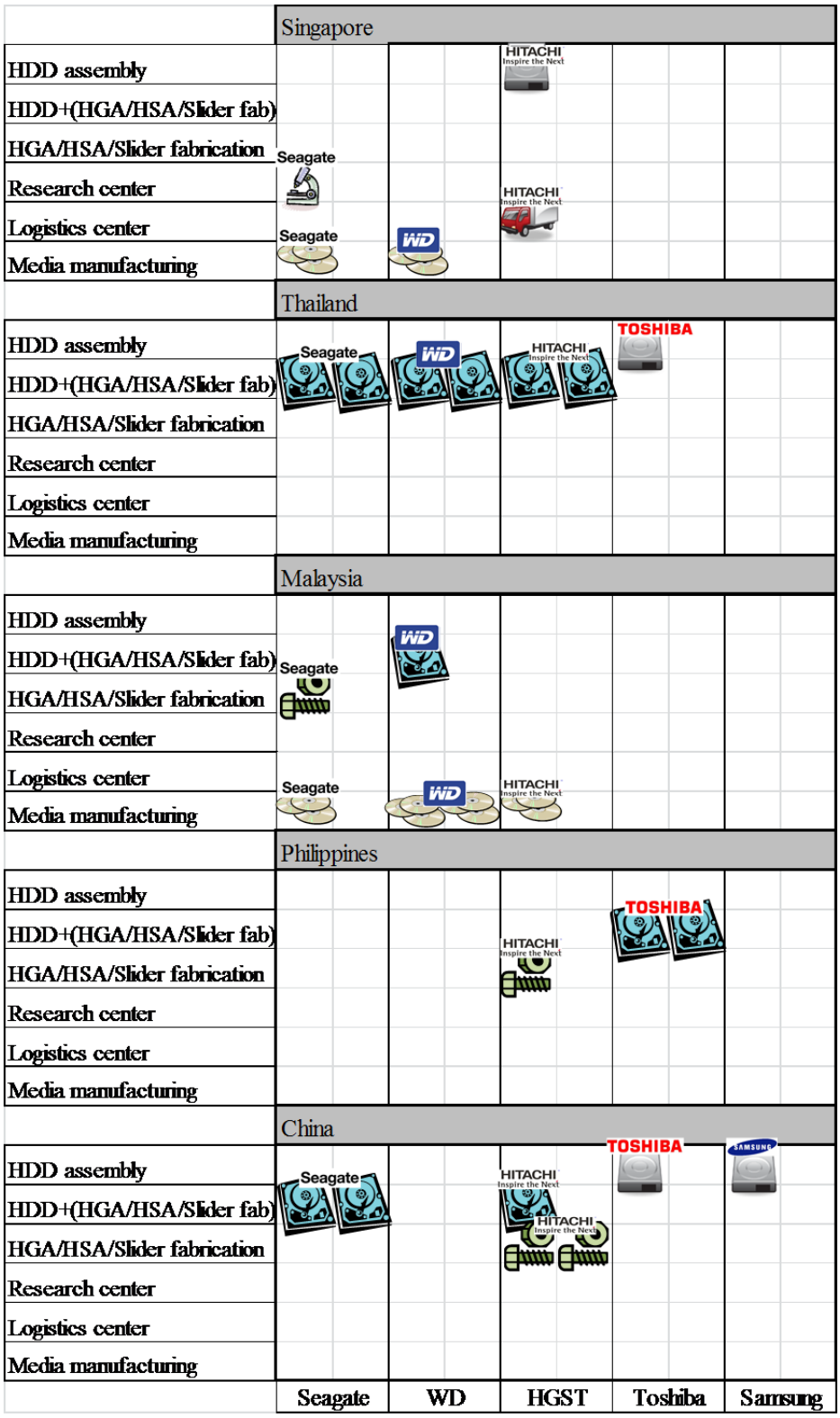

Figure 4.3

The current facilities of the HDD companies in Singapore, Thailand, Malaysia, Philippines, and China

4.3 Assessing competitiveness by MPI index and RCA index

The availability of data from UN comtrade and Global trade atlas of China, Malaysia, Singapore and Philippines is limited to the year ended 2009 (cited at Febuary2011). Therefore, the latest year that we can calculate the MPI index and RCA index is 2009.

4.3.1 Results from the MPI index

MPI index, an economic indicator, is released monthly, quarterly and annually by the office of industrial economics (OIE), ministry of industry Thailand. OIE compiles the MPI for standard selected commodities in Thailand. The indicator measures the amount of production from the manufacturing. The reference year for the index is 2000 and a level of 100. The MPI index aims at reflecting change in the physical volume of the output of the industrial sectors of the economy with respect to time. It provides a concise summary of past developments and aids in forecasting future trends, both of which are critical for making economic policy decisions.

Table 4.2 The results from MPI indices in 2000-2009

Year	Thailand	China	Malaysia	Singapore	Philippines	World
2000	100	100	100	100.000	n/a	127.773
2001	108.874	113.357	103.293	101.585	100	118.175
2002	116.342	155.996	117.752	117.221	95.717	116.189
2003	185.517	213.322	114.816	128.527	91.944	128.921
2004	255.487	245.603	60.617	163.933	71.197	143.701
2005	412.605	294.978	74.702	125.973	83.091	160.849
2006	525.628	333.072	97.953	101.832	78.232	197.631
2007	698.617	288.489	102.107	65.559	138.488	184.073
2008	845.846	269.737	109.572	71.287	132.54	186.982
2009	888.204	251.218	206.028	51.257	123.307	186.054

*Based year for Philippines is 2001 while other nations are 1999.

This thesis calculated the MPI index by using export quantity instead of production quantity due to the limitation of available data. The results have been shown in table 4.2, the MPI indices of Thailand have been increasing over a long

period of time to 888.204 while Singapore's MPI indices have been decreasing since 2005 to 51.257 which is around half of the base year. China, Malaysia and Philippines's MPI indices have been gone up and down over time but still show a growth of MPI indices over the based year to 251.218, 206.028 and 123.307 respectively. When we compared the results from those countries against the world as shown in figure 4.4, the growth rate of Thailand's MPI indices is higher than the world. It can be imply that Thailand has a continuous magnificent expanding of the HDD's output. China also has a rapid growth of the HDD export since 2000 while Malaysia and Philippines shows a slightly increase its HDD export volume. The high cost of HDD manufacturing and the announcement of shutting down one of Seagate's HDD assembly plant at Ang Mo Kio in Singapore made it losing the competitiveness.

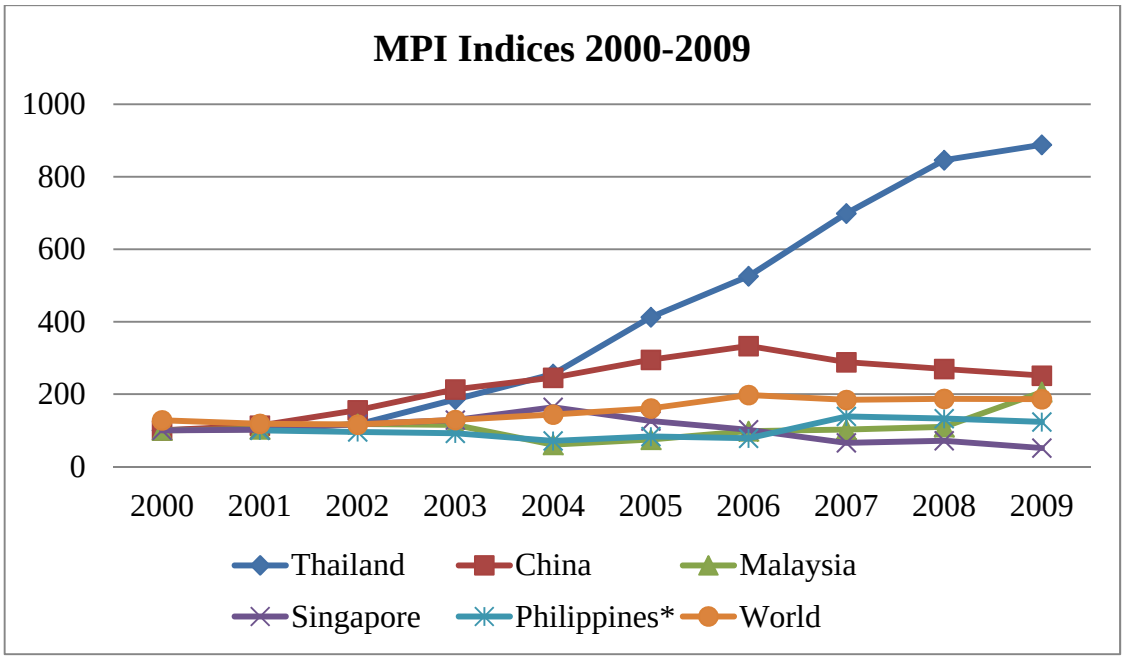

Figure 4.4

The changes of MPI indices over period (2000-2009)

4.3.2 Results from RCA index

The competitive positions of the HDD industry of Thailand, China, Malaysia, Singapore and Philippines in 2009 are illustrated in figure 4.5. These positions are formed by the monetary export values (USD), the world market share (%) and the RCA indices of the HDD industry in 2008. The radiance of each nation is

the monetary export value. The horizontal axis represents the RCA index while the vertical axis represents the world market share. The concept of these components in the figure is originated from the office of the national economic and social development board.

The values of those countries world market share of the HDD industry have been calculated from the monetary export value of the HDD from each country divided by the total world monetary export value of the HDD. The world market shares of Thailand, China, Malaysia, Singapore and Philippines are 18.99%, 19.22%, 5.19%, 8.82% and 1.99% respectively.

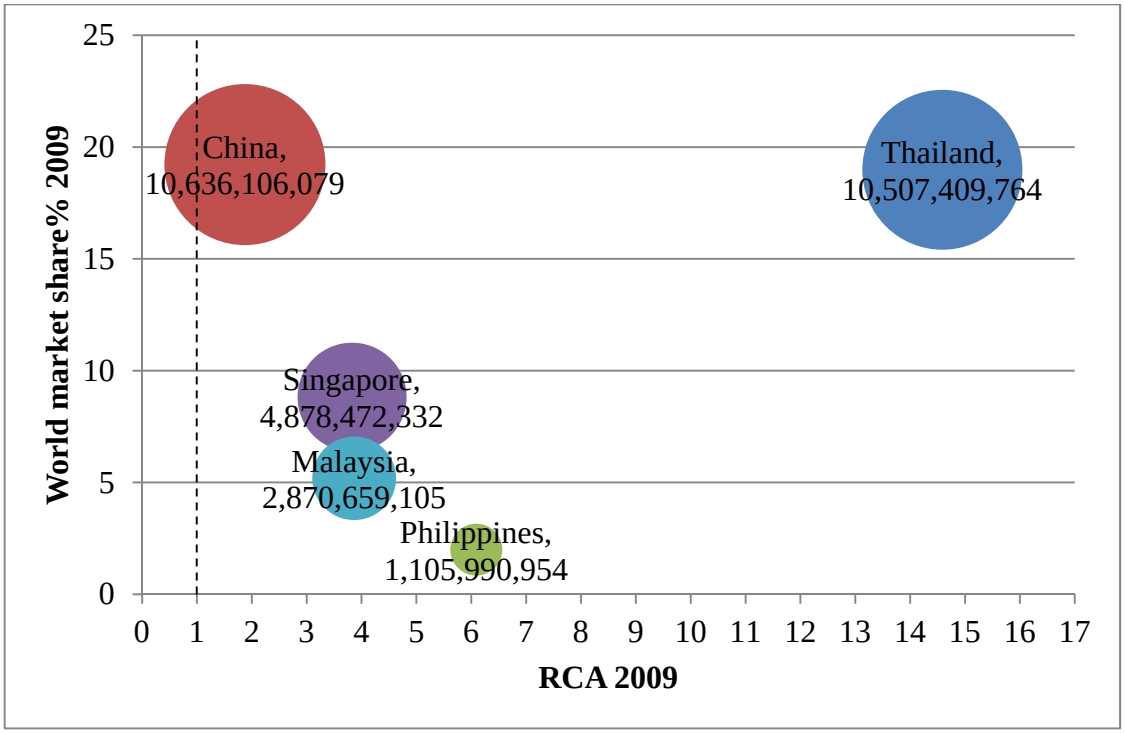

Figure 4.5

Position of Thailand and other countries in the HDD industry in 2009

As shown in table 4.3, in the preliminary study, RCA index was calculated from 2000-2009 and the countries that has been evaluating are Thailand, China, Malaysia, Singapore and Philippines.

Table 4.3 The RCA indices of HDD exports by country from 2000-2009

Year	Thailand	Singapore	China	Malaysia	Philippines
2000	0.003	11.743	1.315	4.672	0.011
2001	0.004	11.542	1.507	5.344	8.660
2002	1.622	12.982	1.830	1.412	9.439
2003	5.086	11.507	2.103	1.421	9.970
2004	5.993	9.625	2.205	3.322	10.165
2005	8.833	7.980	2.169	2.635	11.490
2006	10.153	5.969	2.393	3.151	10.197
2007	13.243	4.646	2.042	3.014	8.847
2008	14.764	4.338	1.826	3.024	7.498
2009	14.587	3.827	1.874	3.866	6.092

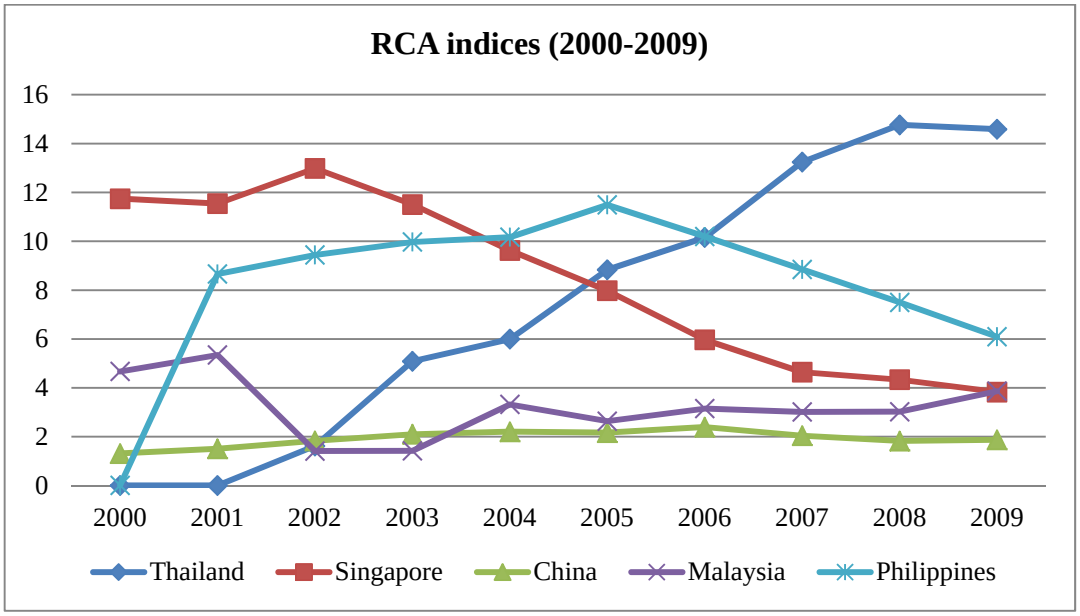

Figure 4.6

The changes of RCA indices over period (2000-2009)

The RCA indices and the monetary value of HDD exports of each country are shown in table 1. The trend of changes in RCA indices is also illustrated in figure 3. The results from calculating RCA indices show that Thailand, Singapore, China, Malaysia and the Philippines have revealed comparative advantage in 2009 which are

more than 1(14.587, 3.827, 1.874 ,3.866 and 6.092). Thailand has an extremely sharply rising trend in value of exports and RCA indices from 2001 to 2009. While Thailand and China have almost the same value of exports in HDD, China has steady RCA indices which are greater than 1 throughout the period. Malaysia and the Philippines have a proximal value of HDD exports which are 2,870,659,105 and 1,105,990,954 US$. From table 4.3, RCA indices of Malaysia were always well above unity from 2000 to 2009 (minimum is 1.4).

In contrast to Malaysia, the Philippines has exports of HDD that grew rapidly during 2000-2005 (from 323 to 165,139 thousand of US$). However, the Philippines was started to lose its value since 2006. HDD has been an important export in Singapore since 2000. Surprisingly, figure 3 shows that RCA indices of Singapore declined to 3.827 in 2009, most likely reflecting a long-term trend toward reduced competitiveness of both countries in the HDD industry.

Table 4.4 Trade balance (US$) of the HDD by country from 2000-2009

Year	*Thailand's Trade Balance*	*Singapore's Trade Balance*	*China's Trade Balance*	*Malaysia's Trade Balance*	*Philippines's Trade balance*
2000	-76,459,754	8,896,872,768	822,658,226	3,400,567,400	-9,130,798
2001	-217,974,363	8,229,269,465	1,364,257,917	2,570,780,289	2,185,266,515
2002	-135,635,917	8,695,041,148	1,001,065,007	477,302,936	2,200,246,866
2003	1,916,609,874	9,172,084,412	-467,966,112	593,692,924	2,190,596,713
2004	2,973,574,274	8,263,310,713	-814,598,704	1,261,133,930	2,232,711,559
2005	5,113,790,721	7,703,246,895	-2,219,764,715	1,164,807,869	2,612,114,261
2006	6,410,811,316	5,399,823,215	-1,377,825,392	1,435,504,692	2,446,290,713
2007	9,129,122,530	4,438,605,405	-3,279,134,160	1,404,587,909	2,068,517,631
2008	11,305,040,319	4,492,578,540	-5,640,307,396	1,912,429,190	1,641,258,867
2009	10,201,434,958	3,291,507,854	-6,045,882,322	2,374,281,437	1,093,724,650

As noted earlier, the RCA index does not provide an insightful explanation of international competitiveness. A country may be a significant exporter of a product but may be an even larger importer. Hence, the paper also calculated the trade balance in 2000-2009 and compared with RCA indices of each country. Table 4.4 shows that Thailand has gained a huge benefit from trade surplus in HDD which is 10,201,434,958 US$ in 2009. Unlike China, the country is facing an issue in a weak position of an importer at -6,045,882,322 US$ in trade balance. Malaysia, Singapore

and Philippines have positive trade balances from 2001 to 2009. Malaysia and Philippines have proximal values which are 2,374,281,437 and 1,093,724,650 US$ respectively. While Malaysia and Philippines keep their trade surpluses constant throughout the period, there is a negative sign in the trade balance for Singapore. A decrease in the value can imply that Singapore is losing its competitiveness.

From the above results of the MPI index and the RCA index, here are the most significant findings: 1) all of the countries have revealed comparative advantages in 2009 which suggests that those countries are significant exporters of HDD. 2) China, Malaysia and Singapore have revealed comparative advantages throughout the period (2000-2009) 3) Thailand and the Philippines shifted their positions by having comparative advantage since 2001. 4) China and Malaysia have consistently RCA indices throughout the period while the trend of Singapore and the Philippines in RCA indices shows that their values are decreasing. To summarize, Thailand has a strong performance and a progressive specialization in the HDD industry. The high value of RCA indices imply that Thailand's exports have to rely on this product much more than China. The value of exports and the steady RCA indices show that China is the major competitor in the HDD industry. The weakness of China is being a large importer of the HDD. In the past, Singapore was the biggest player in this industry. Singapore and the Philippines have a downward trend of RCA indices which can predict that both countries are going to lose their advantage in producing the HDD in the future. Malaysia has tried to keep its competitiveness throughout the period. However, the value of HDD exports in Malaysia is not high compared to Thailand and China.

In this step of analysis, the quantitative evidence does not indicate how those nations gain comparative advantage or disadvantage. Further in-depth study will analyze in qualitative data to explore an insight explanation (e.g. cost of labor). The qualitative analysis will evaluate in Thailand and China which are the main exporters and having a high performance in the HDD industry. The diamond model will be used as a tool to analyze an in-depth factor of the competitiveness.

CHAPTER V
COMPETITIVENESSANALYSIS WITH QUALITATIVE METHOD

This chapter will identify factors of two main key players in the HDD industry by using diamond model. The countries that have been selected are based on the results from quantitative analysis. From the analysis, Thailand and China have the strongest performance as the HDD producers and exporters. Therefore, we chose to study Thailand and China in this stage. The structured interviews with the experts in HDD industry have been employed to collect the qualitative data.

5.1The Diamond model of Thailand

Five determinants that are analyzed are 1) Factor conditions, 2) Demand conditions, 3) Context for strategy and rivalry, 4) Related and support industries, and 5) Government. Data was obtained from the interviews with the HDD companies in Thailand. The shape of Thailand's diamond model for the HDD industry is shown in figure 5.1.

5.1.1 Factor conditions

- Physical infrastructure

The main relevant topics that are concerned with the HDD industry are transportation infrastructure, industrial estate infrastructure, and electric and water utilities. Transportation infrastructure is an enable of Thailand's HDD industry for enhancing the competitiveness. The mode of transportation which ismostly used for Thailand's HDD industry is air transportation. Because of the weight and value of the HDD, more than 90% of the HDD is shipping to the customers by airplane. Suvarnabhumi International Airport is providing the modern facilities to accommodate the logistics activities and acting as an important central of cargo transportation. The

air cargo rate from Suvarnbhumi International Airport has an advantage comparing with other international airport such as Shanghai Pudong International Airport. The trucking service is also used for shipping to China, Malaysia and Singapore.The delivery made by truck is more likely serve for the HDD's component parts.The route from Thailand to China has to pass Laos and Vietnam which are facing issues from the security problem, the custom clearance andthe road surface condition.From table…, it shows that more than 30% of HDD export value is from Chinese market. Thus, if Thailand can improve the road freight transportation and its safety, it will promote the long-distance haul.The water way is also another option for the HDD industry in Thailand but Thailand's port has a shortcoming in term of its location. Comparing with Vietnam's port, there are three largest ports in Vietnam – Saigon port (south), HaiPhong port (north), and Da Nang port (central) which are currently having a high potential of being a big threat to LaemChabang Port in Thailand.At present, the rail transport is not the appropriate mode for Thailand's HDD industry due to its limitations. The rail system in Thailand is a single-track throughout the line and it has a limited capacity and causes a delay delivery. Another main disadvantage of Thai railsystem is its lack of security. That's why most of industry with value product doesn't choose the rail freight for their shipment. In order to reduce the transportation logistics costs and strengthen competitiveness, the Thai rail system need to be taken very seriously.

Table 5.1 Thailand's HDD market and its value in 2009

Trading country	**Export value 2009 (USD)**	**Share (%)**
China	3484673517	33.29
United States	1960099045	18.73
Hong Kong	1187853520	11.35
Netherlands	533897643	5.10
Japan	526247444	5.03
Germany	419591175	4.01
Czech Republic	302872740	2.89
Malaysia	289213492	2.76
Taiwan	203114789	1.94
Singapore	175139257	1.67
Etc.	10466523059	13.22

Source: Global trade atlas, HS code: 847170

The management of industrial estate infrastructure in Thailand is inefficient. The unorganized zonings are not encouraging the investment from multinational company. Unlike Malaysia's industrial estates,their developers have also developed industrial estates in certain states and designed to promote the manufacturing companies that produce or assemble products to establish in the same area. With the systematically clustered together, it increasesthe potential growth and competitiveness of the firms. In addition to these, some of industrial parks in Thailand are not responsible byIndustrial Estate Authority of Thailand, the ministry of industry and it leads to a lack of support providing the suitable infrastructure in the industrial area such as road maintenance.Another physical infrastructure that is facing a problem is the reliability of electric power systems in Thailand. The interruptible power supply may affect the whole operations and the HDD testing procedure.

-Information infrastructure

The source of the useful HDD information in Thailand is unmerged and unsynchronized. There is no presence of the infrastructure to facilitate the sharing of information specific for the HDD industry inThailand.Hard Disk Drive Institute (HDDI), a support institution of Thailand’s HDD industry, provides some data and research studies for the HDD industry but emphasizes only on a technical knowledge.

-Human resources

The HDD industry needs the specialty engineer in every field. Thailand has a good availability of high-tech labor. This is because there are only two large hi-tech operations in Thailand: the automobile industry and the HDD industry. Moreover, the wage of engineer is cheap. On the other hand, some of Thai engineers are not flexible to work at other position (e.g. trainer).

Besides the engineer, the labor in operation line is the key factor that drives the productivity. The nature of HDD industry employment is needed a relatively large numbers of work forces and the labor usually has a high turnover rates. Currently, Thailand’s HDD industry is facing the challenges of lack of operator. The strong points of Thai operator are their level of capability learning, flexibility with a good attitude and a commitment to work. The cost of labor for the operation line is also inexpensive compare with other nations such as Malaysia, Singapore.

Table 5.2 Monthly Salaries for Selected Positions (Survey Date – Q2/2010)

Position	**Baht**	**US$**
MD/GM	100,000	3,064.19
Financial Controller/ CFO	70,000	2,144.94
Personnel Manager/ HR Director	52,000	1,593.38
Office Manager	50,000	1,532.10
Plant Manager	60,000	1,838.52
Purchasing Manager	47,950	1,469.28
Marketing Manager	51,500	1,578.06
Executive Secretary (Bilingual)	29,000	888.62
Typist	8,000	245.14
Office Clerk	10,000	306.42
Receptionist	11,000	337.06
Programmer	18,130	555.54
Webmaster	22,500	689.44
Accountant	15,000	459.63
Researcher	20,000	612.84
Translator	21,000	643.48
Sales/ Marketing Staff	15,000	459.63
Public Relation Staff	12,000	367.70
Engineer	18,000	551.56
Technician	10,200	312.55
Skilled Labor	8,425	258.16
Semi-Skilled Labor	7,500	229.81
UnskilledLabor	6,000	183.85
Driver	8,000	245.14
Housekeeper	6,500	199.17

Source:based on the results of a survey of BOI-promoted companies, conducted in August 2010. © *2010-2011 ISM Technology Recruitment Ltd. (Q3, 2010,*www.ismtech.net*).*

Table 5.3 The minimum wages in selected cities of Thailand, 2010

Cities	Minimum wages (baht/day)
Bangkok	206
Ayudthaya	181
Patumthani	205
Prachinburi	170
Nakornratchasima	173

Source: The ministry of labor, Thailand

- Research funding resources

From the interviewed with the HDD companies in Thailand, all of them strongly pointed out that there is not enough research funding for the HDD industry. They also suggested that the government should grantHard Disk Drive Institute (HDDI) more funding not the other way around.The HDD companies have to ask the support funding from their headquarter company. In 2007, the gross expenditure on research and development is only 0.21% of gross domestic (GDP). The proportion of the source of funds that came from the government annual budget and the private organization is 45%, 55% respectively(Office of the national research Thailand, 2009). According to the tenth plan of the national economic and social development plan for 2007-2011, the government aims to support the gross expenditure on research and development to 0.5% of GDP but at this present it seems to be impossible to succeed it.

5.1.2 Demand conditions

The size of the local market is matter particularly for a high volume production such as the HDD industry. Despite Thailand is not a big country, the source of demand is not coming from the size of population. The customers of the HDD industry are mainly the original equipment manufacturers(OEMs) for personal computer or laptop. The other downstream industries are mobile phone, home entertainment device, auto mobile etc. Other market is the distributors who selling the HDD to the end-users. Surprisingly, being a location for HDD plants for more than 25 years Thailand still no sign of any exist of the computer manufacturing or the distributors. It can be said that it is because the other computer components manufacturing is not in Thailand but that’s not entirely true. For example, Vietnam, a country with PC penetration of just 4%, Intel made a $300 million investment to build a chip testing and assembly plant in Vietnam in 2006. While Intel already has test and assembly facilities in Shanghai, Chengdu, Malaysia, and the Philippines and even there is no large supplier located in Vietnam they still decided to choose Vietnam as their new base. Once the downstream industry comes in and paves the way, the hub centers and the distributors usually come in too. As the HDD industry evolves,

Thailand should get the benefits from the presence of those buyers and distribution channels. Hence, the critical issue here is to improving the HDD demand conditions.

5.1.3 Context for strategy and rivalry

The rules, incentives and norms governing competition in a nation have a fundamental influence on productivity (Porter and Kramer, 2002). Those conditions will create an environment that encourages the vigorous competition in the HDD industry. Every HDD makers are continuously benchmarking themselves across with other company and also between their location bases. The presence of those four HDD makers really helps stimulate the intense competitive environment in Thailand.Thailand's custom offers a hi-technology and efficient custom system that benefits the HDD industry operates smoothly. It combines an information technology with its export regulation. For instance, the HDD makers can use their gold card privileges from BOI to export their products without using any signature from a custom officer. In term of local regulations such as policies that encourage the investment, intellectual property protect, Thailand still need to improve. The current incentive is not favored toThai SMEs to attending in the HDD industry. By not focusing on the intellectual property, it makes region less attractive for foreign company to invest in hi-technology operation such as Media, Wafer. Thailand also not provides enough support for patent submitting. With a sophisticated context for the HDD industry it makes a location a more attractive place to do business.

5.1.4 Related and support industries

-Locally-based suppliers

There are many HDD suppliers located in Thailand. The HDD suppliers tend to choose Thailand as their bases because of the demand from the world leading four HDD companies in Thailand. The number of these suppliers is more likely to be increase. For example, Hutchison technology, the US Company, decided to build the first overseas plant in Thailand to support the HDD component (suspension) for those HDD makers in 2010. As a consequence, there is a continuous exchange of knowledge between these companies (knowledge spillovers). Nevertheless, most of Thailand's HDD industry suppliers are owned by the multinational enterprises that support the

high value component HDD parts. While only a few companies are owned by Thai suppliers and supply the indirect materials to the HDD industry such as packaging, sponge due to their limited authorized share capital and production capacity. It makes Thai suppliers fail to qualify the inspection from the HDD makers. Besides those indirect materials, Thai suppliers could have an opportunity to supply precision parts or machinery tools but the price from Thai suppliers usually cannot beat the price from other nations such as Malaysia, Singapore, due to the current structure of Thailand's tariff policy. Without a support for Thai suppliers, the value added to Thailand is not created. The HDD makers suggested that it should be a consortium to represent those Thai's suppliers and negotiate with the government for getting the privileges. Another highlighted issue is that there is no presence of the hi-technology component HDD parts in Thailand which are media and wafer. With the existence of the hi-technology manufacturing, Thailand could be gained a continuous knowledge creation.

-Presence of clusters

Clusters are geographic concentrations of interconnected companies and institutions in a particular field (Porter, 1998). It creates and maintains relationships and networks between industries and other support entities. Besides the suppliers of specialized components, as mentioned above, the linkages between the HDD industry and government institutions/universities/research and development centers also appear in Thailand. An extensive compliment of Hard Disk Drive Institute (HDDI) exists, including universities' cooperation. There are three Industry/University Cooperative Research Centers (I/UCRC) which are divided into three fields: HDD Advanced Manufacturing, HDD Component, Data Storage Technology and Application. These represent integration across the HDD industry and institutions that provide technology pools and innovation creation. However, those institutions are mainly focused on research and development and there is no local institution that concerns the HDD industry in a supply chain perspective. In fact, there are some government departments that related with the HDD industry, such as the Board of Investment of Thailand (BOI). BOI supports the HDD industry in term of giving privileges and incentives to promote the foreign direct investments. But, it fails to capture the HDD's downstream actors such as computer manufacturing, distribution center. Although BOI is a state agency, it is flexible in extending the time limited privileges to industries. In term of

the collaboration between the HDD industry and BOI, it turns out that the responsiveness from BOI is slow. In addition, the brainstorm meetings between them have not been taken seriously because after the meetings there is usually no follow-up action from the proposed plans. This may be occurred because the meeting participant from BOI is not in a position or having an authority that can make any decision.

5.1.5 Government

In the investment-driven stage, government directly influences each of the four determinants either positively or negatively, especially in developing country. The stability of Thai government has been unsecured forfew years. It is undeniable that this affects the image of Thailand. According to the interviews with the HDD makers, the most critical incident is the protest in Suvarnabhumi International Airport which made an interruption to the business. It is a significant risk but foreign investors in the HDD industry are not considering it as a big issue to choose the location of their facilities. The more important factor from government is its policy. The role of long term national policy is directly involved with enhancing competitiveness. There is no obvious policy from government for creating the comparative factor advantages for the HDD industry. The government should upgrade its basic factors such as the country's infrastructure, educational system. In the future, it's possible that Thailand can lose its labor cost advantages. Hence, Thailand also needs to create the advanced factors such as technology infrastructure, research and development to maintain its competitiveness as the largest HDD producer. The HDD makers are most concerned in the policy of Thai government about the developmentplan forthe HDD industry as the export-based cluster and the promotion plan for encouraging the growth of foreign direct investment (FDI) and MNEs' active operations.

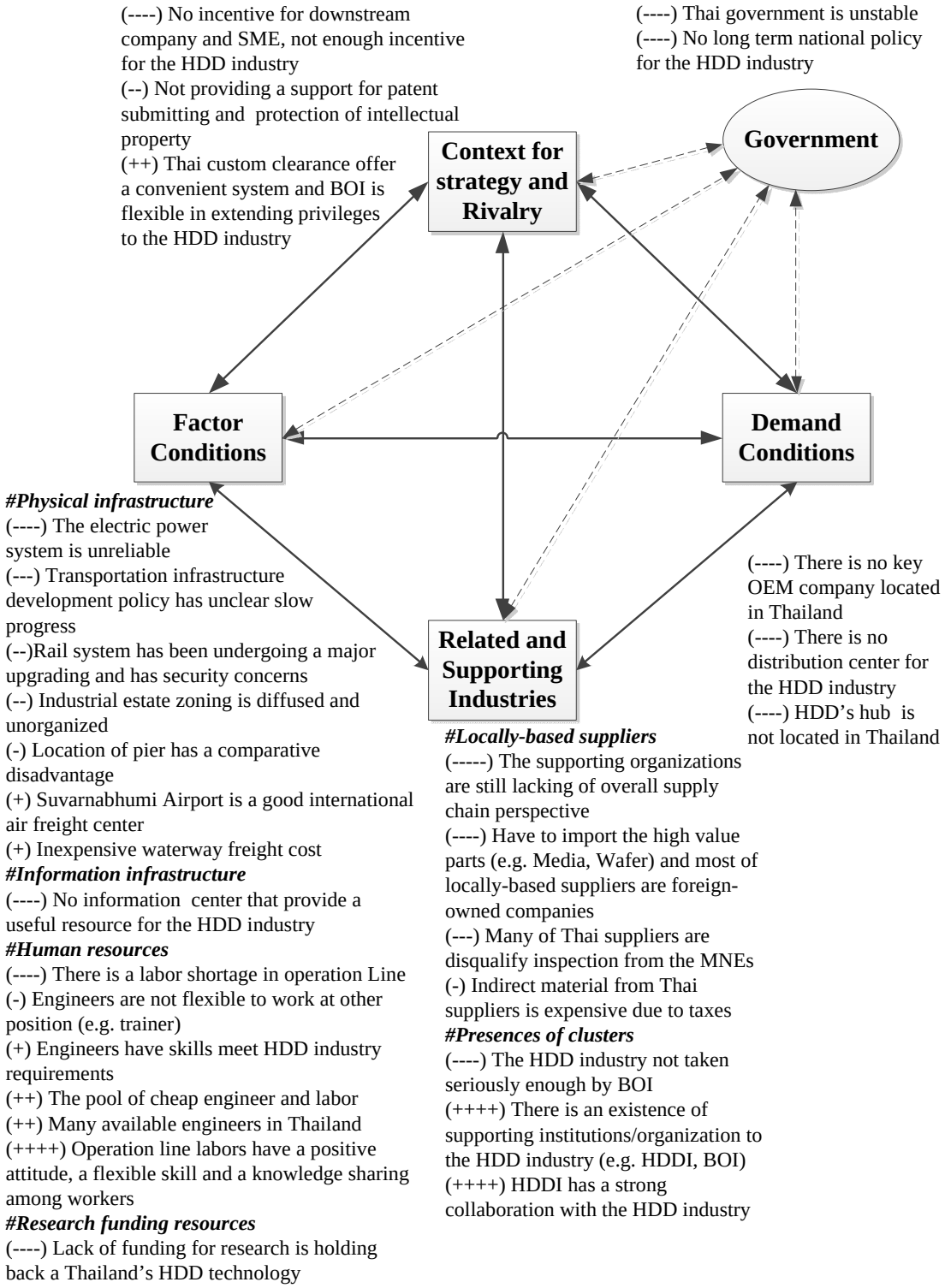

Figure 5.1

The diamond model shape of Thailand's HDD industry

5.2 The Diamond model of China

From the chapter 4, we try to measure the competitiveness using the economic indicators. As the results, China is considered as an important player in the HDD industry. To investigate why it gains the competitive advantage, it is essential to understand competitive factors within the country. Again, five determinants are analyzed same as Thailand in-depth assessment.Data warealso obtained from the interviews with the HDD companies in Thailand. The shape of China's diamond model for the HDD industry is shown in figure 5.3.

5.2.1 Factor conditions

- Physical infrastructure

Currently, the HDD facilities are located in three cities: Wuxi, Suzhou and Shenzhen. Wuxi and Suzhou are in Jiangsu province and Shenzhenis in southern China's Guangdong province. The transportation for the HDD industry in Jiangsu is using theair traffic at Shanghai Hongqiao Airport by using a trucking service via expressway from the manufacturing plant to the airport which takes time around 3-4 hours. The long haul to Europe from Shanghai is cost more than Thailand and alsohas less direct routes comparing with Thailand. The road infrastructure in Jiangsu is one of the most developed in the country. Suzhou is extensively networked with expressways which connect in all directions for instance, the Huning expressway that links Shanghai with Nanjing.The southern part of the province, namely the Shanghai-Nanjing corridor, has regular railway service by every 10 minutes. Jiangsu is in route of the Jinghu Railway from Beijing to Shanghai. Shenzhen, another HDD plant location, is found right above of Hong Kong. The most advantage of Shenzhen for the HDD industry in transportation is the benefit from using Hong Kong international airport and seaport. Because Hong Kong international airport is one of the best hub for international destinations and the price is also cheaper than Thailand international airport. The travel time by road from the HDD plant in Shenzhen to Hong Kong international airport is also taking only 2-3 hours.There is also the rail system connected between these two countries. The trains from Hong Kong's Hung HomMTR station to the Lo Wu and Lok Ma Chau border crossings take 43 minutes and 45 minutes respectively. In addition, there are frequent high speed trains from Shenzhen

to Guangzhou, plus long-distance trains to Beijing, Shanghai, Changsha and other destinations. As we can see in table 5.4, Hong Kong is the top destination that China exported the HDD in 2009. In addition, the seaport at Hong Kong is better than Thailand, in term of its location. Hence, the HDD industry in China is using the water way more than Thailand.To summarized, the location in Shenzhen is more competitive than Thailand while Wuxi and Suzhou is less competitive than Thailand. China's transportation infrastructure has development plansand also taken actions on these plans seriously. Overall, China continuously improves its transportation system to sustainable economic growth.

Another factor is Electricity which is much more reliable than Thailand. Since nuclear power plant cables in some of China industrial zones must offer higher reliability than ordinary cables. Mainland China has 13 nuclear power reactors in operation, more than 25 under construction, and more about to start construction soon (world nuclear association, 2010).Nuclear power has an important role, especially in the coastal areas where the economy is developing rapidly.

Table 5.4 China's HDD market and its value in 2009

Trading country	**Export value 2009 (USD)**	**Share (%)**
Hong Kong	3435254368	32.30
United States	3032391950	28.51
Netherlands	439571559	4.13
Japan	292420535	2.75
Singapore	1444816523	13.59
Taiwan	235480246	2.21
Germany	357887359	3.37
Ireland	39177611	0.37
Malaysia	159318744	1.50
Czech Republic	139038997	1.31
Etc.	1059725269	9.96

Source: Global trade atlas, HS code: 847170

-Information infrastructure

The low level of the information center for the HDD industry is considered to be an obstacle to the development of China's information exchange. According to

the interview with the HDD makers in Thailand, they all agreed that China does not any information center specific for the HDD industry, not that they aware of. This might bebecause the HDD industry is not the main priority industry in China. The source of information in China usually provided by Chinese government and most of the data is in Mandarin.

-Human resources

The skilled workers such as engineer in China are not available as much as Thailand. Because there are many large employers in China and not much choice left for the HDD employer to choose the hi-tech labor. The HDD makers in Thailand found that some sophisticated engineer work forces are in China. In addition, in their opinions the cost of engineer in China is higher than Thailand.

Table 5.5 The minimum wages in selected provinces and cities of China, 2006

Province/City	Standards of implementation	Minimum wages/hour (Yuan)	Approx. of minimum wage/day (Yuan)*
Beijing	2006.7.1	7.9	47.4
Shanghai	2006.9.1	6.5	39
Jiangsu	2006.10.1	6.3	37.8
Shenzhen	2005.7.1	3.97	23.82

Source: Ministry of Labor and Social Security, China
Note*According to China' labor law, the maximum hours for worker = 8 hours/day. Hence, minimum wage per day is calculated from wage/hour x 8 hours/day

Exploiting low-cost labor has been described in the many studies as one of the key motivations for foreign direct investment (FDI) into China. The nature of Chinese labor in operation line is not benefits to the HDD industry. They are not flexible and not commitment in their works. An exchange of skills among individuals operator does not create. The China has an enormous labor pool in its coastal industrial zones but also has the high turnover of low-level labor. Chinese wages have risen sharplywith globalization; average real wages more than tripled in the ten years from 1997 to 2007. Table 5.5 shows the minimum wageper hour in selected cities in China which is not that cheap as it used to be. Wages forunskilled labor in manufacturing construction and basic service sectors are still low, compared with both

skill intensive sectors in China and wages in other Asian countries, (Yang, Chen, and Monarch, 2010).

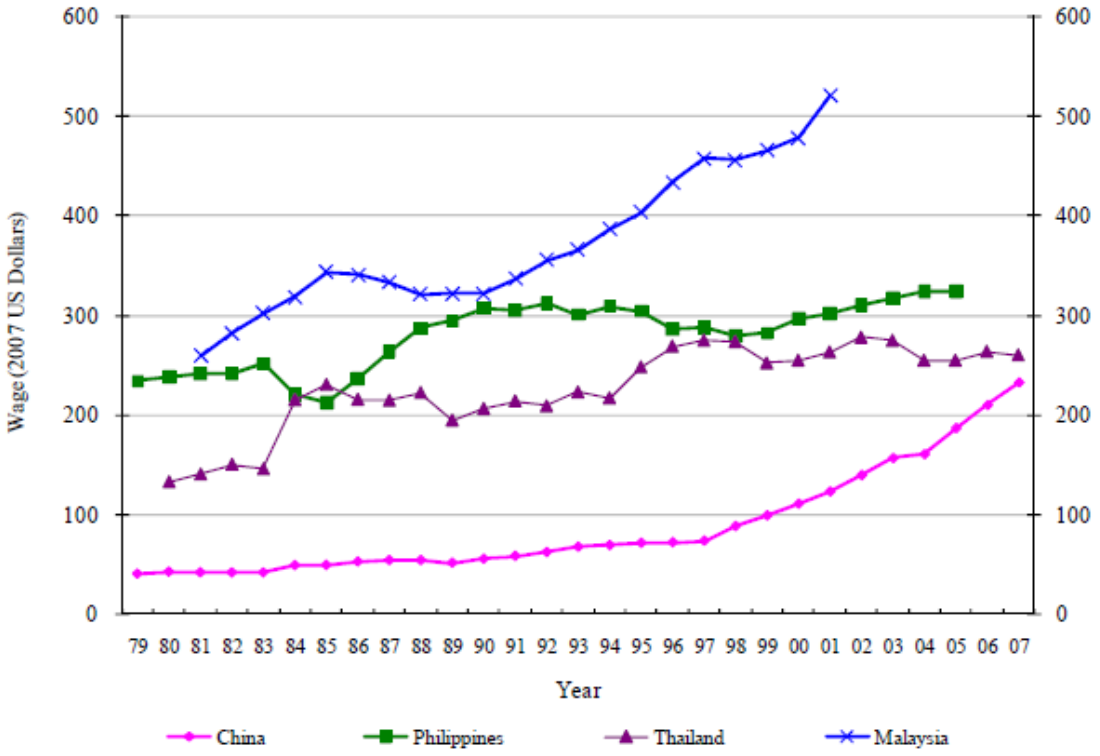

Figure 5.2

Comparison of Monthly Manufacturing Wages between China andOther Asian Economies, 1979-2007 (US Dollars)

Source: Yang, Chen, and Monarch, 2010

-Research funding resources

In 2007, China’sthe gross expenditure on R&D as a percentage of GDP is 2% (ESCAP, 2009). The Chinese government declared that research funding has been grown 20 percent annually in recent years. This is underpinning the nation's continuing remarkable economic growth and the increased competitiveness of its manufacturing industry. Foreign business has been encouraged to establish research and development bases in China and will be allowed to apply with Chinese firms for government-funded research and development projects. However, some uncertainty remains around the extent to which foreign companies will be allowed to participate in

the growth in these sectors given the government's wider indigenous innovation goals (APCO, 2010).

5.2.2 Demand conditions

The most competitive advantage for China is the size of internal markets, being unlimited by its largest population size in the world, around 1,300 million. The domestic market does therefore provide abundant conditions for producers in many industries included the HDD industry. The HDD market in China in term of both consumer expenditure and industrial consumption has been steadily increasing in line with economic growth. There are many manufacturers of the original equipment manufacturers (OEMs) for personal computer or laptop such as Apple, Hewlett-Packard (HP), Dell, Intel, Lenovo, etc. As a result, the supplier hubs are also located close to those facilities to manage the inventory. The other downstream productssuch as mobile phone, home entertainment device are also located in China. This benefit demand conditions enhance China to form as a cluster of hi-technology product manufacturing. These have significantly influenced the HDD industry investor and increased China's competitiveness.

5.2.3 Context for strategy and rivalry

The custom system in China is not competitive as much as Thailand. The custom officers work on only weekdays (Monday-Friday).Therefore, when the HDD makers have to urgent ship the HDD, they have to wait until Monday for the custom officer to sign the permission. The clearance regulation in China is also not flexible, for instance, it needs to check through all the parcels before giving the permission. At first, China's tariff for importing the HDD was 3.0%. Since 2002 China has been reduced to 0% because China was accepted for membership of the World Trade organization (WTO). If China set a new tariff regulation for the HDD, the HDD makers will surely have to move their facilities to China because of its large demand size.The conditions in the nation governing where favored to the HDD industry are not suited to the industries' sources of competitive advantage. Another issue that has been addressed is China's laws and regulations of intellectual property protection. Over the past 20 years, weaker implementing regulations and judicial interpretations,

procedural barriers, and poor enforcement, however, continue to frustrate the efforts of companies to protect their intellectual property in China.This has an impact on the limited science and technology of the HDD industry in China. For example, some of the HDD makers in China does not assembly head gimbal because they worried about the head technology theft.China has to give a strong educational in the value of protecting intellectual property to all citizens to increase the level of intellectual property consciousness among their citizens.In China's administrative system, a province is at the highest level of subnational government. Due to the complexity of the administrative divisions, the regulations of each province are not the same. Therefore, when the business operates cross the provinces, they have to adapt themselves with each province.

5.2.4 Related and support industries

-Locally-based suppliers

The number of HDD's suppliers in China is not much as Thailand. The entry of the HDD industry began in the late 90's, hence the HDD suppliers has just followed the HDD makers to China. There are not much of suppliers that specific fot the HDD in China, however China offers a wide broad of suppliers such as precision part.On the other hand, some of hi-technology HDD component parts such as Media, Wafer have to import from other nations. In addition,the quality of some local suppliers is not good. In term of price, the HDD suppliers in China can offer a good price for indirect material such as mask to use in the HDD operation line.

-Presence of clusters

The HDD's productive can be greatly enhanced by having the linkages from supporting alliances. From the interview with the HDD makers in Thailand, the HDD industry in China is not formed as a cluster yet. It does not encompass collaboration between the HDD industry and other important entities, for example suppliers of specialized HDD component parts, government agencies that provided specific for the HDD industry, the HDD universities' training programs, etc.

5.2.5 Government

As being one of the most stable government in Asia, all power within the government of the People's Republic of China is divided among three bodies: the Communist Party of China, the Central People's Government, and the People's Liberation Army. There is no highly risk to have the action that could interrupt the HDD operations such as the protest. Compare with Thailand, the stability of China is better than Thailand. The national policy of China seems to support the foreign direct investment (FDI) because of China's need of foreign technologies and management. FDI provide better access to technologies for the local economy. Moreover, FDI can also lead to indirect productivity gains through spillovers. It helps creating a training of labor and management. Another possible channel for spillovers is the training of local suppliers of intermediate products to meet the higher standards of production and managerial standard. As a result of the active government promotion through various policy measures, China has been the world largest FDI recipient among developing countries and FDI has grown rapidly since the 1990s. FDI inflow to China has grown from about US$ 1.5 billion a year to more than US$ 40 billion a year in 1999. (Fung, Iizaka, and Tong, 2002)

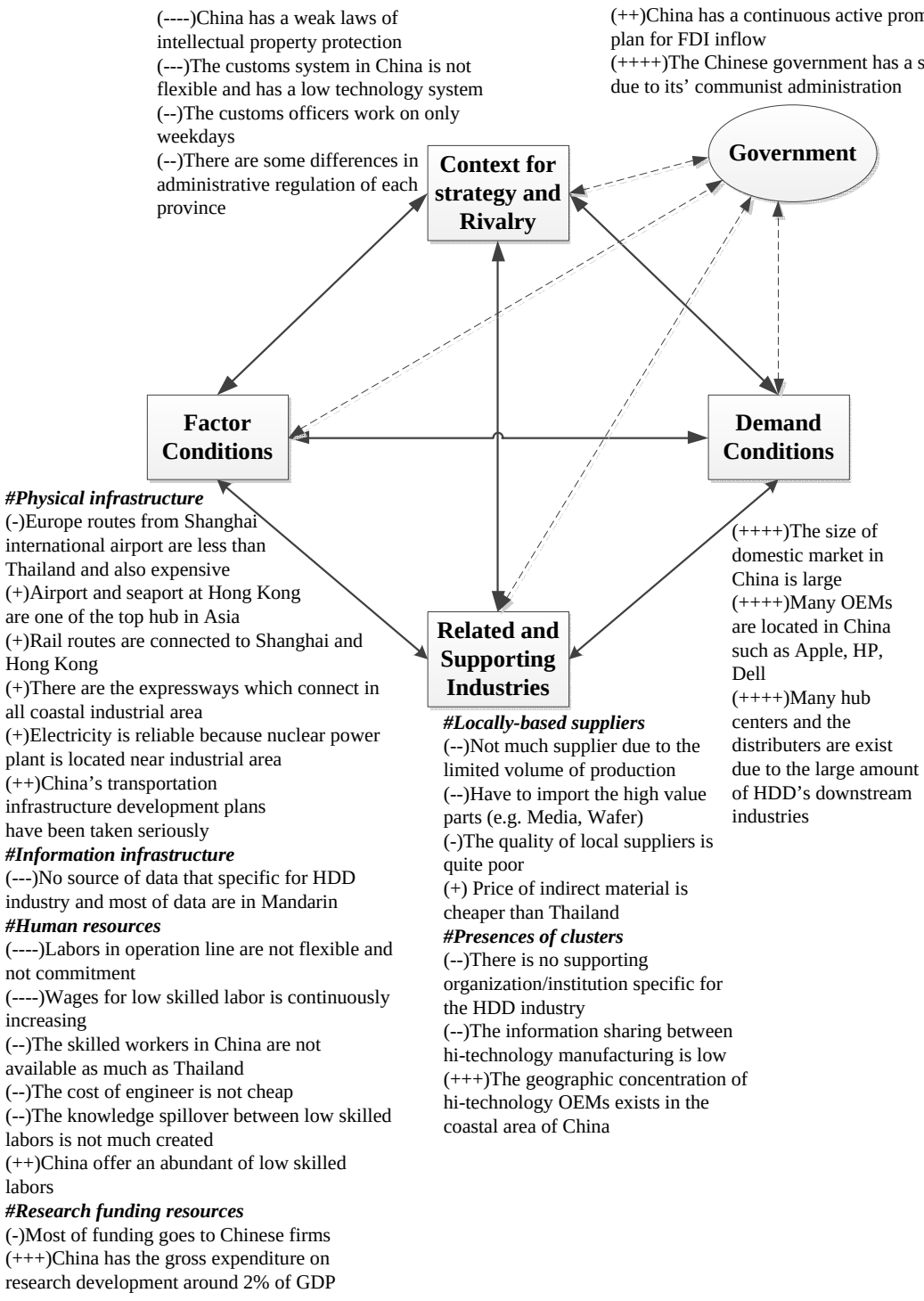

Figure 5.3

The diamond model shape of China's HDD industry

CHAPTER VI
CONCLUSION

This is a final chapter that will conclude the study of the HDD industry competitiveness analysis. All the findings and critical issues will be described in this chapter. Moreover, the future directions will also be suggested for the further study.

6.1 Conclusion of the HDD industry competitiveness analysis

6.1.1 The HDD industry competitiveness conclusion

This study aims to analyze the competitiveness of the HDD industry in Thailand comparing with other nations (Singapore, China, Malaysia and Philippines). First, we conducted the quantitative analysis by assessing the current situation among those countries. The appropriate indicators have been selected to study in this step which are the manufacturing production index (MPI) and the reveal comparative advantage index (RCA). The results show that all of those nations are the key important HDD manufacturing bases. We also imply from the results that Thailand has a strong performance and a progressive specialization in the HDD industry. It also indicates that Thailand has to rely on the exporting of HDD for its economic growth. In the past, Singapore used to be a number one producer in the HDD industry with 64% of world output (Gourevitch, Bogn and Mckenderick, 2000) but the indices show that now Singapore is losing its competitiveness. However, it is currently shifting from being a final HDD assembly base to a research and development and distribution center. Malaysia also plays a vital role in the HDD industry despite it has only one company producing the final HDD located in Malaysia. The RCA indices show that Malaysia has a potential to maintain its comparative advantage throughout the period. Philippines are being mainly bases for Japanese HDD firms. Compare with other key manufacturing locations, Philippines have the least exporting HDD volume and value.

The RCA indices also show that it's more likely to lose its comparative advantage in the future. The case of China, a large land economy, has a high competitive advantage. The first entry of HDD maker to China was behind those countries in 1995. The indices indicate that China is a significant exporter of the HDD but also is a largest importer. The trade balance of China shows that it still has to import a large volume of HDD. To summarized, the quantitative analysis imply that Thailand and China have a strong performance in exporting the HDD and also have a sustainable trend in the future. Base on only quantitative study, we cannot explain an insight of how those countries achieve their competitiveness. Therefore, this thesis further investigated more by using a qualitative analysis.

Porter's diamond model framework has been chosen to approach in the study. The concept is that competitiveness depends on the productivity and to create the productivity it needs a productive business environment. This environment contains four elements: factor conditions, demand conditions, context for strategy and rivalry, and related and supporting industries. Government is also considered to be the greatest direct influence on national advantage in each element especially for developing country. We selected to study in Thailand and China in this stage because the results from MPI and RCA indices have been shown that these two nations are the most competitive in the HDD industry. The analysis of Thailand HDD industry's diamond model indicates that Thailand currently needs to improve many issues. The most critical issue is the domestic demand. With no presence of any computer OEMs in Thailand, it means that Thailand doesn't have the downstream of the HDD industry. Unlike China, the OEMs located in China are being able to ask the HDD makers in Thailand to build the inventory hubs for them in China. This issue is relevant with the role of supporting industries/organizations. BOI should be able to promote these downstream industries by giving the competitive privileges. Malaysia is a good example of offering the benefits for the foreign investor with the building, land etc. Not only the OEMs, the Thai suppliers for the HDD industry also need the support from the related government agencies to step in the HDD industry. As for now Thailand has a positive factor by being a decent source for labor pool. The cost of labor is cheap compare to other nations and Thai labors are having a good quality. The number of workers in the HDD industry is more than 55,000. Some HDD makers

suggested that in the future if the labor cost is increasing, the automation will be used in operation line. Malaysia, for example, is facing a severe problem in finding a work force. Hence, the automation might be conducted in the Malaysia HDD operation line instead of using human and delegate the complicated tasks for Thai labor to do. Thailand has been gained some huge benefits from the HDD industry in term of the employment and the knowledge spillover.

It should be noted that the losing of competitiveness in Singapore is only defined by the term of its HDD manufacturing but not taken the fact that Singapore is currently the largest research and development center for the HDD industry in ASEAN. As for now, Thailand is the largest HDD producer in the world and has strong competitive advantages as the HDD manufacturer. Thailand is successfully able to assert itself in the global market while Singapore is successfully able to shift itself to the research and development/distribution center for the HDD industry.

6.1.2 The effect of the determinants outside the nation

The qualitative analysis by using diamond model is only focused on the business environment inside the nation not the factors outside the nation. The decisions of the HDD companies to choose their manufacturing bases are not entirely affected from the determinants inside the nation. As we already analyzed the five determinants from the diamond model, there are also other elements that need to investigate too. For example, the privileges that offer to the HDD companies from BOI are also important but might not as important as the risk management of those companies. If we offer the benefits as much as we can to the HDD companies, in the end the investment might go to other nation. The HDD companies have to estimate the risks because it is not safe to rely in the only one country. They have to establish their own manufacturing bases in other countries to prevent the risks. The case study from the protest in Suvarnabhumi International Airport is a good example. If the HDD companies were having Thailand as their only bases, they would be facing many significant severe problems from this issue. In addition, it is also the strategy to invest in many potential countries to help the HDD companies holding the advantage from the privileges negotiability power from those countries' government.

6.1.3 The issues of Thailand sustainability in the HDD industry

From the findings, we concluded that the advantage of Thailand labor is the core competitiveness for the HDD industry. However, we should figure the sustainability of Thailand's HDD industry. The top priority is now a strategy plan from the government. Thailand still needs the development in many points. The transportation infrastructure, the skills of labor, the research funding are all relevant with the sustainability. Without the support from the government, the HDD industry in Thailand will be left out and has to rely by itself. The presence of cluster can be strongly build up if all of the important players in the HDD industry are sharing the same goal to sustain the HDD industry in Thailand. It is most likely for Thailand to sustain the HDD industry by expanding the current position from being a largest HDD manufacturer to a research and development center. Thailand will gain a huge benefit if those HDD companies make an investment to establish their research and development in Thailand. Thailand can step up from being a low-skill intensive industry to a high-skill intensive industry due to the knowledge sharing. All it needs now is the long term support and development plan policy from the government to sustain its competitiveness in the HDD industry.

6.2 Future studies

After conclude all the findings, currently Thailand's HDD industry is facing many questions. These questions should be investigated more for a further research. The first question is "What will be our position if Thailand is losing its labor competitive advantage". We surely hope that Thailand is going to be a research and development center or a distribution center for the HDD industry in the future. The example of Singapore is a good one; Singapore's government is focused on research and development by spending a lot in the gross expenditure on research and development. The current situation is more likely to impossible for Thailand to achieve same as Singapore. Hence, the future research should study in the HDD industry's future and the strategy plan to encourage Thailand to be one of the research and development center for the HDD industry. The next question is "Is it possible for Thailand to expand the HDD cluster into the computer assembly and other its

component cluster?" Being a largest HDD producer but the original equipment manufacturers (OEMs) for personal computer or laptop does not exist in Thailand. The concerned issue is that Thailand does not gain any value chain from these downstream industries. It is time to think about the strategy to be an attractive location for high-tech companies. The last question is "Is Thailand the place for a skill-intensive industry? And is it ready for the solid state drive (SSD)?" It is an undeniable truth that technology is changing really fast. The SSD is also the storage device that all of the HDD companies already plan to launch the product in the future Currently, the SSD are in the research and development stage in these following countries in Asia: Singapore, Philippines, and Korea. The SSD requires a hi-technology of integrated circuit which China is specialized in this technology more than Thailand. Hence, Thailand should be prepared for the investment of SSD plant in the future.

This thesis has a limited available data so the future study could be employed by using more available data. For example, there are other indicators that can analyze competitiveness as we suggested in the literature reviews. Therefore, if Thailand has a database that collect those raw data, the future study can use those data to further analyze competitiveness.

6.3 The limitations and remarks of this thesis

6.3.1 Remark for data

Export data that has been used in this study are organized in the HS-code system. We used "847170" to represent as the HDD. The six-digit level of HS-code is internationally used in the same meaning while the eight or ten-digit of HS-code depend on the nations. In fact, Thailand has been created the HS-code in 8-digit since 2007 and "84717020" is the HDD. On the other hand, China defined "84717010" as the HDD. The differences of the description in the HS-code in eight or ten-digit level between the nations need to investigate before gathering the data. The thesis chose to use "847170" because of the data accuracy. The statistics that collected by the office of industrial economics (OIE) shows that the monetary export value of the HDD from

Thailand is around 300,000 million baht which is proximal to the data in HS-code "847170" from Global trade atlas. It is more accuracy to use the HS-code in six-digit level to compare between those nations instead of using the HS-code in eight-digit level. Therefore, the future research should be aware of this issue before collecting the data.

6.3.2 The limitations of competitiveness assessment by using quantitative analysis

This thesis conducted RCA index and MPI index to analyze the competitiveness of the HDD industry at nation level. Both of these indicators only determine the current competitive in the point of time. We cannot use their results to imply any further detail. For instance, we will not know how long the competitiveness is going to last or when will the new comer product is going to replace the old one. The SSD is a good example. For now we know that Thailand is having a strong performance in producing the HDD but in the next 5 years if the SSD is growing in the market and the HDD is becoming to lose its market in the world then it will be not much meaning for having competitiveness in the HDD industry. Hence, quantitative analysis alone is not giving much insight. This is why the thesis studied by approaching both quantitative and qualitative analysis. But we only assessed how those nations gain their competitive advantages and suggested the driven factors that support the competitiveness in the current of time. As we already suggested in the topics of future studies, the further investigation also need a qualitative analysis to strategize the plan for the future of Thailand's HDD industry.

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APPENDICES

APPENDIX A
THE STRUCTURED QUESTIONS FOR THE HDD MANUFACTURER

1. Factor conditions

Ø Physical infrastructure

1.1 Transportation infrastructure (Airway, Railway, Road and Waterway)

- Airway
- Railway
- Road
- Waterway

1.2 Industrial estate infrastructure

1.3 Electric and water utilities

Ø Information infrastructure

1.4 The availability and the accessibility of information infrastructure

Ø Human resources

1.5 University/Institution create an enough skilled labor

- Operator
- Engineer

1.6 Number of available workforce

- Operator
- Engineer

1.7 Advantage in a labor cost

- Operator
- Engineer

Ø Research funding resources

1.8 The availability and the accessibility of research funding

2. Related and supporting industries

Ø Locally-based suppliers

2.1 The variety of locally-based suppliers

2.2 The quality of locally-based suppliers

2.3 Competitive price suppliers

Ø Presences of clusters

2.4 The existence of supporting institutions/organizations

2.5 The role of supporting institutions/organizations

2.6 The collaboration between the supporting institutions and the HDD industry

- HDDI and the universities
- BOI

3. Demand Conditions

3.1 The existence of OEM

3.2 The existence of distribution center

3.3 The existence of hub center

4. Context for firm and strategy rivalry

4.1 A local context and rules that encourage investment

4.2 A local context and rules that encourage sustained upgrading

– e.g., Intellectual property protection

4.3 A local context and rules that encourage business operation -e.g., Custom clearance

5. Government

5.1 The stability of government

5.2 The supporting national policy

APPENDIX B
THE HISTORY OF THE HDD INDUSTRY IN EACH COUNTRY

1) Singapore

A historical development of Singapore as a location of hard disk drive manufacturing is described as follow.

1982	**Seagate technology**: HDD final assembly, located in Ang Mo Kio.
1984	**Seagate technology**: Disc-drive design center, located in Science Park (It is Seagate's only disc-drive design center outside the United States). Now it is an automation support for drive manufacturing.
1994	**IBM**: 3.5-inch HDD final assembly, located in Kaki Bukit. (was acquired by **Hitachi global storage technology** in 2003 and set it as the Asia-Pacific regional headquarters, called “global center” for OEM marketing, production management center, manufacturing of server hard disk drives and HDD head stack assembly)
1996	**Seagate technology**: Recording Media Operations (RMO) located in Woodlands (It is a first RMO facility outside of North America). **IBM**: Set up an Asia Pacific Logistics Center, making Singapore the regional distribution hub for hard disk drives.
1997	**Seagate technology**: Expanded the operation at its facility as a total floor area over 1Million sq. ft. in Ang Mo Kio.
2006	**Seagate Technology**: Announced a plan to expand its recording media manufacturing capabilities by setting up its new media plant in Singapore. The new plant will be built close to the existing

	facilities at Woodlands (RMO Woodlands is Seagate's largest media manufacturing facility).
2009	**Seagate technology**: Announced that it will close its Ang Mo Kio facility in Singapore by the end of calendar year 2010 (the facility responsible for producing all of Seagate's hard disks for mission critical applications).
2010	**Western Digital**: Announced that it is acquiring the facilities, equipment, intellectual property and working capital of Hoya Magnetics Singapore Pte. Ltd., located in Tuas.

2) Thailand

A historical development of Thailand as a location of hard disk drive manufacturing is described as follow.

1983	**Seagate technology**: head stack assembly (HSA), located in Patumthani province. (In 1999, Fabrinet was established at this plant as a spin-off from Seagate).
1988	**Seagate technology**: head stack and head gimbal assemblies (HSA, HGA), located in Samutprakarn province. **Fujitsu** (was acquired by **Toshiba** in 2009): 2.5-inch HDD final assembly, located in Pathumthani province. **IBM/Union technology** (was acquired by **Hitachi global storage technology** in 2003): head disk assembly (HDA) located in Chonburi province
1996	**Seagate technology**: hard drive components-slider, head assembly and head gimbal assembly, HDD final assembly, located in Nakhon-Ratchasima province.

	Hitachi global storage technology: entry server and mobile HDD, head stack assembly, HDD final assembly, located in Prachinburi. province
2002	**Western digital**: head stack assembly (HSA), HDD final assembly located in Pathumthani province
2003	**Western digital**: HGA manufacturing (Purchased a Read-rite plant in 2003), head stack assembly (HSA), HDD final assembly, located in Ayuthaya province.
2010	**Hitachi global storage technology**: Announced a plan to invest 15.5 Billion Baht for expanding HDD production line and build a new HGA production line, located in Prachinburi. province.

3. Malaysia

A historical development of Malaysia as a location of hard disk drive manufacturing is described as follow.

1973	**Western Digital**: semiconductor packaging and test, located in Sungei Way Free Industrial Zone in Petaling Jaya, Selangor.
1988	**Seagate technology**: slider fabrication manufacturing, located in the industrial center of Bayan Lepas (popularly known as Penang's Silicon Valley), Penang
1992	**Komag (Malaysia) Sdn**: a thin-film media, located in Penang. (was acquired by **WD Media (Malaysia)** in 2007 and operates as a subsidiary of Western Digital Corp)
1994	**Western Digital**: Converted operation from semiconductor to hard disk drive (HDD) manufacturing as a 500,000 sq. ft. operation,

	located in Sungei Way Free Industrial Zone in Petaling Jaya, Selangor.
1996	**Komag (Malaysia) Sdn**: a thin-film media, located in Sarawak. (was acquired by **WD Media (Malaysia)** in 2007 and operates as a subsidiary of Western Digital Corp)
2004	**Komag (Malaysia) Sdn**: a thin-film media, located in Johor. (was acquired by **WD Media (Malaysia)** in 2007 and operates as a subsidiary of Western Digital Corp)
2007	**Seagate technology**: Media substrate facility has a built-up area of about 44,000 square meters, located in Johor.
2009	**Hitachi global storage technology**: Purchased a thin-film media facility located in Sarawak from **WD Media (Malaysia)**.
2010	**Western Digital**: HDD final assembly by made the investment of US$400 million for the company's newest facility, located in Petaling Jaya, Selangor. (Construction is due to be completed by the third quarter of 2011) **Western Digital**: The expansion of US$800 million investments into Penang for its research and development center, as well as its media component production.

4. Philippines

A historical development of Philippines as a location of hard disk drive and its component manufacturing is described as follow.

1994	**Hitachi global storage technology**: 1.8-inch HDD assembly*, head gimbal assembly (HGA) and Slider fabrication manufacturing,

	located in Laguna. (Note* the 1.8-inch HDD no longer produce due to the low demand in this market)
1995	**Toshiba**: HDD final assembly, located in Special Export Processing Zone,Laguna Technopark, Binan, Laguna
1996	**Fujitsu** (was acquired by **Toshiba** in 2009): HDD final assembly, located in Carmelray Industrial Park, Canlubang, Calamba, Laguna

Two of the HDD manufacturers own by Japanese company are operating in Philippines. The entry of those Japanese HDD majors was accompanied by the relocation of a number of Japanese supplier companys between 1994 and 1996 (e.g. the entry of Nidec in 1995)

5. China

A historical development of China as a location of hard disk drive and its component manufacturing is described as follow.

1995	**Seagate technology**: hard drives for the PC, located in Wuxi, Jiangsu province
1996	**Hitachi global storage technology**: head gimbal assembly (HGA), located in Shenzhen, Guangdong province
1998	**Hitachi global storage technology**: HDD slider and head manufacturing, located in Shenzhen, Guangdong province
2002	**Seagate technology**: a major expansion in 2002. The 50,000 square meter state-of-the-art facility houses automated printed circuit board assembly lines, hard drive product lines and testing operations, located in Wuxi, Jiangsu province

2005	**Maxtor** (was acquired by **Seagate technology** in 2006): a 76,000 square-foot facility. Using state-of-the-art automation, head stack assembly and HDD final assembly for personal storage market, located in Sozhou, Jiangsu province.
2006	**Hitachi global storage technology**: HDD final assembly, located in Shenzhen, Guangdong province
2007	**Samsung**: HDD final assembly
Unknown year	**Toshiba**: 1.8-inch HDD final assembly, located in Shanghai.

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