THE DETERMINANTS OF OPERATIONAL RESEARCH COLLABORATION EFFECTIVENESS BETWEEN INDUSTRY AND ACADEMIA: THE CASE OF THE HARD DISK DRIVE INDUSTRY IN THAILAND

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A Dissertation Submitted in Partial

Fulfillment of the Requirements for the Degree of

Doctor of Public Administration

School of Public Administration

National Institute of Development Administration

2017

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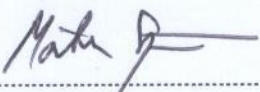
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September 2017

ABSTRACT

Title of Dissertation   The Determinants of Operational Research Collaboration
Effectiveness between Industry and Academia: The Case of
the Hard Disk Drive Industry in Thailand

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Degree   Doctor of Public Administration

Year   2017

Even though the issue of inter-organization collaboration has been explored and revealed in various forms, these studies have not covered the different contexts and forms of collaboration specific to operational research collaboration between industry and academia in Thailand. Therefore, it is needed to consider these phenomena in the context of Thailand. The objectives this dissertation intends to discover are: to describe the context of operational research collaboration between industry and academia, to explore the key determinants of effective operational research collaboration between industry and academia, and to propose a model for effective operational research collaboration between industry and academia: The case of the Hard Disk Drive industry in Thailand. A qualitative approach was adopted by the researcher. The sources of data in this study are related documents and in-depth interviews from key informants that have direct experience with operational research collaboration between industry and academia within the case of the Hard Disk Drive industry in Thailand demonstrated at Western Digital (Thailand), BangPa-In factory.

The findings of the dissertation describe the context within the dimensions of the research collaboration landscape between Western Digital (Thailand), BangPa-In Factory, and academia that consists of: general background, sources of funds for the research collaboration project, the importance of operational research collaboration between Western Digital in Thailand and academia for both organizational and individual levels, key players of research collaboration, and the operational research

collaboration process that explains from start until finish. The findings also suggest that the key determinants affecting the operational research collaboration effectiveness between the HDD industry and academia are as follows: 1) clear scope, goals and objectives, 2) strong commitment of leadership, 3) trust among stakeholders, 4) communication, 5) win-win situation (mutual benefits), 6) characteristic of key stakeholders, and 7) resources. The findings also revealed the key determinants at the sub-level that affected the operational research collaboration effectiveness. The model was formed based on the findings from the mentioned determinants.

Understanding the key determinants will further explain the inter-organizational relations theory within different contexts, and contribute to the practical perspectives, for enhancing the collaboration effectiveness between industry and academia, that it's a major trend in the context of Thailand.

ACKNOWLEDGEMENTS

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ABBREVIATIONS

Abbreviations	Equivalence
AIT	Asian Institute of Technology
BOI	Board Of investment
FDI	Foreign Direct Investment
HDD	Hard Disk Drive
HTTI	Hard Disk Drive Technology Training Institute
IOR	Inter-Organization Relations
ORC	Operational Research Collaboration
NSTDA	National Science and Technology Development Agency
MTEC	Material Technology Center
NECTEC	National Electronics and Computer Technology Center
NANOTEC	Nano-Technology Center
SSD	Solid State Drive
WD	Western Digital

CHAPTER 1

INTRODUCTION

This dissertation proposes to examine the perspective of engineers, Operational Research collaboration Coordinators/Managers and policymakers (Vice President/Managing Director) that work in the Hard Disk Drive industry, especially Western Digital Company, researchers in universities or government autonomous agencies under the Ministry of Science and Technology in Thailand that have had interaction with Western Digital Company in Thailand in Operational Research Collaboration. This research proposes to study the context and background, and to determine the key determinants that affect the effectiveness. In addition it aims to propose a model of operational research collaboration between the Hard Disk Drive industry and academia. The objectives, research questions, and scope of this study are also clearly identified. Additionally, the benefits of the study will be pointed out from both theoretical and practical perspectives.

1.1 Statement and Significance of the Problem

Given the economic development of Thailand, governments in the past have expressed the direction of developing the country through many policies and strategies, which have been developed and adopted during the past four decades. From the 1st National Economic and Social Development plan until the present, Thailand has been one of the developing countries that has made an effort to boost the economic growth of industries and exporting in several industrial products by promoting both the domestic industry and foreign direct investment (FDI), and this has resulted in economic growth evidently. For driving the industrial development whose intent is to import substitution in the earlier state and export promotion, the government created the first industrial promotion act in 1954 and later established the Board of Investment in 1966, as a government's instrument, to promote the FDI with

a variety of incentive packages. The mentioned incentives are allowed without taxation payment which is attractive for investors in the form of land ownership right for foreign investors, permission to bring in foreign experts and technicians, and work permits and visa facilitation. In addition to non-tax incentives, the BOI also assists foreign investors through zone-based tax incentives in the form of corporate income tax holidays up to 8 years and machinery and raw material import duty reductions or exemptions depending upon the zone (BOI, 2011). Moreover, the labor costs of Thailand, in the past, were obviously competitive when compared with developed countries and some countries in South East Asia such as Singapore and Malaysia.

Based on the foreign direct Investment promotion laws and policies as well as labor cost incentives as mentioned, then, Thailand has become an investment destination for foreign investors for the past 4 decades in various sectors of the industry. This empirical change has resulted in Thailand's economic structure in terms of GDP proportion changing from agriculture value-added to manufacturing value-added. According to figure 1.1 manufacturing value-added to GDP increased from 16 percent in 1970 to 37 percent in 2005 while agriculture value-added decreased from 25 percent in 1970 to 10 percent in 2005.

Figure 1.1 Structural Changes in the Thai Economy: GDP Share, 1960-2005
Source: Apisek Pansuwan, 2010, p. 135.

According to UNESCO (2009), Thai export products have shifted to more advanced technology areas. This statement also aligns with the empirical data in figure 1.1 showing that industrial manufacturing has more greatly contributed to Thailand's economic from GDP proportion viewpoint. With this dramatic change, "Thailand is undergoing an economic transition from an agricultural to industrial economy" (Patarapong Intarakumnerd, Pun-arjChairatana & Tipawan Tangchitpiboon, 2002). Moreover, the contributions of manufacturing of export products also represent a significant change. The value of high-tech products increased from 600,000 million baht in 1995 to 3,200,000 million baht in 2006.
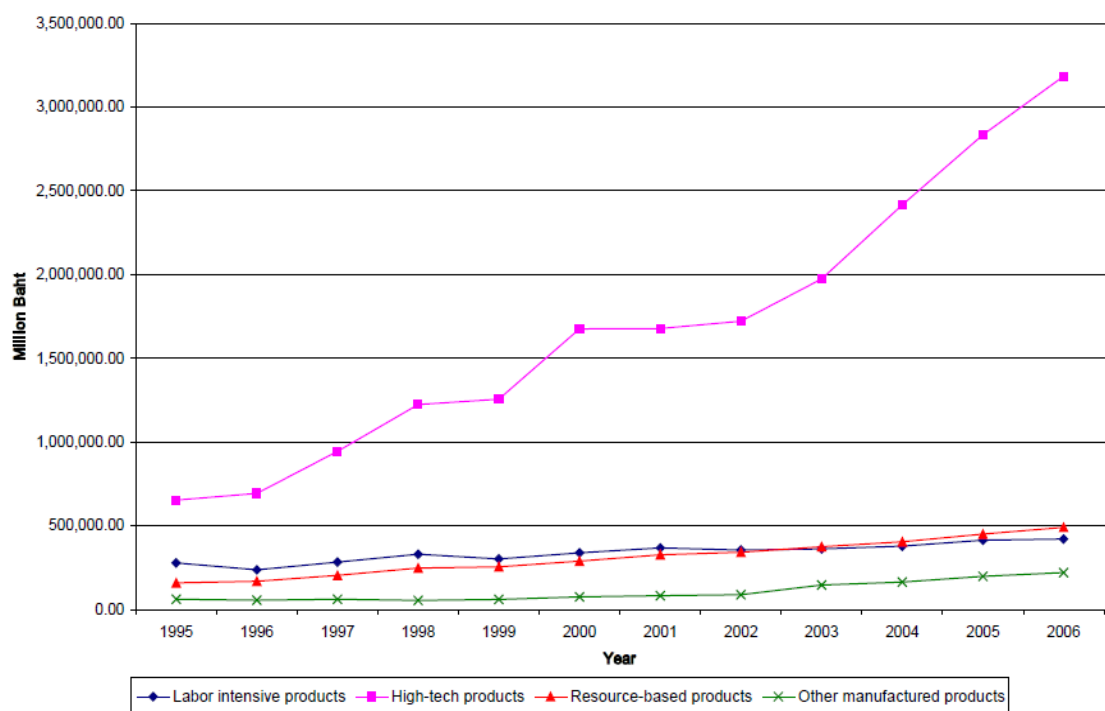
Figure 1.2 Manufacturing of Export Products Classified by Product Group, 1995-2006

Source: Apisek Pansuwan, 2010, p. 138.

The electronics industry, especial HDD industry, is being part of hi-technology product was raised in Thailand more than 3 decades. It has long been one of Thailand's most important from the export manufacturing product point of view; in 2011, Thailand supplied around 41 percent of the world's HDDs, which it is a major

contribution to exporting. In 2012, Thailand's exports of hard disk drive accounted for 7.3 percent of total exports while output was 7.2 percent of total manufacturing production.

Production of HDD in
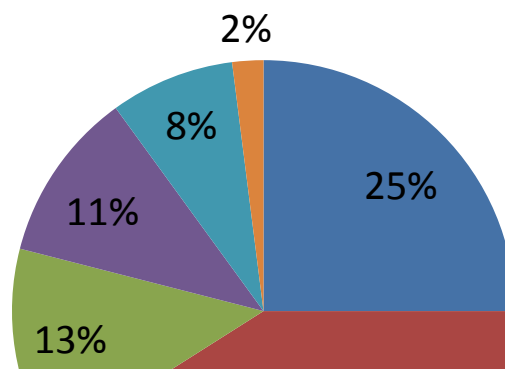
Figure 1.3 Production of HDD Products Separated by Country
Source: Wanvimol Sawangngoenyuang & Tientip Subhanij, 2012.

In 2001, many industry estates in the central part of Thailand faced heavy flooding. The world largest HDD maker, Western Digital, receive a serious impact as well because the main factory is located in one of the six industrial estates that was directly impacted by the flooding. However, Thailand's hard disk drive industry bounced back 2 years after the heavy flooding and today remains a world leader in production. It still accounts for about 40% of global HDD production, exporting more than US$12 billion worth annually (Thailand Board of Investment, 2012).

However, investment in this industry in Thailand is likely to reach a diminishing return soon due to various factors, such as the minimum wage/salary policy, the decline of the global economic situation, changes in technology, etc. Joe (2013) pointed out that the landscape of the HDD industry in Thailand is changing, presenting major concerns as follows: 1) there is a flat demand of HDD products resulting from smartphone and tablet expansion, as these devices uses solid state

drives (SSDs) for data storage and 2) the structure of operational costs of running manufacturing in Thailand have changed.

Moreover, the population structure of Thailand is changing with the proportion of the workforce decreasing; probably leading to a labor shortage soon. Foreign investors have a choice to invest in any country where the factors support growth and sustainability for maximum benefits. Therefore, Thailand's HDD industry must be developed into a knowledge-intensive economy in order to sustain competitiveness and to attract investors. The HDD industry in Thailand, a manufacturing base of FDI, needs both incremental and breakthrough strategies in order to improve in various areas, such as cost reduction, and productivity and quality improvement, so that competitiveness can be sustained and improved. Therefore, in order to sustain this industry in Thailand, productivity improvement is the key activity that needs to be strengthened. According to Porter (1990), the capability of competition depends on the industry's ability to increase its productivity degree. Basically, many strategies and tactics are adopted to drive continual improvement in productivity, both utilizing resources from within and outside the firm. Research collaboration with universities is one of strategies that Western Digital Company, a key maker in the HDD industry in Thailand, has selected to enhance its production base with more capability in terms of driving productivity improvement because the industry itself has a shortage of researchers to perform operational research. Actually, the basic motivation behind university-industry collaboration in research is to develop the research and development capability and innovative potential of the companies, and therefore to increase a country's competitive power (Geisler, Furino, & Kiresuk, 1990). Additionally, Sampan (2013), President of the Electronics and Computer Employers Association, has mentioned that collaboration between industry and academia in operational research needs to be enhanced in order to improve productivity by focusing on automation, which can manage the workforce headcount. This statement directly concerns the capability development of company competitiveness. Since research collaboration is important to the HDD industry in Thailand, this study understands that this phenomenon is also important; however, no studies focus on this industry directly especially the HDD industry in Thailand's context.

Currently, the factors or determinants of operational research collaboration effectiveness and a framework of collaboration between the HDD industry and academia that fit the HDD industry of Thailand's context are still not empirically studied or clearly addressed so that practitioners can utilize them.

Moreover, Gulati and colleagues pointed out that there is no clear idea of the factors that would contribute to the effectiveness of the interaction between the alliance partners. Collaborative managers or project managers and researchers have not paid much attention to how alliance partners develop their relationships after a strategic alliance is formed or how they effectively cooperate in contributing to the strategic alliance (Gulati, 1998, pp. 61-69 as cited in Patthareeya Lakpetch, 2009, p. 8). Therefore, the present author is intent on studying this topic because effective operational research collaboration between the HDD industry and academia requires appropriate factors or determinants to ensure optimal/mutual benefit the to industry for running operations effectively, including academia (University) as well as the country's industry and society generally.

1.2 Research Objectives

The objectives of the study are as follows:

1) To describe the context of operational research collaboration between the HDD industry and academia

2) To explore the key determinants of effective operational research collaboration between the HDD industry and academia

3) To propose a model for effective operational research collaboration between the HDD industry and academia

1.3 Scope of the Study

1) The operational research collaboration between the HDD industry (Western Digital Company) and academia (Universities and Agencies) is the focal point (Unit of Study) of the paper. The scope of this study focuses of the formalized research project collaboration that is 100 percent funded by WD.

2) The frame of sample informants contains the Engineers, Research Collaboration Project Coordinator and Project Managers and Policy-maker of Western Digital, researchers or professors of universities and agencies that have had direct experience in operational research collaboration during years 2012-2014. They are implied to informants, whose projects were completed in 2013 and ongoing projects of operational research collaboration in 2014.

1.4 Limitations of the Study

1) This study focuses on a case study of the high technology industry, the hard disk drive industry, which is 100 percent foreign direct invested, and the data may not be able to be generalized to the general industry in Thailand.

2) Some of the engineers of Western Digital Company have resigned, and some researchers that have had experience in operational research collaboration may have moved to new organizations/offices that cannot be easily approached.

1.5 Definitions of Key Terms

For the purposes of this study, some basic definitions are needed to help in understanding the contents of this dissertation. In this section, the author provides the definitions of key terms as follows:

1) Hard Disk Drive (HDD) are data storage devices for storing digital data in computing and information technology (IT) systems.

2) Operational Research is the academic research methodology of science in the HDD operations to find solutions in a technical manner that enable the incremental and breakthrough improvement in productivity.

3) Collaboration is the effort and commitment between the HDD industry (Western Digital Company) and academia to achieve operational research collaboration projects.

4) Academia is the public universities and government autonomous agencies under the Ministry of Science and Technology such as the National Science and Technology Development Agency (NSTDA), the Material Technology Center

(MTEC), the Nano-Technology Center (NANOTEC), the National Electronics and Computer Technology Center (NECTEC), etc.

5) Operational Research Collaboration Effectiveness refers to the results of operational research collaboration that can be accomplished within an agreeable time frame. The achievement or success is measured by the specific operational research's objective according planed resources per the industry or the company's viewpoint.

1.6 Benefits of the Study

The author (researcher) expects that the benefits of this dissertation can be explained in terms of its theoretical and practical benefits.

1) Benefits to management in the HDD industry for managing operational research collaboration with academia

2) Leading to further understanding and filling in the gaps in the determinants of operational research collaboration effectiveness between industry and academia

1.7 Organization of the Dissertation

The first chapter is a discussion of the significance and problem statement, the research objectives, the scope, limitations, and benefits of study as well as the definitions of key terms.

Chapter two is an overview of or introduction to HDD products and the HDD industry in Thailand as well as Western Digital Company.

Chapter three covers the literature review and past studies of related research. This chapter also discusses the inter-organizational (IOR) theory, collaboration, and the key constructs of the study.

Chapter four is the study of the research methodology, including Methodology, Population, sampling, the data collection, and the data analysis methods as well as trustworthiness.

Chapter five provides the results of the study, including a discussion of the findings of this research.

Chapter six provides the conclusion, a discussion, and contributions and recommendations for further study.

1.8 Chapter Summary

Operational research collaboration between industry and academia, the case of Western Digital Company, is one of the strategies to sustain the competitiveness of this industry to continue investment in Thailand. This phenomenon continues to increase because WD's local management and corporation have chosen to catalyze further improvement toward the operations in various dimensions such as cost, quality, productivity, and so on by utilizing external expertise (researcher) from academia to carry out operational research collaboration projects with the engineers of the company.

However, little is known about this collaboration and its implications for the industry. Therefore, this dissertation seeks to understand the phenomena of operational research collaboration and whether the collaborations is effective or not. If so, what are the determinants that influence the effectiveness of the collaboration? Furthermore, it also leads the understanding the strength and weakness. The study is a qualitative research case study of Western Digital Company, the world's largest HDD manufacturer, whose production is based in Thailand. This dissertation is important because it will bring to the reader's attention some areas that need to improve in terms of how to manage operational research collaboration between industry and academia more effectively and also in terms of understanding the key determinants related to effective collaboration.

CHAPTER 2

THE HARD DISK DRIVE (HDD) INDUSTRY IN THAILAND

2.1 Introduction

This chapter details Hard Disk Drive, Digital Data Storage Devices, and this industry in Thailand and is organized around 3 main parts. The first part is an overview of the history of the HDD industry in Thailand. Then the second part presents data on the value or contribution of the HDD industry to Thailand. Finally, the third part is an overview of Western Digital Company (WD) in Thailand and the collaboration between WD and academia in general is discussed.

2.2 History of the HDD Industry in Thailand

In Thailand, the Hard Disk Drive, or data storage device industry, part of the electronics industry, began in 1983 when Seagate Technology Company moved their production base from Singapore. The main reason that they moved their operations to Thailand was because of a Foreign Direct Investment promotion policy which was initiated by the Thailand Board of Investment (BOI) and the labor costs that are significantly cheaper than running business operations in Singapore.

In the mid-1980s, many production processes were moved from Singapore to Thailand. Due to the concentration of manufacturing, Singapore became congested. Agglomeration forces eventually resulted in dispersion forces in the HDD industry. At that time, the Singapore dollar was appreciating against the US dollar like the currencies of the other newly-industrialized countries, the Republic of Korea and Taipei, China, and a shortage in the supply of labor resulted in high wage rates (Hiratsuka, 2011).

In the year of 1983, in order to serve Thailand export policy, the government had granted the foreign and investors for cooperation. Another few years in 1985, we

were continually welcome them for the export propose. While, 1987 was the year that the export rules and regulation were relieved that foreign capital allowed 100% in case of exporting reached more than 80%.

To exempt from this mission through eight years, even if the foreign capital were established in our rural area, therefore, a huge amount of international investors shifted to Thailand especially those whom located in Singapore. There were firms that did the business of components, assembling parts, cutting and shaping. To consider the history of HDD in Thailand industry, the process had been developed since 1983 when Seagate relocated from Singapore to Samutphrakarn in the part of head-stack assemblies (HAS). It turned Thailand as the central who was a main producer the global HDD. Furthermore, Thailand was another location apart from Singapore that spread the intensive workforce.

Other than the location at Sumutphrakarn, in 1987, Seagate had begun building another site in Nakhon Ratchasima which located in the northeastern region of Thailand (McKendrick, Doner, & Haggard, 2000). At Chok Chai, it was one of the areas, where the Board of Investment of Thailand named this zone 3. Interestingly, the government set the infrastructure as the most glamorous investment site.

Nevertheless, on 1999, Seagate paused its final assemble line. In 2004, it focused on the construction at Chok Chai, while Thai's government offered another full tax holiday for another eight year instead so as to attract the HDD industry.

Outside of Seagate, the Japanese factory named Fujitsu which had located in the US since 1986, began to locate in Bangkok in 1994. In 2001, Fujitsu established its product that turned 3.5 inch HDDs (for Desktop PCs) to 2.5 inch HDDs (for Notebooks).

Apart from Asia manufacturers, the US famous IT producer called IBM had set its assembly at Srirach, Chon Buri in 1991. In 1997, another factory was founded in Parchinburi as well as expanded in phrase 2 plant in 1999. Another year in 2003, Hitachi Global Storage Technologies (HGST) was formed and renamed the IBM's HDD operations.

In 2002, Western Digital Technologies began operating a manufacturing facility that had previously been owned by Fujitsu in Navanakorn in the northern of Bangkok area (Western Digital, 2002, 2003). Fujitsu sold some of the land and

facilities from the 3.5 inch HDD plant to Western Digital, and switched to 2.5 inch HDD production.

In 2008, Thailand became the second largest HDD exporter in the world, sharing about 17.4 percent of world exports. The major HDD manufacturers have based their production in Thailand, including Seagate (1983), Hitachi GST or IBM (1991), Western Digital (2002), and Toshiba (2008), which acquired Fujitsu's factory at the Navanakorn industrial Estate (Archanun Kohpaiboon, 2010).

Over the past two decades, the industry grew rapidly and it has become a major production hub of leading HDD multinational companies, which resulted from FDI promotion policy along with competitive labor costs. Not only HDD makers but also supporting industry for the HDD cluster have moved to Thailand as well such as NMB Minebea, Nidec Electronic, Alphana Technology, Magnecomp Precision Technology, TDK, Hutchinson Technology Operations, and so on.

Production of HDD in 2011
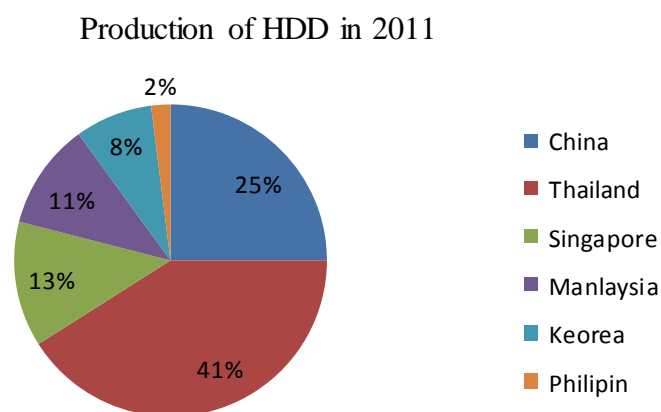
Figure 2.1 Percentage of HDD Production Around the World in 2011
Source: HDD Industry in Thailand, 2012, p. 3.

According to figure 2.1, in 2011, Thailand was number one in the world's HDD production base, accounting for 41.0 percent of the world's HDD production, nearly 300 million units a year, almost all of which was for export (Wanvimol Sawangngoenyuang & Tientip Subhanij, 2012). In 2013, the HDD industry in Thailand had only two key manufacturers; one was Seagate Technology and the

second one was Western Digital (WD) due to Hitachi GST and Toshiba being acquired by Western Digital company in 2012. However, a current key maker after merger and acquisition remains 3 companies. For worldwide market share landscape in 2014 after remain 3 makers, Western Digital is the number one company in the HDD industry in the world.

HDD Markat Share in 2014
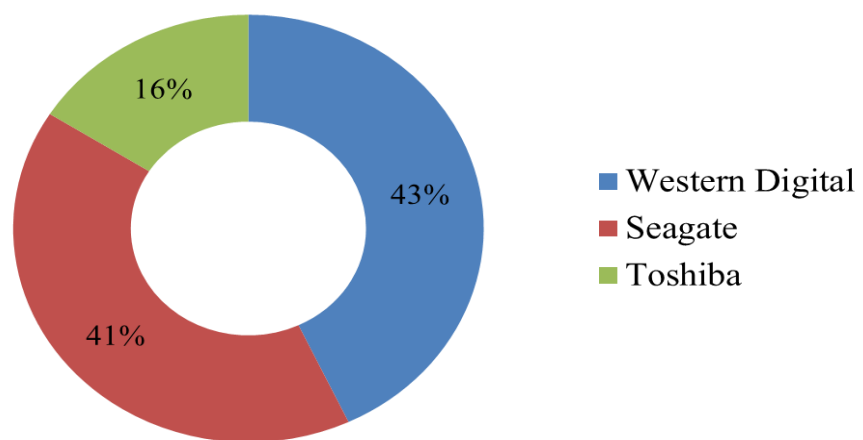
Figure 2.2 HDD Market Share Segregated by 3 Makers
Source: HDD Industry in Thailand, 2012.

2.3 Value of the HDD Industry in Thailand

Given the worth of HDD, Thailand is one of the world's HDD production bases where production accounted for 41.0 percent of the world's HDD production in 2011; nearly 300 million units per year were shipped from Thailand around the world. The value of exports in 2011 reached 52.4 percent of the goods in the electronics sector or 6.6 percent of Thailand's total exports. The HDD manufacturing sector accounted for HDD production reaching 32.2 percent of total industrial output, which was the highest when compared to the other groups of goods. From the employment point of view, the HDD cluster contributes to a direct employment headcount at about 100,000 people.
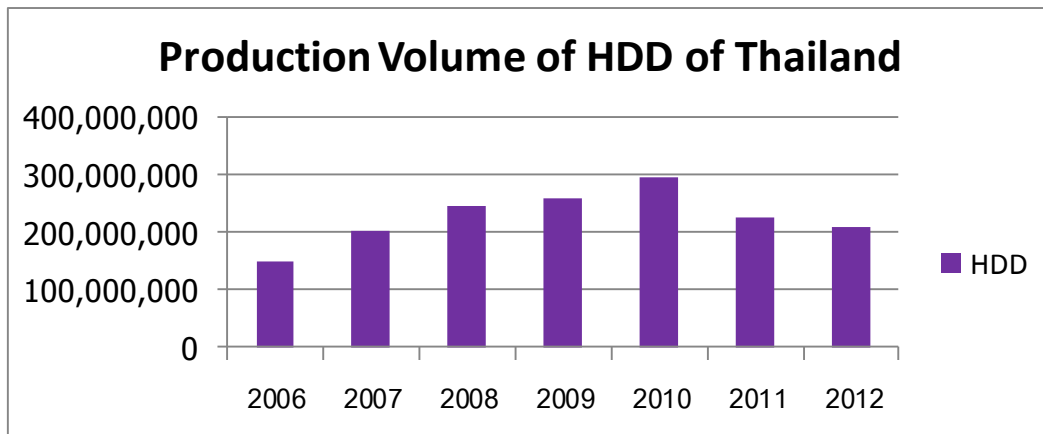
Figure 2.3 Production Volume of the HDD of Thailand
Source: Electrical and Electronics institute, 2013.

In terms of the HDD volume, the growth rate of the HDD industry in Thailand continually jumped up until the heavy flood situation in October 2011 that impacted the global supply chain. However, Thailand's HDD industry has rapidly bounced back from heavy flooding and remains a world leader in production. This industry recovered in 2012 Q2 as production constraint problems arising from the floods were resolved in a relatively short time. In the 3rd quarter of 2012, the Sales volume decreased, which cause from the world economic problem. Interestingly, the device product such as smartphones and tablets have been valued as a high demand, likewise, the hard disk drive product was well-adjusted in order to survive in the business because those new gadgets had capacity of the data storage, which called solid state drive (SSD).

In 2013, improved global economic conditions were expected to facilitate stronger growth of the hard disk drive industry. This is consistent with the HIS iSuppli Research Institute's projection in figure 2.3 where in 2013 hard disk drive sales as expected to reach 537.9 million units, a 2.7 percent increase from the previous year. Despite the growing importance of SSDs, demand for hard disk drive should remain moderate (Bank of Thailand, 2012, p. 38). Thailand is still now ranked as the top HDD and components manufacturing base worldwide with a production base of 2 makers (Western Digital and Seagate) being located there.
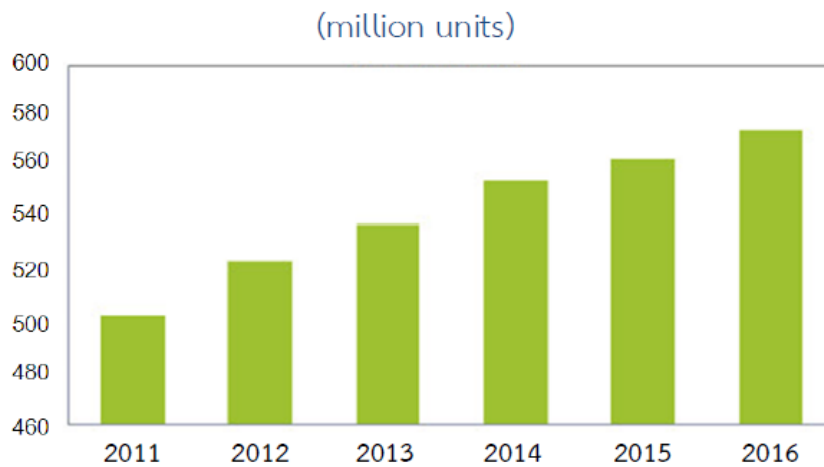
Figure 2.4 Projected Worldwide Sales of Hard Disk Drive

Source: Thailand's Economic Conditions in 2012.

2.4 Western Digital Company in Thailand

Western Digital Company, founded in 1970 as a specialized semiconductor manufacturer and headquartered in Irvine, California, has invested around $1,580 million in Thailand to produce digital storage devices or Hard Disk Drive since 2002 when they completely acquired Fujitsu Company in the Navanakorn industrial estate. Since that day, the company has expanded rapidly. According to figure 2.3 they were able to produce and ship out HDD products from Thailand to the world at more than 200 million units within 5 years of investment and more than 700 million units after 10 years of operation in Thailand.

In 2016 in Thailand, the company employed more than 23,000 local Thai people, which enlarged the nation's tax base, making WD the single largest U.S. employer. The operations of Western Digital Company in Thailand also pay local suppliers for raw materials, finished goods, services and capital equipment. WD's business demand for these goods and services has led to the creation and growth of local companies which, in turn, create additional jobs filled by local residents.

All of this economic activity has a meaningful impact. In fiscal year 2013, the company's direct and indirect contributions to Thailand's economy totaled well over $ 21,703 million US (around 651,090 million Thai baht), or more than 5% of the

nation's gross domestic product (Thailand's GDP is around 10,000,000 million baht) after 10 years of investment (WD's Profile Presentation, 2013).

2003
- Aug 8th – Acquired Magnetic Head Operations
- Oct 29th – ISO 14001 & OHSMS 18001 Certification by BSI

2008
- Nov 28th – **300M** Drives Shipped

2011
- May 31st – **600M** Drives Shipped

2001
- Dec 20th – Definitive Acquisition agreement signed with Fujitsu Thailand

2005
- Jan 16th – **50M** Drives Shipped

2007
- Dec 21st – **200M** Drives Shipped

2010
- Aug 3rd – **500M** Drives Shipped

2013
- Oct 31st – **802M** Drives Shipped

2002
- Jan 2nd – Acquisition closed
- Feb 7th – Shipped first customer drives
- Oct 3rd – ISO 9001:2000 Certification by BSI

2004
- Aug 5th – Introduced Scorpio 2.5" product

2006
- Jun 3rd – **100M** Drives Shipped
- Jul 15th – Start first HDD build at WDTh B4

2009
- Dec 29th – **400M** Drives Shipped

2012
- Aug 24th – **700M** Drives Shipped

Figure 2.5 Key Milestones of Western Digital Company in Thailand

Source: Western Digital Company Profile

It can be seen that the economic was not impact so much in WD operation in Thailand. The company can regularly achieve its talent staff, while demanding in the number of blue and white collar workers. Not only seeking the external candidate who perceived as the competence ones, WD is also built potential people from within. The development programs have set as well as cooperate the partner from outside who are specialists in instructional design of engineering courses and operational development.

Similarly, WD has cooperated with the Thailand's National Electronics and Computer Technology center, which set up the training institute focus on HDD technology. This institution includes expert in any fields i.e. researchers, academics and business and technology leaders in order to groom and instruct the young engineers entering to the business of hard drive as well as its vendor effectively.

For this reason, to work closely with the Asian Institute of Technology and other Thai universities are preferred. The strategic plan is to develop college courses and programs that concentrate on the different components of hard disk drive technology.

2.5 Collaboration between Western Digital (Thailand) and Academia

Regarding the collaboration program between Western Digital Company and academia, many programs have been carried out in order to sustain competitiveness through human resource development as well as innovative activity to drive further improvement in HDD operations with various objectives and many institutions. Some examples of programs are described as follows.

2.5.1 Early Recruitment Program

This program is aimed to attract the talented 3rd and 4th year undergraduate students, graduated and PhD. Student in university, whose majority are in engineering faculty as well as the various field. The plan of the curriculum and coursework is additionally designed with comprehensive skill sets for aligning to the HDD industry. The students that participate in this program will earn direct experience through the internship program which conducts senior projects, theses and dissertations related to the HDD industry. Upon graduation, graduated students become WD employees.

2.5.2 Technical Diploma Program for Engineering Operators

This collaboration program between Western Digital and Technical College arranges a diploma program in order to build a solid foundation in technical knowledge for highly-skilled operators in order to provide career advancement opportunity for engineering operators. The curriculum is designed that focus in electronics and mechatronics field. Upon being granted a diploma, the engineering operator will be promoted to technician.

2.5.3 Bachelor Degree in Engineering for Technicians

The Bachelor Degree in Engineering for Technicians program is designed for talented technicians that have been working with the company for more than 3 years in any technical department. WD collaborates with universities to carry out this program to develop highly technical skilled sets in the engineering field for talented technicians. Upon graduating with a bachelor degree, those technicians will be promoted to engineer.

2.5.4 Co-operative Work-Education Program

Western Digital Company collaborates with 50 local and 5 overseas universities to carry out the co-operative work-education program. This program was launched in 2008. More than 400 students, both Thai and foreign, from many universities join this program. The base of WD's factory that conducts this program is located in the BangPa-in industrial Estate, Ayutthaya Province. The majority of students are in various engineering disciplines, who are now studying both bachelor and master degree. For example, foreign students come from the USA, Germany, Australia, Indonesia, Canada, and South Africa.

2.5.5 The Hard Disk Drive Technology Training Institute (HTTI) Program

The Hard Disk Drive Technology Training Institute (HTTI) was set up through the collaboration among Western Digital Company, the Asian Institute of Technology (AIT), and the National Electronics and Computer Technology Center. The public and private sector partnership is need to develop the preferred innovation. This program was intended to create the HDD Technology Training Institute which brings together researchers, academics, and business and technology leaders to train and educate engineers to work for hard disk drive manufacturers and other companies in their supply chain.

2.5.6 The World's First Master's Degree in HDD Engineering Program

The WD has collaborated with the Asian Institute of Technology (AIT) and National Electronics and Computer Technology Center (NECTEC) to establish the "World's First customized Master's Degree in HDD Engineering" program. This venture is in accordance with Thailand's first hard disk drive manpower development project and the WD HDD Technical Training Institute (HTTI), launched previously. The purpose of this program is to develop WD's engineer's capability in terms of advance skills and knowledge of HDD. This curriculum emphasizes 3 main skill areas: 1) Process Automation and Improvement; 2) Process Technology, which includes product analysis, product prevention plan, control contamination, and product design by using nano-technology; and 3) Software Development and

Simulation Techniques which include the development of a robotic control program for production, a writing computer control program, and the analytical technique for effective production.

2.5.7 Research Collaboration

The with academia (university and government autonomous agencies under the Ministry of Science and Technology such as the National Science and Technology Development Agency (NSTDA), MTEC, NANOTEC, NECTEC) to carry out operational research with matching and 100 percent funding by WD. This program intends to improve HDD operations in various dimensions such as cost and quality as well as productivity improvement which will enable highly-effective operations in order to sustain competitiveness with other countries. Professors or experts from academia conduct research with WD's engineers to meet specific desired objectives upon contract agreement.

2.6 Chapter Summary

This chapter is comprised of a literature review on the HDD industry in Thailand with specific reference to Western Digital (Thailand) Co, Ltd. Currently, the Hard Disk Drive and electronic component industry in Thailand has contributed a great deal to the Thai economy. Thailand is ranked as the world's number one HDD manufacturer. The HDD production base in Thailand accounts for 41 percent of the world's HDD production and there are more than 100,000 workers employed by the industry and more than 400,000 million Baht worth for exports.

However, there are other factors that should be of concern in maintaining Thailand's status as the world's number one HDD production base, for example, competing with other developing countries, such as China and Malaysia, to gain a larger share of HDD manufacturing. In addition, Thailand should focus on R&D in advanced technologies in HDD production and should develop facilities for supporting the growth of the HDD industry in the future. Western Digital (Thailand), the world's leading hard drive manufacturer is ranked to be the world's number one of HDD manufacturer, has used many strategies to sustain its competitiveness by

focusing on many programs to improve various dimensions of operations management to delay diminishing returns for investing in this industry in Thailand. There are many programs of collaboration with academia (universities and government agencies) such as the Early Recruitment Program, the Co-operative work-education program, The World's First Master's Degree in HDD Engineering program, research collaboration, and so on.

CHAPTER 3

LITERATURE REVIEW

Given the theory and literature to cover this dissertation on the determinants of operational research collaboration effectiveness between industry and academia in Thailand, the author has segregated the related literature into 7 main items as follows:

3.1 Related Theory of Collaboration

3.1.1 Inter-Organizational Relations General Theory

Several theories have been employed to explain inter-organization relations (IORs) that have been studied by many scholars in terms of the factors influencing organizations to create inter-organizational relationships (Galaskiewicz, 1985, pp. 281-304; Oliver, 1990, pp. 241-265; Powell et al., 1996, pp. 116-145; & Gulati, 1998, pp. 397-420).

Oliver (1990, p. 241) defines an inter-organizational relationship as "an enduring transaction flow and linkage that occurs among or between an organization and one or more organizations in the environment." Galaskiewicz (1985, pp. 281-304) identified three arenas of inter-organizational relations: resource procurement and allocation, political advocacy, and legitimation. Resource procurement, allocation, and legitimation arenas involve resource dependency issues in their explanatory framework. For example, the resource procurement and allocation perspective points out that an organization can influence enter inter-organizational relationships by the organizations that control resources. The form of greatly-genuine association implies the organizational efforts to engage all authorized members, while influence another connect to this morality.

The organizational power refers to the authenticity that intend to implicate another In order to procure the resources it needs and to cope with environmental uncertainty, organizations participate in IORs in different forms. Oliver listed six

types of inter-organizational relationships: trade associations, voluntary agency federations, joint ventures, joint programs, corporate-financial interlocks, and agency sponsor linkages. Alliances mostly resemble joint ventures and these can be considered as one form of IORs. Additional, Oliver asserted that not only are IORs usually entered through top-management but they also may happen between sub-units of two organizations or between individuals at lower hierarchical levels.

Oliver (1990, pp. 241-265) also posited six contingencies prompting organizations to establish an inter-organizational relationship. These contingencies include necessity, asymmetry of information sharing, reciprocity, efficiency, stability, and legitimacy.

Due to necessity, an organization needs to establish a relationship with other organizations in order to gain the resources and knowledge that it does not have. This occurrence may be triggered by asymmetry of information sharing, which refers to a gap between the amount of information different organizations have, making at least one of them want to interact to bridge that gap through technology transfer and coordination. In order to acquire technological know-how, it can get entering to this partnership as the preference. This opportunity of the new member can gain a useful information, especially knowledge from the existing associates, whereas it is possible to complete its purpose i.e. initiate the new feature and or innovation that is similar to the market trend.

Learning in the organization is occurred when the firm can achieve, incorporate and employ the new capability that complement its mission strategically and reach the competitive advantage. This collaboration made the sources for relocation, while initiate the capability of the partner. The both ways of acquiring such knowledge can be either the utilization of best-practice from the host or experience as a merger while entering into the owner under the collaborative agreement (Tsang, 1998, pp. 346-357).

3.1.2 Inter-Organizational Collaboration

This section considers various issues related to inter-organizational collaboration, the main dependent variable of the study. The concept of collaboration is first clearly defined and discussed, followed by overviews of types, levels, benefits, and challenges of collaboration.

3.1.3 Concept of Collaboration

Various concepts appear when studying the relevant literature in order to define the meaning of collaboration. Many scholars have pointed out the meaning or definition of collaboration that should be considered for a clear understanding of the term.

Leary, Slyke, and Kim (2010, p. 107) pointed out that the term "collaboration" is widely used in all sectors—public, private, nonprofit—and is especially prevalent in the public administration and public management literature. Collaboration basically means working together to achieve a common purpose (Roberts & O'Connor, 2008). GNU Collaborative International Dictionary of English definitions gives the definition collaboration as the act of cooperation i.e. labor union, In addition, Majumdar (2006) has mentioned that the term of collaborations are shaped in order to enhance the quantity, quality, accessibility, and cost effectiveness. Apart from that it aimed to reduce gaps in services exception and perception. Across the range of definitions there are, however, common characteristics. Essentially, collaborating is looking for ways to work together to achieve greater efficiencies and a scale of outcomes. It allows the facilitation and operation of multi- organizational arrangements to solve problems that cannot be solved or easily solved by single organizations. However, a review of various academic literature shows that there is no unified understanding of the concept. Therefore, this section explores the different aspects of collaboration offered in the literature.

Gray (1989, p. 5) specially defines collaboration as "a process that parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own limited vision of what is possible." Later, the definition of collaboration is further refined: "Collaboration occurs when a group of autonomous stakeholders of a problem domain, engage in an interactive process, using shared rules, norms and structures, to act or decide, on the issue related to that domain" (Wood & Gray, 1991, p. 146). They distinguished collaboration as the process of an inter-organizational effort and collaborative alliance as the form of an inter-organizational effort aimed at problems too complex to be solved by one organization.

Additionally, the definition of collaboration developed by Thomson can be seen as a starting point for review and study: "Collaboration is a process in which autonomous actors interact through formal and informal negotiation, jointly creating rules and structures governing their relationships and ways to act or decide on the issues that brought them together; it is a process involving shared norms and mutually beneficial interactions". Wood and Gray's (1991) who originally defined this definition made the later scholars as the followers. (Thomson & Perry, 2006, p. 23).

Similarly, Pasquero (1991) defined collaboration as a loosely-coupled, multi-layered network of referent organizations designed to lead stakeholders to take voluntary initiatives toward solving a shared social problem.

Hohmann (1985) explains that collaboration is a response to the "increasing complexity of professionalism" through a combined effort to meet specific educational goals.

In the same sense, Beder (1984) defined collaboration as the process of working with other organizations to achieve mutual benefits.

More specifically, Miller, Rossing, and Steele (1990, p. 25) use the term "collaboration" to imply that "the parties share responsibilities and authority for basic decision making."

Likewise, Appley and Winder (1977, p. 284) explained that in collaboration, "individuals share mutual aspirations and a common conceptual framework. The interactions among individuals are characterized by 'justice as fairness.' The aspirations and conceptualizations are characterized by consciousness of motives toward the others, caring or concern for the others, by commitment to working with the others over time."

Looking at collaboration from a different angle, Gray (1989, p. 27) established a comprehensive frame for considering why collaborations occur. In her examination of collaboration, she poses the organizational theorists' perspective that "collaboration is a logical response to turbulent conditions" where organizations move closer to developing interconnections with others. She offers six contextual factors associated with increased incentives to collaborate that include the following: economic and technological change; declining productivity growth and increasing competitive pressures; global interdependence; blurring of boundaries between business, labor and

government; shrinking federal reserves for social problems; and dissatisfaction with court-initiated solutions.

Similarly, after reviewing 133 articles from various literature, Mattessich and Monsey (1992, p. 7) defined collaboration as a "mutually beneficial and well-defined relationship entered into by two or more organizations to achieve common goals. The relationship includes a commitment to a definition of mutual relationships and goals; a jointly developed structure and shared responsibility; mutual authority and accountability for success and a sharing of resources and rewards." Resources and rewards are mutually available. Collaborating organizations share authority through a new structure with a common mission. Planning and communication channels are comprehensive. Resources, reputation, rewards, and products are shared by the collaborating organizations.

In accordance with these perspectives, Himmelman (1996, p. 28) views collaboration as an "exchange of information, altering activities, sharing resources and enhancing the capacity of another for mutual benefit and achieving a common purpose."

Knox (1993, p. 19) stated that "the best basis for sustained and mutually beneficial collaboration is a symbiotic relationship based on shared purposes, complementary contributions and shared benefits."

Roschelle and Behrend (1995, p. 70) also described the collaboration as ''the mutual engagement of participants in a coordinated effort to solve a problem together.''

Cropper (1996) also defined inter-organizational collaboration as a decisive and purposeful relationship between units that keep self-determination, trustworthiness and original characteristics; therefore, the power to disengage from the relationship.

Synthesizing the multidisciplinary literature, Graham and Barter (1999, p. 7) defined collaboration as a "relational system in which two or more stakeholders pool together resources in order to meet objectives that neither could meet individually." Stakeholders can be conceived as individuals, groups, organizations, or even societies. Thus, collaboration is not an attribute of the stakeholder *per se*, but an emergent property of a relationship which links a collective body of stakeholders together. In

other words, that which emerges from the relationship is greater than what each of the stakeholders could have accomplished individually.

Longoria (2005) wraps up the definitions offered by Mattessich and Monsey (1992) and Graham and Barter (1999) which share four broad themes:

1) The fundamental nature of collaboration is that of a joint activity in the form of a relational system between two or more organizations.

2) An intentional planning and design process results in mutually-defined and shared organizational goals and objectives.

3) Structural properties emerge from the relationship between organizations.

4) Emergent "synergistic" qualities characterize the process of collaboration. While both side of academies preserve that a desirable outcome by the reason of inter-organizational collaboration, this approach, expressed by Longoria (2005) that the distinctive outcomes of collaboration could not be consolidated by the definition a priori.

In another work, O'Looney (1995, p. 1), writing in the social service literature, suggested that collaboration is used to "denote the processes and governance approaches (e.g., negotiation, shared leadership, consultation and coordination, consensus building, etc.)."

From an educational point of view, Idol and West (1991, p. 71), in a discussion of experience-based collaboration, defined educational collaboration as a "structural process and interactive relationship."

Winer and Ray (1994) defined collaboration as follows: "A mutually beneficial and well-defined relationship entered into by two or more entities to achieve results they are more likely to achieve together than alone."

Bardach (1998) also defined collaboration as any joint activity by two or more agencies that are intended to increase public value by working together rather than separately. From the above discussion, the term "collaboration" is denoted as the entity or relationship and the collaboration process as the act of collaborating.

Powell et al. (1999, p. 37) described collaborative setting as "organizational and inter-organizational structure where resources, power and authority are shared and where people are brought together to achieve common goals that could not be accomplished by a single individual or organization independently."

Austin (2000) discusses collaboration as the mutual benefit apart from the self-interest. It links each partners working harmonious and get both satisfaction as reflected in the following characteristics:

      1) A moderate degree of dissimilarity between or among partners,

      2) The potential for mutual satisfaction of self-interests,

      3) A sufficient selflessness on the part of each partner to assure the satisfaction of self-interests by all involved. It is assumed that participants share equal power and influence in the decision-making process.

Mullen and Kochan (2000) and Brownstein (2002) argued that relationships across disciplines and professions are important components of collaboration. In their discussion of organizational partnerships, Mullen and Kochan (2000, p. 184) described the function of partnerships as "support groups [that] link individuals across institutional or professional status domains to aid them in their work responsibilities and to provide support for professional development."

In contrast, El Ansari and Phillips (2001, pp. 352-353) added a structure and time orientation component to their definition of partnerships, a term often used interchangeably to describe collaborative relationships. Partnerships are "formal, multi-purpose and long-term alliances or community organizations of individuals or groups to achieve common goals and can be homogeneous or heterogeneous, can stimulate social change and people empowerment, and can concentrate on advancing shared vision or problem solving."

In addition to achieving mutually beneficial goals, Rich et al. (2001) suggested that collaborative partnerships can also aid in the development of a sense of shared responsibility and concern among its members.

Organizations confront dwindling resources, complicated system issues, changing demography, multiple voices and participation in decision-making, organizational distress, demand by extra organizational forces, and a broader focus on social issues. This reality has stimulated an increased need for and occurrence of formal and informal relationships among organizations (Whetten, 1981; Hord, 1986; Gray & Wood, 1991; Dunigan & McPherson, 1993; Goodlad, 1994).

Collaboration can be comprehensively defined as a "fluid process through which a group of diverse autonomous actors (organizations or individuals) undertakes

a joint initiative, solve shared problems, or otherwise achieves common goals" (Abramson & Ronsenthal, 1995, p. 1479).

Generally, inter-organizational collaboration is considered a developmental process (Hord, 1986; Gray & Wood, 1991; Kanter, 1994; Legler & Reischl, 2003). Inter-organizational collaboration as a developmental process has preceding conditions, a recognizable set of characteristics, and a dynamic process of planning and coordinating. When inter-organizational collaborations are successful, they result in creating value in relationships and resources for the partners (Kanter, 1994). Inter-organizational collaboration also transforms the organizations that participate in the collective activity (Kanter, 1994; McGrath, 1998; Legler & Reischl, 2003). In order to maintain a collaborative relationship, both parties must perceive mutuality of interests and benefits for the relationship (Gollattscheck, 1981).

Thomson and Perry (2006) defined collaboration as "a process in which autonomous actors interact through formal and informal negotiation, jointly creating rules and structures governing their relationships and ways to act or decide on the issues that brought them together; it is a process involving shared norms and mutually beneficial interactions."

In addition, Sanker (2012, p. 3) proposed that collaboration can be defined as two or more parties who formed and cooperating together. The ends result is to produce something that finally gain more benefit than the each of the individual efforts and donation.

From these reviews, it is suggested that collaboration is a dynamic process with both integrative and aggregative characteristics that tend to create an intrinsic tension between the extent to which autonomous organizations negotiate to maximize their needs or the maximize the collective interests of collaborating organizations. Therefore, for further understanding, a summary of the definitions of inter-organizational collaboration concepts and definitions is described below:

Table 3.1 Summary of Various Scholars' Definition of Inter-Organizational
Collaboration

Scholars	Year	Definition of Collaboration
Beder	1984	The process of working with other organizations to achieve mutual benefits
Gray	1989	A process through that parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own limited vision of what is possible
Miller, Rossing, and Steele	1990	The parties share responsibilities and authority for basic decision making
Wood and Gray	1991	The partnership is taken place if another parties entering into the process, while consuming the common regulations, pattern and structures as well as take an action or agree on that concerned domain.
Mattessich and Monsey	1992	The common interest determine all stakeholders in or out organization to reach their mutual benefit. This affair refers such aspects i.e. authority, responsibility and accountability of achievement as well as capital and benefit.
Winer and Ray	1994	The parties will carry out such cooperation among two or more individualities to achieve the mutual benefit altogether.
Roschelle and Behrend	1995	The mutual engagement of participants in a coordinated effort to solve a problem together
Abramson and Ronsenthal	1995	Fluid process through which a group of diverse autonomous actors (organizations or individuals) undertakes a joint initiative, solves shared problems, or otherwise achieves common goals
O'Looney	1995	Denotes the processes and governance approaches
Cropper	1996	IOC is a positive, purposive relationship between organizations that retain autonomy, integrity and distinctive identity and thus, the potential to withdraw from the relationship

Table 3.1 (Continued)

Scholars	Year	Definition of Collaboration
Bardach	1998	Any joint activity by two or more agencies that is intended to increase public value by their working together rather than separately
Powell et al.,	1999	An organizational and inter-organizational structure where resources, power, and authority are shared and where people are brought together to achieve common goals that could not be accomplished by a single individual or organization independently
Austin	2000	Collaboration in comprised of partnerships that involve equal partners working together toward satisfying mutually beneficial self-interests
Hord; Kanter Legler and Reischl	1986, 1994, 2003	Inter-organizational collaboration as a developmental process has preceding conditions, a recognizable set of characteristics, and a dynamic process of planning and coordination; creating value in relationships and resources for the partners; transforming the organizations that participate in the collective activity; and perceive a mutuality of interests and benefits for the relationship.
Thomson and Perry	2006	Collaboration is "a process in which autonomous actors interact through formal and informal negotiation, jointly creating rules and structures governing their relationships and ways to act or decide on the issues that brought them together; it is a process involving shared norms and mutually beneficial interactions."
Roberts and O'Connor	2008	Collaboration basically means working together to achieve a common purpose.
Sanker	2012	Collaboration is defended as a synergistic relationship formed when two or more entities working together produce something much greater than the sum of their individual abilities and contribution.
GNU Collaborative International Dictionary	-	Collaboration is the act of working together; united of labor.

Source: Adapted by Author

3.1.4 Types of Collaboration

Given collaboration in the literature in general, collaborative relations between organizations take various forms. Among them are strategic alliances, partnerships, trade associations, interlocking directorates, joint ventures, research consortia, and networks (Van de Ven & Ring, 1991; Barringer & Harrison, 2000). This assortment of names signifies the subtle differences in intent and approach in the formation of a relationship between or among organizational groups. The vagaries evidenced in the terminology are indicative of the unique character of each relationship and of the difficulties in developing any uniformity of approach in the study of these relationships. The summary of these key relationships is shown as follows.

1) Joint Venture

Joint venture happens when organizations integrate some parts of their resources with each other to create a newly-integrated corporation with a unified ownership status (Barringer & Harrison, 2000). It is most commonly adopted in mature industries where it is important to capture economies of scale and scope. Such ventures are often time-limited and specific in their scope of services. These alliances are characterized by equal ownership, joint board governance, and the participation of a few partners. Although member organizations become integrated in their function and services, they do not completely merge into one organization (Bailey & Koney, 2000).

2) Network

A network is an arrangement through which an organization organizes complex organizations as independent entities around its main current of activity (Barringer & Harrison, 2000). Here, the organization acts as a strategic focal point and this central organization coordinates the interdependencies of the various participating member firms. The combination of each firm achievement such as their success area can blend and generate a new feature, product and service (Bailey & Koney, 2000).

In most cases, networks are formed out of financial or legal necessity and are bound by legal agreements such as articles of incorporation and by-laws that establish their relationship within the network while maintaining the organization's own identity and function in areas not relevant to the network.

3) Consortia

Consortia are considered as a type of common organizational investment whereby organizations engage in specified efforts aiming at solving a specific issue or technology such as research and development (Barringer & Harrison, 2000). Consortia are alliances in which organizations work with one another in order to pool their resources to achieve a long-term goal. Generally, consortia are not legal entities but they serve as a formal agreement among agencies to combine resources. These alliances may be formed in an effort to coordinate services or mandated as a requirement for funding. Consortia are often led by a single organization that manages the process and has a significant amount of control over resources.

4) Partnerships

Partnerships are actualized through the process of relationship (Gallant et al., 2002) and characterized by shared goals, common purpose, mutual respect and willingness to negotiate and cooperate, informed participation, information giving, and shared decision making. In other words, a partnership is a new organization formed through the process of collaboration by autonomous stakeholders of a problem domain that modifies the way two or more organizations interact by defining new boundaries that change the organizational identity of the partners (Crowley & Karim, 1995).

Kernaghan (1993) suggested that a partnership is a relationship that involves sharing power, work, support and/or information with others in the achievement of joint goals and/or mutual benefit. A collaborative partnership involves a mutually agreed-upon division of labor among equal partners that are empowered to participate in all decisions (Tushnet, 1993). Partnering takes current, former or future colleagues or competitors, reorganizes the way they interface, and fundamentally improves how they deal with conflict by melding them into an alliance (Doz & Hamel, 1998).

Generally, the theme of partnership comes through strongly. Eppel (2008) states that the partnership refers the sharing of human resources, internal process that can bring about preferred outcome and enhance the environment of working together across professional boundaries as a collaboration.

By collaborating, organizations seek to leverage the differences among them in terms of knowledge, skills, and resources so as to develop innovative and synergistic solutions to complex problems they cannot solve on their own (Hardy, Lawrence, & Grant, 2005).

5) Alliances

Alliances are viewed as agreements that take place between two or more organizations without any common ownership or identity, which facilitate some types of interactions (Barringer & Harrison, 2000). Alliances are created for three primary purposes: co-option, co-specialization, and organizational learning (Doz & Hamel, 1998). It reforms competition to coalition, while initiate materials from the field. The Co-option shift the way of doing business. Likewise, the Co-specialization is combined effort between two or more specialized parties to value and grow the appliance, assets and talents.

Finally, alliances also create avenues for organizational learning through intimate and personal collaboration with other organizations.

6) Trade Associations

The organizations which called 'Trade Associations" are referred to the non-profit firm and instituted from the industrial organizations. They aim to gather and publicize their information in and out as well as legitimate the group that can have a bargaining power (Barringer & Harrison, 2000).

Generally, this phenomenon of trade associations is a power tool that can intervene the government. While the lobbying action is frequently taken place, the lobbyists are also represent this association strongly.

7) Interlocking Directorates

Interlocking directorates can be categorized into 2 kinds; direct and indirect form. As for the former, a member of firm's directorate one is held the position as the director in organization; while, the latter form, refer the person who governs both in the firm and also be a member of directorate in the other firm (Barringer & Harrison, 2000). Therefore, this type of directorate can complete the mutual benefit as he/she can share valuable information and inter-organizational cooperation as well as stretching the initiative between firms. From the literature that has been reviewed in relation to types of collaboration, one can see that the majority

of research collaboration between Western Digital Company (Industry) with academia falls within the domain of a consortium and alliance. However, this needs to be empirically investigated.

3.1.5 Patterns of Collaboration between Industry and University

Closer relationships between university and industry, especially in research activities, enable the enhancement of the nation's competitiveness at the macro level and lead to improvements in various dimensions for industry operations management at the micro level. In the context of US study, Geisler and Rubenstein (1989) stated that university-industry relations cover a wide-range spectrum of links from a one-off transfer of information to a sophisticated and long-term relationship such as a co-operative research center or a research park. Creating a category that shows all of the relations between the two sectors is therefore very difficult (Blackman & Segal, 1991; Mora-Valentin, 2002). Nonetheless, numerous attempts have been made by scholars to develop categories of industry-university relations in an effort to conceptualize such relations.

Geisler and Rubenstein (1989) created a comprehensive classification of both formal and informal relations between industry and university based on the US context as shown in Table 3.2.

Table 3.2 Categories and Mechanisms of Industry-University Relations

Categories of Relations	Description (Modes of Interaction and some mechanisms)
1. Industrial Extension Services	1.1 Information transfer and consulting
	1.2 Workshop, classes
	1.3 Undirected corporate gifts to university funds
	1.4 Capital contributions to university department, centers, laboratories
	1.5 Industrial fellowships
2. Procurement of services	2.1 By university from industry. Prototype development, fabrication, testing, on-the-job training for students, thesis topics and advisors, specialized training

Table 3.2 (Continued)

Categories of Relations	Description (Modes of Interaction and some mechanisms)
	2.2 By industry from university. Education and training of employees (degree program, continuing education; contract research, consulting services.
	2.3 Industrial associates. Industry pays fees to university to have access to total resources of the university.
3. Cooperative Research	3.1 Joint research planning and execution
	3.2 Faculty and student participation
	3.3 Cooperative research projects: direct cooperation between university and industry scientists on projects of mutual interest; usually basic, non-proprietary research. No money changes hands; each sector pays salaries of own scientists. May involve temporary transfer of personnel for conduct of research.
	3.4 Cooperative research programs: industry support of portion of university research project (balance paid by university, private foundation, government); results of special interest to company; variable amount of actual interaction
	3.5 Research consortia: single university, multiple companies, basic and applied research on generic problem of special interest to entire industry; industry receives special reports, briefings, and access to facilities
4. Research Parks	4.1 Research cooperation on frontiers of science and technology
	4.2 Informal interactions
	4.3 Increased sharing of research facilities and participation in consulting, seminars, and continuing education
	4.4 Contractual arrangement—specific and detailed; both parties contribute substantially to the enterprise

Source: Geisler & Rubenstein, 1989.

Martin (2000), discussed case studies of industrial relations practices in sample universities from twelve countries, both industrialized and developing, and classified university-industry interactions as follows:

1) Consultancy (conducted on a formal or informal basis)

2) Teaching and curriculum development (such as sandwich courses, jointly developed degree courses, continuing education courses of short, medium, and long duration, exchange of staff, etc.)

3) R&D activities (including contract research and co-operative and sponsored research initiated and administered by internal or external structures), some of which lead to the setting up of spin-off companies involved in capitalizing on research discoveries and inventions, assisting university academic staff in commercializing their R&D expertise and in providing business development assistance to entrepreneurs involved in these activities.

4) Others (such as regular mutual visits, jointly organized meetings, conferences and seminars, joint publications, joint participation in exhibition and fairs, industrial support to individual students or associations, industrial representation on the governing boards of higher education establishments, etc.)

With reference to a few studies in the developing country context, Aslan (2006) has suggested a taxonomy of university-industry links in Malaysia based on surveys of selected Malaysian public universities and interviews of selected academic staff and university administrators. The conclusion is described in table 3.3.

Table 3.3 A Taxonomy of University-Industry Links in Malaysia

Categories of Linkage	Description
1. Equipment/laboratory Related Service	1) Procured to industry: hiring university laboratory facilities; analysis, measurement and testing
	2) Procured from industry: hiring industrial laboratory facilities
2. Research-Related	1) Contract research
	2) Joint research (with or without government grant)
3. Research Commercialization and Property-led Initiatives	1) Academic Start-Up
	2) Patent licensing
	3) Outright sale of technology to industry
	Joint venture between university and private firms to

Table 3.3 (Continued)

Categories of Linkage	Description
	commercialize inventions by academics
	4) Technology park and incubator facilities provided/managed by university for industry or academic entrepreneurs
4. Education and Training	1) Students attachment and practical training in industry
	2) Industry input in curriculum planning, development and evaluation
	3) Executive Development Program/Company staff training/Continuing Education Course
	4) Adjunct Professor from Industry
	5) Master and doctoral projects in industry
	6) Lectures by industry's personnel in university
	7) Industrial sponsorships for chair in university
5. Informal & Human Capital Related University-Industry Links	1) Informal contacts (e.g. personnel contacts by academics with friends)
	2) University graduates employed by industry
	3) Conferences, workshop and expos
	4) Co-publications
	5) Donation and endowment
	6) Staff exchange between university and industry

Source: Aslan, 2006.

In another Malaysian study, Tapsir et al. (2008) presented five major groups of university-Industry partnerships activities, i.e. research and innovation, consultancies, teaching and curriculum development (continuing education courses, staff and student exchange), training and educational-related schemes, international collaboration (memoranda of understanding and memoranda of agreement).

Bonaccorsi and Piccaluga (1994, pp. 229-247) introduced six groups of industry-university relationships based on the forms that are generally cited in the scientific and practitioner literature (Rothwell, 1983, pp. 5-25; Geisler & Rubenstein,

1989, pp. 43-62; Bloedon & Stokes, 1991). The main criteria for classification are based on organizational resource deployment in terms of the personnel, equipment, and financial resources that the two parties are willing to commit to the relation.

1) Organizational Resource Involvement by the University

First of all, organizational resource involvement on the part of the university is nil if the firm's contact is with an academic as an individual and without any agreement being signed with the university; beyond that case, university resource involvement grows from B to F, reaching a maximum when the whole university is involved in creating specific structures which have the objective among others to collaborate with firms.

2) Length of the Agreement

The length of the agreement between universities and firms can vary from short (but renewable) in the case of personal formal relationships, to long, in the case of the constitution of specific structures or in the case of formal non-targeted agreements. In the case of relationships between universities and industries organized by third parties, the length of the agreement is very short, unless a more stable relation comes out of this episodic type of contact.

3) Degree of Formalization

The formalization of the agreement is low or completely absent in the case of personal informal relationships; in the case of relations through third parties the formalization can either exist or not exist; in all other cases the relations are formalized. This is very important because it is sometimes argued that increasing formalization and monitoring in an IOR can lead to conflict among participants who are struggling to maintain their organizational autonomy in the face of growing interdependence.

Table 3.4 Categories of University-Industry in Inter-Organizational Relationships

Classifications	Description	Examples of Relationship
A. Personal Informal Relationships	Exchange between the firm and an individual inside the university, without any formal agreement involving the university itself Typical examples are consultancy contracts with professors or information exchange meetings organized in an informal way. Also, firms may benefit from relations with other firms founded by researchers who worked or still work in the university.	1) Individual consultancy (paid for or free) 2) Informal exchange forums and workshops 3) Academic spin-offs 4) Research publications
B. Personal Formal Relationships	Collaborations involving personal relations as in the previous case-but with formalized agreements between the university and the firm	1) Scholarships and postgraduate linkages 2) Student interns and sandwich courses 3) Sabbatical periods for professors 4) Exchange of personnel
C. Third Parties which are developed through University-Industry relationship	Relations which are developed through intermediary associations-some of which run by the university, some completely external to it, and some others in an intermediate position which facilitate the transfer of knowledge from university laboratories to firms. At the same time, these institutions may function as indicators of market needs for those researchers who wish to know more about them.	1) Liaison offices 2) Industrial associations (functioning as brokers); 3) Applied research institutes 4) General assistance units 5) Institutional consultancy (university companies)
D. Formal Targeted Agreements	Relations which involve a formalization of the agreements and the definition of specific objectives since the beginning of the collaboration; examples of the objectives are prototype development, testing, on the –job training for students	1) Contract research; 2) Training of employees; 3) Cooperative research projects (including direct cooperation between academic and industrial scientists on projects of mutual interest usually regarding basic and

Table 3.4 (Continued)

Classifications	Description	Examples of Relationship
		nonproprietary research; anytime when conduct the researches, each side of the firm has to pay their own scientists the salaries. 4) Joint research program such as industrial support of portion of university research projects
E. Formal Non-targeted Agreements	Relations which involve a formalization of the agreement as in the previous case; however in this category the relations have broader, often long-term and strategic objectives	1) Broad agreements; 2) Industrially sponsored R&D in university departments 3) Research grants and donations, general or directed to specific departments
F. Creation of Focused Structures	Research initiatives which are carried out together by university and industry in specific permanent structures created among others for that purpose	1) Association contracts 2) University-industry research consortia 3) University-industry cooperative research centers; 4) Innovation/incubation centers; research, science and technology parks -Mergers

Source: Bonaccorsi & Piccaluga, 1994, p. 233.

Brimble and Doner (2007) have classified interaction in the Thai context as Training and Education, Services and Consulting, and Research (as shown in Table 3.4). There is a preponderance of linkages involving universities training employees in relatively low technology areas and individual consulting relationships between academics and particular firms.

Table 3.5 Linkage Activity between University and Industry

Modality Group	Type of Linkage Activity	Description of Linkage Activity
1. Training/ education	1) Cooperative education 2) Industrial training (continuing education) 3) Small business training 4) Visiting lectureships	1) Involving students spending a significant portion of their academic program in private companies 2) In the application of new technologies such as machine tools 3) Addressing issues of concern to small or nascent entrepreneurs 4) Formal arrangements where private companies support staff to participate in teaching activities
2. Services/ consulting	1) Industrial extension services 2) Technology brokerage/ licensing 3) Business consulting/ Services 4) Direct or indirect Investment 5) Coordination of technology-related issues	1) Including testing, calibration, repair services, production trouble-shooting, simple design modifications 2) Assistance in obtaining or licensing technologies either from the university or from a third party 3) From business schools, or through research parks, science parks, incubators 4) Through equity investment and venture capital Schemes 5) Through such inter-organization entities as regional technology councils
3. Research	1) Research consulting 2) Joint or cooperative research 3) Partnership contract 4) Personal interchange or industrial fellowships 5) Shared equipment or facilities	1) Contractual research carried out for a private company with specified terms 2) Often carried out in dedicated laboratories, centers, or institutes 3) Long-term arrangement between university and company to build up research/education facilities 4) On a regular or long-term basis 5) On a regular or long-term basis

Source: Brimble & Doner, 2007.

3.2 Theories Related to Determinants of Effective Collaboration & Concept

One thing that scholars of inter-organizational collaboration tend to agree on is that collaboration among organizations is challenging (Huxham, 1996; Fyall & Garrod, 2005). In addition, several papers have presented that the majority of inter-organizational collaborative arrangements are unproductive (Eibinder et al., 2000; Fyall & Garrod, 2005). Nevertheless, the obstacle may cause from the high rate that are often reported for the inter-organizational collaboration. The reliable approaches of interpretation and measurement of inter-organizational collaborative effectiveness are highly need (Gulati, 1998; Donaldson & O' Toole, 2002).

Similarly, to evaluate the effectiveness of inter-organization collaboration is doubtfulness in terms of context, concept, and measurement (Shilbury & Moore, 2006).

There appears to be no universal agreement on precisely what effectiveness means, in terms of subjective approach. The word of inter-organizational collaborative effectiveness has no common ground. The several scholars concur that multiple criteria as well as evaluation of different dimensions and characteristics should be provide in both paths of processes and outcomes (Shilbury & Moore, 2006).

Former scholars had applied a system resource approach (Yuchtman & Seashore, 1967), compare the effectiveness to the durability or survival (Shilbury & Moore, 2006). The expectation of those studies define the collaboration effectiveness would not be eliminated by the organizations that engaged. The relationship with the environment is central to the application of the systems resource model (Shilbury & Moore, 2006). A view of this possible question is that if some organization set collaborative arrangements just only for temporary, while another firm may aim to exist for a many senses, even they are no longer competent (Fyall & Garrod, 2005; Longoria, 2005). In fact, organizations may engage in inter-organizational collaboration for purely symbolic reasons (Longoria, 2005). Moreover, the effectiveness of inter-organizational collaborative have not obviously shown either the partial success or partial failure; while, the coalition can be defined as effective if it survives or ineffective if it is terminated. Undoubtedly, it is feasibly that an

arrangement of collaboration may be achieve not in general; or that it can be determined of how firm perform effectively by some of its members.

The other alternative approach that can be used to identify the inter-organizational collaborative effectiveness is the internal process (Steers, 1977). This way prioritizes the dynamic inside among inter-organizations as the key element criteria for inter-organizational collaborative success. Regarding that the aspects such as the assurance, combined systems, and steady functioning are determined as reliable indicators of inter-organizational collaborative effectiveness compared to the former, resource/survival approach.

Another different approach to measure an inter-organizational collaborative effectiveness is the goal attainment. This term values the achievement of the goal(s) for which the collaborative arrangement was created (Fyall & Garrod, 2005; Longoria, 2005). The hypothesis of this principle that define the effectiveness of collaborative arrangement, has to attain the goals for which it was established. While such a way of determining the effectiveness of a collaborative arrangement may intuitively make sense, it is not without problems. However, an outcome-based measure does not count the means or the quality of collaborating process. Indeed, collaboration as defined in this study is not inherently related to a specific outcome. The achievement of several outcomes is in part dependent on a multitude of factors (resources, capacities, environment, etc.) that are not necessarily related to how effective the collaboration is (Keyton et al., 2008).

3.3 Effective Collaboration

The dependent variable of this study has been taken from the goal-attainment approach (Perrow, 1961; Etzioni, 1964; Price 1968; Fyall & Garrod, 2005; Longoria, 2005; Daft, 2007), which was derived from the literature review. According to these scholars as Perrow (1961), Leach & Pelkey (2001), Aysin (2004) and Longoria (2005) argue the definition of effective colloboration on whether the initial objectives and goals of collaboration have been achieved or not, and which antecedents are accounted for or against from the goals.

3.3.1 Determinants of Collaborative Effectiveness

Although the difficulties in defining what inter-organizational collaboration effectiveness might actually be, many scholars have endeavored to summarize the key determinants of ICE. Waddock and Bannister (1991) conducted an extensive review of the literature to come up with a list of determinants of ICE. According to them, there are several aspects to identify the effectiveness of an inter-organizational collaborative. Firstly; the trustworthiness culture is aligned altogether in the organization. Secondly, the common interests are taken into account. Thirdly, team members shall have positive expectations and feelings about the collaborative arrangement. Fourthly, they respect and recognize their interdependence. Fifthly, they value to the collaborative arrangement. Sixthly, the corporate objectives should be well clarification. Seventhly, there is a balanced power within the collaborative arrangement. Lastly, a strong leadership must be there. In addition, Waddock and Bannister (1991) stated that inter-organizational collaborative effectiveness is maximized when all of those aspects are met.

Fyall (2003) argued the effective inter-organizational collaboration that the qualifications of the phenomenon are 1) key stakeholders are involved. 2) there are good interpersonal relationships, 3) trustworthiness, 4) preferred organizational culture and inclusive management style, 5) similarity and agreeableness, 6) legitimate conditions, 7) decisive leadership, 8) helpful, 9) management resources and power are harmonious, 10) tight focus and identification, and 11) transparency.

3.4 Research Related to the Study

Given the research related to the collaboration between organizations, scholars have researched collaboration and suggested that there must be several essential components for the internal operation of a collaboration, including: 1) a main purpose consist of the incorporates good timing, a shared vision, and a critical need for action; 2) team member is generalist, negotiation, and have a need of affiliation 3) has clearly-established roles structure, agreeableness, open-mind, prefer two-wats communication, give a credibility and have problem-solving skill; 4) open-process, open for the buy-in ideas, allows for provisional success, and can monitor the group's

progress; and 5) sufficient funds and resources, entrepreneurial leadership, and have a skilled facilitator as well as consensus-based decision-making (Gray, 1989; Kagan, 1991; Melaville & Blank, 1991; Chrislip & Larson, 1994).

Gray (1989) has mentioned that although there are variations in the definition of collaboration, there are general factors that have been identified as characteristics of successful collaborative partnerships. Collaboration is a decision-making process that involves two or more organizations. In general, the partners are interdependent, solutions are reached by dealing with differences, decision-making is owned by all partners, each organization assumes collective responsibility for its future direction, and the process is fluid and emerges over time.

The essential components of collaborative partnerships include equity and representativeness among partners, resources that will facilitate the process, the ability of partners to balance their responsibility to and self-interests of their individual organizations and partnership, a clear reason or purpose for the collaborative effort, commitment, communication, and skilled leadership (Gray, 1989; Chrislip & Larson, 1994; Austin, 2000; Mizrahi & Rosenthal, 2001; Wolff, 2001; Johnson et al., 2003).

Many factors influence the effectiveness of inter-organizational collaboration. Weiss (1987) offers six factors for successful collaboration based on a review of the literature. Managers may seek to engage in collaboration if: 1) they calculate that additional net resources will flow, 2) the professional norms and values of staff support cooperation, 3) there may be some political advantage, 4) there is a need to ameliorate internal problems, 5) they can reduce environmental uncertainties, and 6) they are legally required to do so. Weiss offers a process model with perceived problems shared across the organizations, acting as a trigger. Given these shared problems, if resources exist to facilitate co-operation and the organizations have an organizational capacity to mount collaboration, then collaboration is likely to take place.

Gray (1989) grouped the important factors in organizing for successful collaboration into two categories: member factors and process factors. Member factors are those that are related to the participants in the collaboration, such as inclusion of all affected stakeholders at the stage of problem definition, sufficient stakeholder incentives, and commitment and effective leadership. Process factors are

the factors related to discretion over the process of collaborating such as ripeness of the issue, decision-making structure, and availability of mediators during crisis points in decision making, organization and centralization of the collaboration, and the relationship between the parties. A third group of factors are added to these to encompass the resource factors that may be beyond the control of the collaboration participants. These include political support and funding.

Forming a collaborative partnership may be quite easy, but there are yet few success stories (deWit, 1998). The following list of success factors, based on suggestions by Van Ginkel (1998), and deWit (1998), highlights the challenges in striking a successful collaborative relationship: mission and objectives which need a shared identity, a commitment to the same goals, and advantageous returns to related members; people that have the relevant expertise and that support the collaboration; time and resources that require the investment in both time and money necessary to realize a project and communication, which are advised to involve key players and set up a list serve to keep as many participants in as frequent contact as possible.

3.5 Current Empirical Studies on Inter-Organizational Collaboration

To collect the data from 133 research studies in topic of collaboration in higher education and business, social science, health, and government agencies, Mattessich et al. (2001) showed a the list of 20 dimensions that determined a successful collaboration and grouped them into six categories. Firstly, history of collaboration or cooperation in the community, a leader in the community that are perceived, and the political and social atmosphere are those significant factors. Secondly, the membership characteristics, which showed mutual respect, understanding, trust; focus on the collaboration as in their self-interest and the ability of compromising. Thirdly, the systematic action, which indicated how members sharing in both process and outcome; present an effective decision-making; openness; a clear roles and policy guidelines are well established and the adaptability skills of changing conditions. Fourth, communication are open and frequent demonstrate as well as the firm provides various channels. Fifth, concrete, achievable goals and objectives, a shared vision; and the same page for the collaboration in organization.

Sixth, there are sufficient financial and human resources. These qualifications can be structured as the process and structure mechanisms.

Adopted from Mattessich and Monsey (1992), Ellen and Perrault (2008), in a study of community-university inter-organizational collaboration, found six important factors: 1) established informal relationships and communication links, 2) mutual respect, understanding, and trust, 3) flexibility, 4) development of clear roles and policy guidelines, 5) shared leadership, and 6) a learning purpose.

According to the handbook of inter-organizational relations (Cropper et al., 2008), there are four core concepts that underlie all IOR research. These are: factors describing the relating to organizations (age, level of specific investment, and experience with IORs); factors describing the nature of the relationships (trust, reciprocity, incentive structures and administrative control); factors relating to contexts (goals, structure, environment, and legal, political, economic); and factors relating to process (trust, leadership, process for innovation, evaluating and intervention).

Huxham and Vangen (2005) argued that the common aspects which are potential, reliability, risk-taking, working conditions, assets, effective communication, engagement and equality are identified as of the inter-organizational collaborations. Importantly, two themes established by the researchers were the collaborative identity and the social capital. While it does not project an integrated conceptual framework for the collaboration process, this description is still perceived ambiguity.

Préfontain et al. (2000) presented six dimensions for consideration when considering critical factors of collaboration for public service delivery: 1) political, social, economic, and cultural environment, 2) institutional, business, and technological environment, 3) partner's objectives and characteristics, 4) the collaboration process, 5) modes of collaboration, and 6) project and collaboration performance. Similarly, from a review of the literature, a study of client groups, and consultation with an expert panel, Lambert et al. (2001) identified five requirements for successful collaboration: 1) clearly-defined, mutually-valued, shared goals, 2) measuring progress towards goals, 3) adequate resources, 4) good leadership, and 5) working well together with relationships based on mutual support and trust, acknowledging their differences and sharing information openly.

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Legler and Reischl (2003) also used quantitative methods to refine inter-organizational collaboration theories. This approach is supported for the finding of key elements in the formation and maintenance of partnership and construct the understanding the research linage. The key factors found were: stakeholder diversity, interdependence, resource sharing, coordination, planning, communication, and written agreements.

Pertuze, Calder, Geeitzer and Lucus, (2001, pp. 84-85) reported the result of a three-year study aimed at determining best practices for industry-university collaboration. Twenty-five informants gained from the multinational companies and various industries such as aerospace, information technology, materials, consumer-electronics and automotive are interviewed in areas of technology personnel associated with industry-university. A set of seven themes are proposed that a company can get most valuable from the collaboration with the university as following: 1) to identify strategic context as the selection process mainly; 2) to appoint project managers properly; 3) to share with the university team member the vision clearly; 4) to supply long-term relationships based; 5) to sustain the effective communication toward university team; 6) to create a sense of project awareness; and 7) to ensure the supportive throughout, until the research can be exploited.

Based on the literature outlined above, there are several key determinants or factors regarding the effectiveness of inter-organizational collaborative arrangements. These are: character and competency among concerned parties, supportive resources, structure and process of operational research collaboration, trust, adequate communication, good relationships, etc. These characteristics could constitute the facets of Inter-organizational Collaborative Effectiveness, etc.

3.6 Tentative Conceptual Framework

This study is a qualitative research and the tentative conceptual framework of the study is based on a variety of theories and models offered by scholars from different fields. In order to enhance the explanation of the determinants of operational research collaboration effectiveness between the HDD industry and academia in Thailand, a tentative conceptual framework has been developed, taking into account

the major factors that determine the effectiveness of inter-organizational collaboration. The variables in the conceptual framework may consist of independent variables that affect the dependent variables. The tentative independent variables are as follows: One are the factors related to the intention or end in mind of collaboration. A shared visions are existing, clear defined of collaborative objectives and purposes, key stakeholders have committed and involved in both organizations. Two are the factors related to the situation in which the participants feel a win-win agreement with clear mutual benefits. The roles, accountability, involvements and interests among stakeholders. Three are the factors related to leadership attributes. Four are the factors related to trust in each other among participants. Five are the factors related to characteristics of participants, skill and knowledge of participants as well as interpersonal skill, etc. Six area the factors related to resources, having enough necessary resources and administration support. Seven are the factors related to communication including open and frequent communication; and formal and informal communication channels. These categories can be framed into two mechanisms: process and structure factors. The dependent variable is operational research collaboration effectiveness, which can be considered and measured in terms of the operational research collaboration accomplishment within the time frame and achievement of the specific research's objective per planned resources.

Table 3.6 Preliminary Determinants of the Effectiveness of Inter-Organization Collaboration

Determinants	Scholars
1. Intention and end in mind of collaboration - Share vision, clear collaborative goal and objectives, unique purpose and well defined, commitment and involvement of key stakeholders	Gray, 1989; Waddock & Bannister, 1991; Chrislip & Larson, 1994; Austin, 2000; Mizrahi & Rosenthal, 2001; Wolff, 2001; Mattessich et al., 2001; Johnson et al., 2003; Fyall, 2003
2. Win-win agreement (mutual benefit) among stakeholders - Clear contract, roles, accountability, involvements and interests	Gray, 1989; Waddock & Bannister, 1991; Fyall, 2003; Ellen & Perrault, 2008

Table 3.6 (Continued)

Determinants	Scholars
3. Leadership -Strong and skillful leadership	Waddock & Bannister, 1991; Kagan, 1991; Melaville & Blank, 1991; Chrislip & Larson, 1994; Austin, 2000; Mizrahi & Rosenthal, 2001; Wolff, 2001; Johnson et al.., 2003; Fyall, 2003; Ellen & Perrault, 2008
4. Trust -Trust in each other among participants	Waddock & Bannister, 1991; Mattessich et al., 2001; Fyall, 2003; Ellen & Perrault, 2008; Huxham & Vangen, 2005; Cropper et al., 2008
5. Characteristics of participants - Skill and knowledge of participants, interpersonal skill	Gray, 1989; Kagan, 1991; Melaville & Blank, 1991; Chrislip & Larson, 1994; Fyall, 2003;
6. Resources. - Enough necessary resources and administration support	Gray, 1989; Kagan, 1991; Melaville & Blank, 1991; Chrislip & Larson, 1994; Mattessich et al., 2001; Fyall, 2003
7. Communication - Monitor progress of project and communication among participants	Gray, 1989; Chrislip & Larson, 1994; Austin, 2000; Mizrahi & Rosenthal, 2001; Mattessich et al., 2001; Wolff, 2001; Johnson et al., 2003; Ellen & Perrault, 2008

3.7 Policy of Researcher Collaboration Promotion between Academia and Industry

Given the higher educational policy of Thailand related to researcher collaboration between academia and industry, the Thai government with the cabinet has deployed policy to promote research collaboration between academia and industry through the Ministry of Education, which can be described as a key matter in educational development plan issue 12 (2017-2021) as following;

Regarding one of the educational missions of the Ministry of Education, they are willing to upgrade the quality and the standard of education in all levels. To serve and achieve this mission, three strategies have been scrupulously formed to support.

One of strategy is emphasized on builds and develops workforces as well as Research project by promoting research and innovation that able to utilize its in commercial viewpoint. By implementing this, it can be cascaded this strategy to the Office of the Higher Education Commission (OHEC). To consider the direction of Ministry's direction that promoting researches, OHEC has set the vision, which lead the development of Thai higher education by supporting higher education institution to be academic excellence, build ethic and quality of workforce, develop research and create body of knowledge to academic service to society and community. Then, this vision and policy also has been deployed to all higher education institutions or universities. Given the mentioned vision, mission and educational policy are linked with a new public service paradigm that describes a set of ideas as to the role of public administration in the governance system that places citizens at the center. Robert and Janet (2007) have pointed out that the key matters or principles of new public service are: 1) serving citizens2) seeking for the public interest, 3) focusing on citizenship over entrepreneurship, 4) thinking strategically, act seriously, 5) recognizing the accountability 6) serving rather than steering, and 7) rewarding the people. For the 4th item, think strategically act democratically, this principle encourages public organizations to initiate policies and programs meeting public needs that can be most effectively and responsibly achieved through collective efforts and collaborative processes. It could be concluded that new public service paradigm and principle guides the public organization to collaborate with private sector in the right manner and support the role that public administration in the governance system that places citizens at the center.

Additional, Regarding the World University Rankings 2015-2016 methodology, there are multiple elements in evaluating the performance of university such as teaching (the learning environment) Research (volume, income and reputation), Citations (research influence), International outlook (staff, students and published researches) and finally the Industry income (refer to the knowledge transfer). According to industry income, this dimension looks for the capableness of the academic institutions, where can support the industry with the innovations, the design and coaching. This category also seeks to capture such knowledge-transfer activity by looking at how much research income an institution earns from industry (adjusted for

public and private partnership or PPP), scaled against the number of academic staff it employs. This category of criteria also suggests the win-win approach as the businesses are intending to pay for research, while a university can attract funding from its capacity.

Moreover, an announcement of the Ministry of Education of Thailand also has defined the matter related to higher-education institution standards. It explains the missions of operational standards of higher education institutions that consist of sub-standard 4 dimensions are: 1) to groom the graduated students, 2) to produce the research, 3) to serve the academic service towards society, and 4) to preserve the arts and culture. To focus on the 3rd mission sub-standard, higher education institutions should deliver academic services to cover target groups in which specific both domestic and international such as consultant, research study to find out the answer to society and short training session provider, etc. This sub-standard of the mission called "academic service" can be provided in the form of free or commercial services that provide a return on sales or retrospective services so that come back to develop and improve to create new knowledge.

The previous studies that given from the higher educational policy of Thailand, the theory of new public service paradigm, World University Rankings and higher education institution standard that announced by Ministry of Education, they inspire the higher education institution to work with private sector in various channels. However, the mention is commented what is higher education institution should do? Apart from that the outcomes of this dissertation is aimed to model the collaboration between the HDD industry and academia might be beneficial to academic institutions in terms of applying the model in the right manner for enhancing the effectiveness of working with the private sector to meet the new public service paradigm.

CHAPTER 4

RESEARCH METHODOLOGY

This chapter covers the overall research design and method, the research procedure, the strategy and the research's multiple data collection and data analysis activities used to collect adequate data to cover all of the study's objectives and to answer the research questions. The methodology also includes the selection of the sample and the population, establishment of trustworthiness, etc.

4.1 Overview of Research Approach

In this study the main focus was on the phenomenon of the operational research collaboration between industry and academia, the case of the Hard Disk Drive Industry in Thailand, with particular reference to Western Digital Company. A Qualitative Approach was adopted by the researcher. The research design attempts to clarify the plan step by step to cover the research's objectives and questions. Yin (2014, p. 28) describes a research design as a logical plan for getting the initial set of questions, including the collection and analysis of relevant data. The study aims to review, describe, and explore the findings as mentioned in the research questions following:

1) What is the context of the operational research collaboration between the HDD industry (Western Digital Company) and academia in Thailand?

2) What are the important determinants that significantly affect the operational research collaboration effectiveness between the HDD industry and academia?

3) What is the model of operational research collaboration between the HDD Industry (Western Digital Company) and Academia?

4.2 Research Paradigm

This study intends to understand the social phenomenon the "operational research collaboration between industry and academia. It is a subjective approach where the researcher believes the reality to consist of people's subjective experiences of the external world; thus, this study has adopted an inter-subjective epistemology and the ontological belief that reality is socially constructed. Walsham (1993) suggested that in the analytical paper, there are no 'right' or 'wrong' principle. In addition, which side that should be applicable and preference. Myers (2009) also argued that the accessibility way of access the truth came from the social construct i.e. value, norm and language are given. While, Deetz (1996) added that to investigate the phenomenon, the approach is based on how perceptions of people they value and give a meaning to that things. This study is situated in the interpretivist paradigm because to the objective of this study is to understand and interpret the policymaker's, project manager's, coordinator's, and researcher's perspectives on the determinants that could impact the operational researcher collaboration effectiveness between industry and academia.

4.3 Research Strategy

According to the three mentioned research questions, three aspects are characterized the research strategy: qualitative, case study, and model proposing.

4.3.1 Qualitative Research

Silverman (2000) states that the suited path, which is selected between research approaches should depend on what the researcher is trying to find out, and to a lesser extent a preference for working in a particular research tradition, which in turn may well depend on familiarity with the disciplines associated with what is loosely termed "qualitative" or "quantitative,". Qualitative research is a board umbrella term that covers various range of techniques and philosophies, thus the definition of it is not easy. In broad terms, Hennink, Hutter, and Bailey (2011, pp. 8-9) suggested that qualitative research is an approach that examines people's

experience in detail, by applying a specific set of research methods such as in-depth interviews, focus group discussions, observation, content analysis, visual methods and biographies. Actually, qualitative approaches are typically used for providing an in-depth understanding of the research issues that embraces the perspectives of the study population and the context in which they live. Similarly, Denzin, and Lincoln (1994, p. 10) suggested that to apply the qualitative approach is persuaded the clear view of the lifelike. It intends to interpret things from the natural settings.

A suitable research approach for should acknowledge the complexity of social processes and focus on both context and specifics of operational research collaboration.

The researcher presumes that a qualitative approach is suitably applied to discover, describe, and holistic understand of processes and activities. The following list identifies some of the basic assumptions of a qualitative study linking them to a study of the operational research collaboration between the HDD industry and academia in Thailand:

Firstly, it is emergent designed. The research design cannot be completely determined in advance of the fieldwork. The data collection is evolved from the research process and analysis activities. However, this exploratory research is required the clear understanding what is emerge and what are activities to carry on.

Secondly, in view of a descriptive scheme, qualitative research emphasizes understanding and describing a phenomenon. Description includes a detailed account of the context, the activity, the participants and the process, and one of the research's objectives was to describe the operational research collaboration between the HDD industry and academia and to have that description assist in understanding it. Moreover, it uses the researcher as the primary instrument for data collection and analysis: Qualitative research supposes that data are mediated directly by the researcher rather than through questionnaires, surveys or other data collection instruments. In this study, the researcher collected data through examination of documentary evidence, in-depth interviews with key informants in operational research collaboration between industry and academia with reference to Western Digital Company, and observation of the operational research collaboration setting.

Thirdly, this approach type is primarily related with process. It focuses on processes and is interested in understanding and describing dynamic and complex

process. This study was concerned with "what" question about operational research collaboration between industry and academia, focusing on Western Digital Company, including: What is the current situation of the operational research collaboration between the HDD industry and academia in Thailand? What are the strengths and weaknesses of the operational research collaboration between the HDD industry and academia? And what are the important determinants that significantly affect the operational research collaboration effectiveness between the HDD industry and academia? The understanding of the important determinants led to the formation of the proposed model.

Fourthly, it involves fieldwork: Fieldwork implies that it has direct and personal contact with the people involved in a phenomenon and in the natural setting of the phenomenon. The researcher conducted field work with informants or participants involved in the operational research collaboration between the HDD industry and academia in Thailand in order to understand the phenomenon in its natural setting.

Lastly, the process of research is inductive: The qualitative research approach is exploratory and focuses on discovery. Neither test the hypotheses nor intend to test the generalizability or predictive power of the preliminary conceptual model, this paper applied various techniques by data collection and used a modified inductive analysis.

Linking the assumptions to the specific character of research demonstrates that a qualitative research approach was suitable for this study. The research on the collaboration between industry and academia required some techniques. Firstly, a holistic orientation to identify the complex of activity, entities, processes, forces, and their interrelationships. Secondly, to seek new directions in the way of collect data. Thirdly, participants are focused throughout fieldwork activities. Fourthly, the inductive process to find the grounds of the data. Therefore, the approach of qualitative is complemented and linked the strategic plan to reveal the findings.

4.3.2 Case Study

A case study approach arranges a mode of inquiry for an in-depth examination of phenomenon. Yin (2014, p. 16) described the scope of a case study that it helped

exploring the circumstance deeply and within world of nature context. Moreover, the borderline between phenomenon and context may not be clearly evident. Yin added that the "distinctive need" for case study research "arises out of the desire to understand complex social phenomena." Given that operational research collaboration between industry and academia is a complex social process comprising activities, entities, processes, and forces and their interrelationships, a case study design was warranted.

Case study research, while an appropriate research approach for studying the operational research collaboration between industry and academia as with the present study, was not without limitations and problems. A major limitation of a single-case study is the lack of statistical generalizability. This study did not have a goal of generalizability but one of understanding a complex phenomenon in research collaboration.

Given the boundaries of case study, Yin (1989) suggested that specific time boundaries need to define the beginning and end of the case. The boundary of this case study will be addressed two ways; first, the study covered the time period from the beginning of formal operational research collaboration between Western Digital Company with academia in 2012 through 2014 from the operational research collaboration effort responds to the needs of the organization. Second, the tentative conceptual framework or model introduced in Chapter 3 offers an initial logical bounding of the case. The framework for the supposed determinants of operational research collaboration effectiveness among industry and academia can be represented an open system as well as boundaries of components that are not clarion.

4.3.3 Model Proposing

The fourth aspect of the research's objective was that of model proposing. The tentative conceptual model introduced in Chapter 3 guided the initial stage of the research by identifying a framework for what was in the scope of the case as well as reflecting the researcher's previous experience and knowledge of Operation Research Collaboration between industry and academia (the case of Western Digital Company).

The model provided a sensitizing framework for approaching the topic of operational research collaboration. It did not drive the data collection as in traditional

hypothetical-deductive research. Instead, the model organized concepts such as the environment, communication, process or structure and characters of all parties in operational research collaboration that the researcher explored indirectly in the data collection. Patton (1990, pp. 228-216) mentioned, however, that the researcher "does not enter the field with a completely blank state" and that some way of organizing the complexity of reality is necessary." He adds that sensitizing concepts serve such a purpose by providing a "basic framework highlighting the importance of certain kinds of events, activities, and behaviors."

The study did not have a goal of developing a predictive model to generalization. Instead, the study was an exercise in developing a descriptive model that would adequately represent of operational research collaboration between industry and academia in this particular context. Wilson (1984, p. 8. suggested that a model may be prescriptive or illustrative, "but above all, it must be useful."

4.4 Study Design

The framework of systematic design should address the study's objective and questions. This section summarizes the study design, activities, and extent of the data resulting from the approach.

Table 4.1 Summary of the Research Method, the Research Procedure, and the Data Collection with the Research Instrument and Resulting Against the Research's Objective

Objectives	Data Categories	Techniques of Data Collecting	Outputs
To describe the context of operational research collaboration between the HDD industry and academia	Secondary/Primary source collecting	Related document, MOU, presentation, records and In-depth interview key informants, observations	Findings; a context of operational research collaboration between WD & Academia

Table 4.1 (Continued)

Objectives	Data Categories	Techniques of Data Collecting	Outputs
To explore the key determinants of effective operational between the HDD Industry and Academia	Secondary/Primary source collecting	Related document. MOU, presentation, records and In-depth interview key informants, Observations	Finding; key determinants of effective operational research collaboration between Industry and Academia
To propose the model of effective operational research collaboration between the HDD industry and Academia	Primary source	In-depth interview key informants, Observations	Findings; a model of operational research collaboration effectiveness between WD & Academia

4.5 Methods of the Data Collection and Source of Data

In order to identify a group of key informants, such as researchers, engineers, and key informants that would be most likely to have experience with operational research collaboration between the HDD industry (Western Digital Company) and academia, purposeful sampling (Creswell, 2003, p. 185) was utilized. Creswell noted that in qualitative research, "the intent is not to generalize to a population, but it is to develop an in-depth exploration of a central phenomenon," which is best achieved by using purposeful sampling strategies (2005, p. 203) to select the key informants.

4.5.1 Source of Data

The source of data in the study is key informants. Therefore, the criteria for informant selecting are discussed in this session.

The criteria for selecting key informants in this study were as follows:

1) Policymakers (VP/MD), Project Managers, Coordinators and Engineers of Western Digital Company that had direct experience in Operational Research Collaboration with Professors or Researchers from Academia. This group of key informants are working relate directly or direct experience to research collaboration program.

2) Professors or researchers that work in Academia (University or Government agencies) that has direct experience in operational research collaboration with Western Digital Company that demonstrated an accomplished research project per intended outcomes in the previous 3 years.

3) Dr. Vorapol Socatiyanurak, additional informant, Chairperson of the Research Startup Gap Fund Committee. This committee has been established to push up the research results that have been completed in laboratories of public universities or government agencies of Thailand to become products and services that are beneficial to the economy overall. So, he also has direct experience in driving collaboration between private and public sector.

Furthermore, regarding the scope of the study mentioned in Chapter 1, the selected case study of operational research collaboration between Western Digital Company and academia will cover both completed and ongoing projects during fiscal years 2013-2014 are presented in tables 4.2 and 4.3.

Table 4.2 List of Completed Operational Research Collaboration Projects in 2013 (Project Name, University & Researcher's Name)

No	Research Title	University	Researcher Name
1.	The IBE grid cleaning by chemical etching A preliminary study.	King Mougkut's University of Technology Thonburi (KMUTT)	Dr. Suppalak
2.	Magnetic recording head wafer Technology and Magnetic recording head Technology	Thumasart University (TU-RAC)	Dr. Benya Cherdhirunkorn

Table 4.2 (Continued)

No	Research Title	University	Researcher Name
3.	Floor tile damage prevention and minimization.	King Mougkut's University of Technology Ladkrabang (KMITL)	Dr.Siridech B.
4.	Neptune tester productivity optimization	King Mougkut's University of Technology Thonburi (KMUTT)	Dr.Charoen S.
5.	Development of Algorithm for Read-write Hard disk Head Inspection using Digital Image Processing Phase2	King Mougkut's University of Technology Ladkrabang (KMITL)	Dr.Manas S.
6.	Final Lapping Process Characterizations	Prince Songkla University (PSU)	Dr.Jessada Wannasin
7.	Research and Development of University cable Tester for Lapping Machine	King Mongkut's University of Technology North Bangkok (KMUTNB)	Dr.Chaiyod Pirak
8.	Vibration characterization for final lapping machine	National Electronics and Computer Technology Center (NECTEC)	Dr. Jittiwut Suwatthikul
9.	Row Bond Adhesive Characterization	Chulalongkorn University (CU)	Dr. Sukkaneste Tungasmita
10.	ASL Lapping Control Algorithm Development for Barbados	Kasetsart University (KU)	Dr. Yodyium Tipsuwan
11.	Design and Implementation of HSAs PZT External Test Module	King Mougkut's University of Technology Ladkrabang (KMITL)	Dr. Kasin and Dr.Kitiphol
12.	Auto Visual Inspection Software Development	National Electronics and Computer Technology Center (NECTEC)	Dr. Pished Bunnun

Table 4.2 (Continued)

No	Research Title	University	Researcher Name
13.	CO2 Cleaner Machine Noise Reduction	Chulalongkorn University (CU)	Aj. Wisit
14.	Framework Design and Development for Automation Machine	Prince Songkla University (PSU)	Dr. Thanate Khaorapapong
15.	HGA Automation re-layout using optimization technique	King Mongkut's University of Technology North Bangkok (KMUTNB)	Dr. Krisada Asawarungsaengkul
16.	ASL Lapping Machine Kinematic Modeling and Simulation Software	Mahidol University (MU)	Dr. Sujin Suwanna

Table 4.3 List of Ongoing Operational Research Collaboration in 2014

No	Research Title	University	Researcher Name
1.	Particle Liberation through Acceleration Technology(PLAT) using the Aerosol Time of Flight Mass Spectrometer (ATOFMS)	Khon Kaen University (KKU)	Dr.Choosak P.
2.	Slider Fab Loading Optimization Project	Khon Kaen University (KKU)	Dr.Kanchana S.
3.	Wiper characterization for final lapping process	King Mougkut's University of Technology Ladkrabang (KMITL)	Dr.Pornsawan Assawasaengrat
4.	Data Capturing System of Indirect Material parta (IDM) in a HDD Industry	Khon Kaen University (KKU)	Dr.Kanchana S.

Table 4.3 (Continued)

No	Research Title	University	Researcher Name
5.	Clean Room/Backend Process Mapping by Simulation for Backend Resource Utilization	King Mongkut's University of Technology North Bangkok (KMUTNB)	Dr.Athakorn
6.	ANFIS Backend Yield Prediction Model for KPI System	Thumasart University (TU-RAC)	Dr. Charturong Tantibundhit
7.	The Shape Optimization design of HAS base Plate in Ball Swaging process principal	Suranaree University of Technology (SUT)	Dr.Konton Chamiprasart
8.	Head Touchdown Detection using Piezoelectric Sensor	Mahanakorn University of Technology (MUT)	Dr.Veerachai Malyavej
9.	Vibration Compensation in HDD by using Active Noise Control System without TRC	King Mongkut's University of Technology North Bangkok (KMUTNB)	Dr.Witthawas Pongyart
10.	Prototype of Automated Guided Vehicle for Automatic Container Transport in WD factory	King Mongkut's University of Technology North Bangkok	Dr.Akkarat Boonpomga
11.	Lubricant for Final Lapping Characterization	Chulalongkorn University (CU)	Dr.Anongnat Somwangthanaroj
12.	The development of epoxy adhesive whose properties are suitable for head gimbals assembly process	Chulalongkorn University (CU)	Dr.Anongnat Somwangthanaroj
13.	WD Auto Bar Auditing and Mapping System	Institute of Field Robotics, King Mougkut's University of Technology Thonburi (KMUTT)	Dr.Pakorn Kaewtrakulpong

Table 4.3 (Continued)

No	Research Title	University	Researcher Name
14.	Mechanical characterization of Diamond Impregnation in Lapping Plate	Chulalongkorn University (CU)	Dr.Boonrat Lohwongwatana
15.	Investigation of key process parameters in Lapping and Grinding of Slider Fabrication (Lapping-Grinding Technology)	Chulalongkorn University (CU)	Dr.Boonrat Lohwongwatana
16.	HF-MFM Characterization of advanced write heads	Silpakorn University (SU)	Dr.Badin Damrongsak
17.	ACF Process and Rework Optimization	Kasetsart University (KU)	Dr.Chakapand Aramphongphan
18.	Auto Swage shuttle cleaning Project	Kasetsart University (KU)	Dr.Chana Raksiri
19.	Non ABS contact GL measurement	Kasetsart University (KU)	Assoc.prof.Prapaisri Sudasna Na Ayudthaya
20.	Monitoring Grinding force and Vibration during Precision Machining (Precision Machine Characterization)	Chulalongkorn University (CU)	Dr.Tachai Luangvanunt
21.	Simulation of Arm adjustment model	Design & Engineering Consulting Service Center (DECC)	Dr.Wiroj Limtrakarm
22.	ASL Lapping Control Development for Final Lap based on 38 Fingers with Curve Plate	Institute of Field Robotics, King Mougkut's University of Technology Thonburi (KMUTT)	Dr.Prakarnkiat Youngkong

Table 4.3 (Continued)

No	Research Title	University	Researcher Name
23.	Residual stress measurements in AlTic by XRDS and comparative study	Chulalongkorn University (CU)	Dr.Boonrat L
24.	Improve HGA loading for manual line	Kasetsart University (KU)	Dr.Anan Mungwattana
25.	Hydrothermal Corrosion of Alumina Produced by RF Sputtering: Causes and Prevention Strategies Project	Khon Kaen University (KKU)	Dr.Papot Jaroenapibal
26.	Alumina Corrosion in DI water	Chulalongkorn University (CU)	Dr.Varong Pavarajarn
27.	Serial Number Reading System of Row Tool and lts attached Slider Bar	Institute of Field Robotics, KMUTT	Dr.Pakorn Kaewtrakulpong

Source: Western Digital Company, 2015.

For this study, the sample of key informants and the case of the operational research collaboration project was selected by applying purposive selection, as described in Tables 4.4 and 4.5 as follows:

Table 4.4 Key Informants for Interviewing

Key Informants	Quantity	Proposed Selecting
Policy Maker		
- Managing Director	2	2
- Research collaboration Project Manager	1	1
- Research collaboration Project Coordinator	1	1

Source: Western Digital Company, 2015.

Table 4.5 List of Completed and Ongoing Operational Research Collaboration
Projects (Population and Sample)

Case & Key Informants	Quantities	Proposed Selecting
Completed Operational Research Collaboration Project in 2013	16 Projects	3 Projects
- Researchers	17 Researchers	3 Researchers
- Engineers	17 Engineers	3 Engineers
Ongoing Operational Research Collaboration Project in 2014	27 Projects	3 Projects
- Researchers	27 Researchers	3 Researchers
- Engineers	27 Engineers	3 Engineers

Source: Western Digital Company, 2015.

The case of operational research collaboration for this study will be proposed selecting 3-5 projects for each completed and ongoing project. The interview process will be completed as long as data/information are fully adequate according to the research questions.

4.6 Data Collection

The study used three techniques to collect the data:

1) Documentary evidence or documented information consisting of primary source material related to Operational Research Collaboration between industry and academia, in the case of Western Digital Company.

2) In-depth interviews with key informants that have had direct experience based on defined criteria in Operational Research Collaboration between Industry (Western Digital Company) and Academia and notes on the key contents of the interviews that cover all interview questions. In addition to taking notes, the researcher also did a voice recording to record all of the wording from the data and information from the key informants.

3) To conduct in operational research collaboration, some sample of ongoing operational research collaboration was observed by the researcher as a passive observer such as the event of meeting between professor and engineer or project manager. This was considered to be the best way to be not involved and to keep the researcher's distance from the subjects.

4.7 Data Analysis

As the researcher collected and processed the data, several procedures assisted in analyzing the data to ensure the credibility and dependability of the data and findings. The intention of data analysis is to reduce large amounts of collected data to make sense of them. Bernard (2000, p. 439) added that there are several approaches to do the data analysis, which refer the interpretive, narrative, discourse analysis, grounded theory analysis, content analysis, and cross-cultural analysis. In hermeneutics or interpretive analysis, the researcher "continually interpret(s) the words of those texts to understand their meaning and their directives." This study applied hermeneutics or interpretive analysis. Miles, Huberman, and Saldana (1994, p. 12) characterized qualitative data analysis in terms of three concurrent flows of activity: 1) data condensation, 2) data display, and 3) conclusion drawing/verification. This study also adopted the three flows of activity to analyze the data of all sources

based on the data collection method. Therefore, for adopting the data analysis theory as a framework, the researcher will take up for: 1) listening to voice recordings along with note reviewing; 2) transcription to paper to display the data; 3) condensing the key words and sentences; and 4) grouping content and writing contents.

4.8 Trustworthiness of the Study

Johnson (1997) and Newman and Benz (1998) have suggested in detail the issue of internal validity of qualitative research. They identified the various strategies that should be considered by researchers if they wish to enhance the internal validity of their studies such as: 1) Triangulation, 2) Prolonged engagement, 3) Member Checking, 4) Peer review, and so on. The methods to ensure the trustworthiness for this study are described as follows.

4.8.1 Triangulation

This involves the cross-checking of data/information from different dimensions. Data triangulation is when the researcher refers to different sources of data in understanding a particular phenomenon. For accomplishing this, researchers have to check the content of the data and information against documented information against the outcomes from the key informants interviewed and also check with key informants of difference groups.

4.8.2 Prolonged Engagement or Longer Periods of Time

Obviously, given the time and resources, researchers would like to remain in the field as long as possible collecting data to provide a more accurate picture of the phenomenon observed. With more than 10 years in the field, the trusting relationship is openly adopted among the researcher and the key informants such as policymakers, project managers, project coordinators as well as engineers who work in Research Collaboration project as a project owner.

4.9 Chapter Summary

This chapter has discussed and summarized how the researcher executed this study. The original proposal for this research identified the primary components of the study, including the research paradigm, research strategy, study design, method, data collection and analysis, and the Trustworthiness of the Study. The researcher used a multi-method approach in the study to address the complexity of operational research collaboration in the HDD industry in Thailand's context.

For accomplishing the original research's objective, the research strategy was appropriate but extremely challenging.

CHAPTER 5

RESULTS OF THE STUDY

5.1 Research Collaboration Landscape between Western Digital (Thailand), a BangPa-In Factory, with Academia

For reaching, assessing, and capturing the reality of the research collaboration phenomenon between industry and academia in the case of Western Digital (Thailand), the researcher reviewed and used various sources of data and information such as documented information in the form of working procedures, and a presentation package and memorandum of understanding (MOU). Additionally, in-depth interviews with key informants, policymakers, researchers, engineers and research collaboration project managers and coordinators were carried out as planned as well as prolonged observations made in the real setting of the research collaboration context.

5.1.1 General Background

Western Digital Company in Thailand, a Bangpa-In factory, is located in Bangpa-In industrial estate, in the BangPa-In district in Ayutthaya province. This location is one of the biggest Hard Disk Drive and Hard Disk Drive components manufacturing of the Western Digital Corporation while the second largest factory is located in Kualalumpur, Malaysia. In fiscal year's 2015 quarter 4 performance, the manufacturing report showed that 60 percent of the Hard Disk Drive Volume of Western Digital Company was about 21 million of Hard Disk Drives, which were assembled and shipped out to the global market from the BangPa-in factor.

Given the research collaboration between Western Digital (Thailand) BangPa-in factory and Academia, this program was launched in 2005 as indicated in the following: "We have started this program last 8 years ago since former Vice President

still led this operations," stated WD Policymaker 1. At the beginning of the program, during 2005 to 2007, the research collaboration program was focused on some problems that the area owner might not have been able to fix by himself due to a lack of knowledge and manpower at that time. At that stage, the emerging of this collaboration phenomenon is diversified in organization generally. Then, the management of Western Digital (Thailand) had signed the agreement with National Electronics and Computer Technology Center (NECTEC) in 2008. The main purpose for this agreement was to enhance the potential of Hard Disk Drive Cluster development in Thailand.

Under that agreement, Western Digital (Thailand) and NECTEC agreed to push the effort together to send 15 researchers, at the doctoral level in various disciplines that applied to participate in this program, from various universities and government agencies in Thailand, to the design center of Western Digital headquarters in the United State for 18 months to learn about various areas of Hard Disk Drive design.

At first, the primary intention for executing this program was to transfer the Hard Disk Drive advanced technology to Thailand's operations but this program was not continually succeed because to the policy and direction of headquarters changed. However, 15 researchers from Thailand gained a value-directed experience working with this high technology company in its design center.

Table 5.1 Disciplines of Advanced Technology and Quantity of Researchers that Participated in the Advanced Technology Transfer Program During 2008-2012

Disciplines of Technology	Researchers
Metrology	3
Machine Design	1
Product Design	1
Process Design	4
Reliability	1

Table 5.1 (Continued)

Disciplines of Technology	Researchers
Chemical Analysis	2
Material Analysis	3
Servo control	4
Total	**19**

Source: Western Digital Company, 2015.

After the program sending 19 researchers to the United State closed, the new approach of operational research collaboration policy between Western Digital (Thailand) Bang Pa-In Factory that was led by WD Policy Maker 1. "I stop thinking to send Researchers to United State anymore but I still concern about challenges both internal and external issues that we are facing to drive Western Digital Thailand operations to the future. We are quite slow to capture some changes both process and product technology that impacting to manufacturing capability to achieve factory's mission to produce superior quality of Hard Disk Drive product, delivery on time with lowest cost," he said.

Another informant just said "Look into our operations that we have 200 design and development engineers incorporate working with 30-40 front-line engineers and also we have a thousand of researchers in universities and government agencies such as a National Science and Technology Development Agency (NSTDA), if we are able to utilize those groups of capable people, then it should be beneficial to overall Hard Disk Drive industry in Thailand and Western Digital (Thailand) BangPa-In factory,"

Then, Western Digital (Thailand), at the BangPa-In factory, launched officially Operational Research Collaboration with academia to answer the needs or challenges of its operations. At the first stage of the proposal, WD Policymaker 1 stated that "I ask the team to address the issue or the problem that they are facing in shop-floor and invite (Open House) the researchers from university to visit and review those issues or problem together with our engineers who are owned the issue." Then, the research collaboration process began. Similarly with Project Manager or

Coordinator 2, he said that "the starting point of research collaboration program is raised when Engineers in front-line facing with any issues, topics or problems that they are unable to fix it by themselves" caused from a lack or limit of knowledge of those issues. Then, they contacted the Research Collaboration (RC) Department to review the needs and expectations together to find out an appropriate researcher on the researcher name list or in networking that had the discipline, background of education, and experience matching those specific topics.

At the beginning stage of the research collaboration program, the research paradigm tended to emphasize "quick fix" solutions rather than try to understand the fundamental or basic sciences related to the contexts of Western Digital's (Thailand) operations in which Hard Disk Drive manufacturing is the core business and function. "We emphasize on quick fix solution and focus on efficiency in any research collaboration projects and we also emphasize short-term perspective rather than long-term point of view" WD Policymaker 1 stated. However, a quick fix solution was clearly not the answer needed for its operations in long run. Then, the paradigm of research collaboration between Western Digital Company in the BangPa-In factory shifted to researching the knowledge of fundamental or basic sciences in its manufacturing context. Basically, engineers that work in the manufacturing context are practitioners that specialize in "know-how" while lecturers or researchers in academia re a scholars with expertise in "know-why." A research collaboration project is a channel to transfer knowledge and experience between both groups of people. "The limitation of engineers in term of fundamental or basic sciences in deep knowledge will be solved by research collaboration program," Policymaker 1 said. By this approach, company by senior leaders expected that it will lead to increased organizational capability in the long run in terms of knowledge utilization for achieving the organization's intended goals such as Quality, Cost, Productivity, and so on.
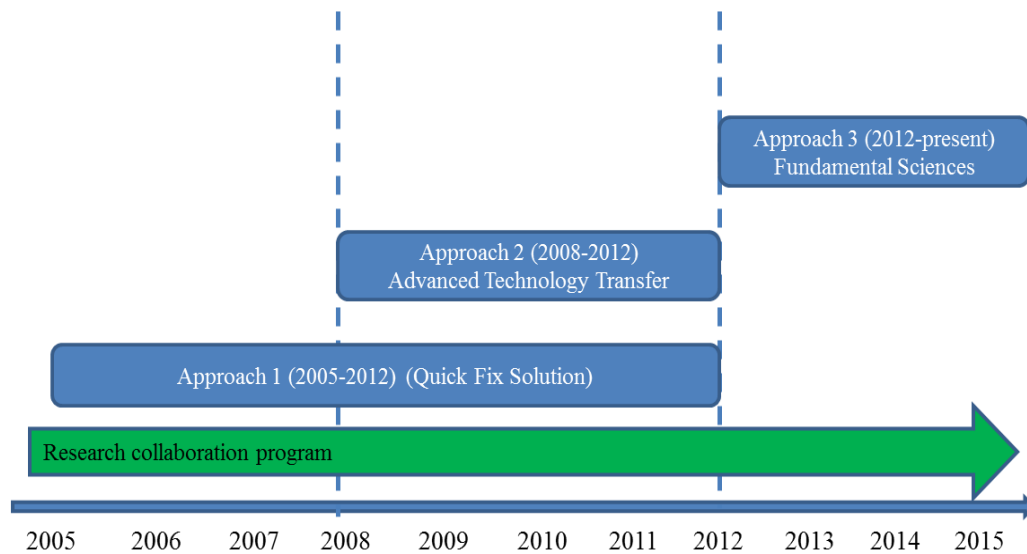
Figure 5.1 Approach of the Research Collaboration Program of WD

Table 5.2 The Paradigm Shifted Research Collaboration between Western Digital
(Thailand) BangPa-In Factory with Academia

Key Features	Approach 1 (2005-2012)	Approach 2 (2008-2012)	Approach 3 (2012-present)
Purpose	• Quick-Fix Solution	• Advanced Technology transfer from headquarter (R&D Center)	• Fundamental or basic sciences research
Time frame of program	4-6 months (short-term project)	2 years and 9 months	1-2 years (Long term project)
Key Players	• Researcher & Engineer	• Researcher (Doctoral level from various universities)	• Researcher & Engineer

5.1.2 Sources of Funds for the Research Collaboration Program Co-Funding Versus one Hundred Percent Funding by Western Digital

Regarding the source of funds to support the research collaboration program between Western Digital (Thailand) BangPa-in Factory with academia, there two approaches were applied. The first one was "co-funding" with external organizations such as government agencies under the Ministry of Science and Technology. The second was 100 percent funding by the company. However, the company can face with the issue of the law related to the right of intellectual property (IP) sharing. It is a difficult to handle and make agreement with external organization especially government agency in terms of the right of intellectual property and IP sharing by using the co-funding program. "In order to make sure that any happened IPs is owned by the company, so the 100 percent funding by company is the policy that we are adopted," stated by Research Collaboration Project Manager/Coordinator 2.

5.1.3 An important of Operational Research Collaboration between Western Digital with Academia

The viewpoint of the important of research collaboration program between WD with academia will be described in terms of benefits or value in various dimensions from all parties' perspectives summarized from primary and secondary data.

5.1.3.1 Organizational Level

Close the gap of theoretical limitations and workforce shortages

Research collaboration between industry and academia is one of the channels to make a connectivity between the practical and theoretical world. Engineers that work in the industry are practitioners that deal with day-to-day activities, especially problem solving. All of them are hands-on and tend to utilize their experience with a limitation of theoretical perspective to solve the problem. Therefore, the effectiveness of problem solving or improving in their area is not too high. Some problems might recur even if those problems are fixed. Moreover, the workload of engineers is quite high due to a limitation of manpower that can lead to a limitation of time for fixing the problem or improvement in their area. The scholars or lecturers in academia as researchers are expert in fundamental theory in their field. The matching between

both of them will be beneficial for the company's efficiency and effectiveness enhancement of problem solving and also performance improvement.

Another point of views, HDD industry is a technological intensive industry that the organization need to acquire more competent workforce from both internal and external organization. Research collaboration is a channel that allows the organization to acquire a competent workforce from academia as mentioned by Policymaker 2:

> For technology point of view, our engineers' capability is not covered all elements of knowledge that related to HDD manufacturing process so that why we need supporting from external researcher or lecturer from academia to help us.

Research Collaboration coordinator 1, a staff engineer that worked for the Research Collaboration Organization of WD and had 3 years' experience as a process engineer and 2 years in the role of research collaboration coordinator, also mentioned how important operational research collaboration is to the WD organization. From his viewpoint, the research collaboration with academia enables the organization's performance development by acquiring external knowledge and transferring this to engineers and also privileges the organization to utilize a competent external workforce, and published researches, to close the gap and overcome competent workforce shortages as well.

1) An Economic Benefit

In addition to the company gaining effectiveness in problem solving and improving in specific areas as well as relieving the manpower limitations mentioned above, based on empirical data the company also gained in terms of financial perspective more than 800 million baht as of 2015, which reflected the contribution from the research collaboration project in a form of return of investment (ROI). Moreover, the statement issued in the investment policy by the Board of Investment of Thailand (BOI) condition is also influence the company to accelerate the research collaboration program. According to the BOI's incentive program to promote investment in Thailand, one condition that focus on motivating the company

is to collaborate with other organizations both public or private organizations in research project by raising the Skill, Technology and Innovation (STI) scheme. This policy that intended to increase the reputation of the company is to develop local skills, and technology and innovation, by obtaining additional rights and benefits for the investment if the company's expenditure in develop skills, technology and innovation for the corporate income tax exemption and exempted from import duty on machinery. "If we spend 500 billion baht to research collaboration project in 11 years timeframe, then we will obtain an additional rights in the corporate income tax exemption for 8 years beside on existing right that we have," the Director of finance said.

2) Academia's, the Faculty's, and University's Point of View

University's Mission Aligning "An academic service to society". A research collaboration program is an opportunity that allow the university's complete one of its mission. While, a generic mission of academic organization especial public university is to provide an "academic service" to society. This mission also cascades to lecturers or researchers in the university as well. The interaction between both is able to demonstrate "academic service" objectively for university point of view because lecturers or researchers are directly able to deliver their academic capability to contribute to research collaboration success.

3) Financial Benefit

In addition to the benefits mentioned above, faculty or university that they are made a research collaboration agreement or contract and their lecture or researcher have participated the research collaboration program with Western Digital Company, they also gains a financial benefit as well. The earnings that were gained from the research collaboration program also will be paid back to the university. "Some of amount of earnings about 15 percent will be contributed to university that it's a normal practice for traditional public university," Researcher 2 stated.

4) Opportunity for Master and Ph.D. Student Admission

The setting of research collaboration is a chance for interaction between researchers from the university and the experienced engineers of Western Digital Company. The university has an opportunity to promote the curricula in their

faculties with those engineers. Simultaneously, Western Digital Company also has implemented scholarship programs for their engineers to enroll in and study any engineering and sciences fields that match the company core business to enhance the engineers' skill and knowledge. Many universities take this advantage to invite experienced engineers to enroll and study in their various faculties (both master and Ph.D. level) that match the interests of their engineers. Based on empirical data, there are more than 3 students that applied to the Ph.D. program and 10 students that applied for a master degree once they were invited to enroll by a lecturer or researcher from various universities.

5) Opportunity to Train Student in the Real case study in the field

In the contract of research collaboration, there are open opportunities for researchers or lecturers to bring students from their university to join the program as researcher assistants. The main task of a researcher assistant is to support the researcher in data collection in the manufacturing shop floor and to do some paper work. The researcher also utilizes the researcher assistant to participate in setting area as well as let him getting a feedback of information to the researcher when they found any changes in the setting. This activity supports the university to develop the skills and knowledge of their students in the right manner that relate to the quality of the student. Since the research collaboration program between universities and Western Digital Company was launched in 2005 and continued until 2015, more than 500 students from universities in various fields and majors in engineering and the sciences have participated in this program as a researcher assistant. "There are a lot of opportunities of our students to learn the real case and working environment in the industrial world is facing currently," said Researcher 1. Additionally, researcher 2 also said the following: "I really delighted that the company very supportive toward educational stand point, the company accepts all conditions that we propose to nominate the student to involve research project as a researcher assistant in the project proposal." He also described more: "We propose to have 2 bachelor, 1 master, and 1 Ph.D. student as members of the research team as a researcher's assistant, and all of them were approved".

6) Source of Input for Curriculum Development

In normal practice, any curricula of any fields in any faculties of the university need to be reviewed and revised periodically. Various sources of data and information are needed as an input for any curriculums development. The input from the real world of the practitioner in the industry is very important information besides other sources for curriculum development. Lecturers as researchers are able to receive data and information directly on what is the movement of knowledge in the current and future applicable to the industrial world in their field and get back to their faculties. Then, they are able to review the curriculum so that it aligns with those movements. This means that the university is able to utilize or take advantage of research collaboration programs with industry as a feedback mechanism or system for their curriculum development. Researcher 3 stated the following: "We are looking for a movement in the industry real sector especial Physics' application in the field to be an input for our curriculum development."

5.1.3.2 Individual Level

1) Researchers and Engineers Benefits

Engineers and researchers are able to learn from each other. The researcher learns the practical know-how of the manufacturing context from engineers while engineers learn know-why or theory from researchers or lecturers, which means that there is a knowledge spillover happening among all stakeholders from this activity. Therefore, the raising of research collaboration programs is the right thing to do to fill the gap of theoretical lack and to relieve the manpower limitations or shortages. The engineers of the company and researchers from academia work together to achieve mutual-intended goals. This interaction creates an environment that enhances tacit knowledge transfer or spillover between both of them. This phenomenon happens in the surroundings of the operational research collaboration program in the context of Western Digital (Thailand), in the BangPa-In factory.

2) Benefit to Engineer as an Individual

One of the key roles and responsibilities of the engineer in the company is to solve and fix any problem in his/her responsible area or function. In the situation where there is a limitation of a competent workforce and there are shortages,

research collaboration projects are able to close that gap by helping engineers to solve and fix problems according to their primary role and responsibility, which means that the research collaboration project helps them to achieve their key performance indicator (KPI) as well. Engineers that take responsibility for a research collaboration project are also able to obtain credit from the project achievement in general, and this impacts their performance and career path finally.

3) Benefit to Researcher as an Individual

Financial Benefit

Basically, lecturers or researchers that participate in research collaboration projects earn compensation in terms of financial incentives as well. In the contract, agreement has clearly identified how much the company shall pay for any research collaboration single project.

Besides gaining financial benefit, lecturers as researchers also are able to acquire or harvest new knowledge around the research topic. They can also share that knowledge with their students in the classroom when they have to lecture on the subject that related to those topics.

5.1.4 Key Players in the Operational Research Collaboration between WD and Academia

The operational research collaboration between industry and academia (the case of the HDD industry, Western Digital Company) could not take place without the stakeholders from university and Western Digital Company.

The key players of research collaboration are the group of professionals, policymaker, engineers, project managers or coordinators and lecturers or researchers that work in the HDD industry and academia. They are committed to working together to carry out operational research collaboration per the memorandum of understanding and contract agreement of both collaborating organizations.

1) Research Collaboration Manager or Coordinator

The Research Collaboration (RC) Manager or Coordinator is an official position that is assigned nd appointed by Western Digital Company to drive the program. He or she works for the Research Collaboration Department that is responsible for the research collaboration program. He or she matches the needs or

problems of engineers with qualified researchers in their network. The first appointment and meeting between the engineer and researcher is to discuss of seeking the innovation.

These professionals also carry out all administrative work and facilities as project coordinators from the beginning until the completion of the research collaboration projects. It is remarkable that the research collaboration manager or coordinator is a very key player in driving the project to achieve the intended goals from both an efficiency and effectiveness point of view. RC Manager 1, who has been working for Western Digital in this function for more than 3 years, said that "[his] function is a center of connectivity to match between qualified researchers and engineers who have an issue or problem in their area." Therefore, it is said that the research collaboration manager is one of the key players to drive operational research collaboration progress at the beginning stage in Western Digital Company's context.

2) Researcher or Lecturer

The researcher or lecturer is the group of professional field who work in the university as an academic specialized in various disciplines, sciences and applied sciences, especially the engineering area. The researchers come over HDD industry, Western Digital Company, through various channels and situations. Many researchers were approached by the RC manager or coordinator as a company representative in a network of collaboration with academia. Some researchers were recommended by another researcher who has an acquaint relationship as a friend to on board.

In the case of researcher 2, his friend, researcher 1, visited him at the university that located proximity the route to Western Digital as well as have some common discussion for the topic of mathematics matter. After that researcher 2 had a chance to participate in a research collaboration program between academia and the HDD industry as an advisor at the beginning. After that he became a project leader for the new research topic once he got to know the RC manager or coordinator of the research collaboration department of Western Digital Company.

3) Engineer

Engineers are a group of professionals that work for Western Digital Company in various departments. They have various educational backgrounds in the engineering field and experience. Mainly, they are responsible for supporting the

manufacturing process in terms of all technical issues and manage the HDD production in the right manner.

For the research collaboration program, the engineers in all functions in any departments of Western Digital Company are encouraged to participate in this program. Once they do so, they will become a project owner or key player to work closely with the researcher from university, who is searched and matched or paired by the RC manager.

5.1.5 Operational Research Collaboration Process in the Context of Western Digital (Thailand), Bangpa-In Factory

All research collaboration projects will be started by engineers and their supervisor as a project owner. In the day-to-day activity, engineers encounter challenging issues or problems in their function, roles, and responsibility as well work surroundings. Once the problems are clearly determined and they decide to take advantage of the research collaboration program to tackle that issue, then the operational research collaboration is begun and it moves forward following the process.

5.1.5.1 Project Formation and Planning

The project forming will begin when the engineer as a project requester/owner defines the problem and discusses that issue with his/her supervisor and RC manager or coordinator. Once the problem is clarified sufficiently, the RC Manager or Coordinator will search for and match a qualified researcher on the network list.

Then, a preliminary discussion between the 3 parties, which consist of project owner, RC manager or coordinator, and researcher begins. Once the preliminary agreement among the project owner, researcher and RC manager or coordinator is made, the project is defined and matched with the researcher's experience and expertise, and then the beginning of the research collaboration project is formed and it moves to the next step, where there as at less 3 steps as described in the following.

1) Objective of project is need for a clarity, in this step, all parties that are related to the project will work together to define the reason and

answer the question why this research collaboration project exists and what the benefit to the organization is in terms of the financial perspective.

2) Project charter and proposal, the engineer as a project requester will work closely with the researcher to raise a project charter and proposal. These are clearly described and consist of a research collaboration project overview, project duration, methodology and approach, team members of project establishment, project deliverables, project milestone, budget and expected benefit in terms of return of investment (ROI).

3) Research project agreement, in this step, the research collaboration manager is a key person that words with the researcher to review carefully legal perspective, terms of payment and also to define authorized persons for approval. It reveals that there is agreed for Non-Disclosure Agreement (NDA) between Western Digital Company and researcher and/or the university's representative.

5.1.5.2 Project Execution

The project execution is a very important step for transforming the plan into activities and delivering the results compare to the research objectives. The researcher will become a key player that works closely with the engineer as a project owner in order to create progress for each research project. Besides the two groups of key players as mentioned, there also have a student either bachelor or master or doctorate degree as researcher's assistance is a part of execution team to make the research project progress. According to Researcher 2,

> We utilize students to embed themselves in the research field almost 5 days a week in order to interact with engineer and people in production line to collect needed data and feedback it back to us in real time in order to avoid un-informed information in any changes that could affect to research project.

At the same time, the RC Manager or Coordinator is implied as a key influencer to support the research project as project administrator and coordinator during project execution. The major steps of research project execution are described as follows.

1) Project Kick-Off Meeting

RC Manager or coordinator will be a host or organizer of the "orientation meeting." The intent of the meeting is to explain and remind the role and responsibility of each function, the RC manager, the researcher and engineer or project owner as well as to explain the steps in executing the research project completion. It represents the official start of research project execution. The orientation meeting allows all research project stakeholders to dialogue and exchange some ideas toward the research project as a beginning. If the researcher is participating for the first time, he or she also takes this opportunity to meet and introduce him/herself to the members and department head of the project owner. The orientation meeting normally is a greeting time among the research project stakeholders. All of them also utilize this event for creating a communication channel for more convenient contact in the right way.

2) Project Progress Monitoring

For this step, the RC manager is a person in charge that works closely with engineers as a project owner and researcher to track the progress of each individual research project. A meeting among the research project stakeholders is a popular mechanism to review the progress of the project versus the plan. It will be carried out per agreed appointments and detailed agenda. In the meeting sometimes there are invited heads of departments or the engineer's manager and other representatives from related departments to attend the meeting in order to acknowledge what is going on regarding the research project in their area. Students or the researcher's assistant also will be invited to attend a meeting to support the researcher. In some cases, the researcher will authorize a student to present the progress of the research project. In the meeting circumstances, the stakeholders of the research project will discuss the surroundings of the research project. The scope of the research project should be brought back to review in some case that the original scope is not fit with existing situation caused from the change in Operations. Moreover, the project risk is taken to discuss among research project stakeholders to address on what could be obstructed to the project achievement per intended goal. The researcher is a person in charge of providing the progress report in documented form as needed for both administrative purposes and as objective evidence to track the progress officially.

3) Project Completion

Once any project is carried out until finished by the researcher and project owner, it is the responsibility of the RC manager to make an appointment to gather all stakeholders for an official meeting to review and validate the project completion. The main focus point regarding the project completion meeting is to review the results of the research project versus the intended goals and objectives as described in the research project proposal. The researcher is a key person in the a meeting who presents the results and outcomes of the research project to the stakeholders. Besides the research findings that will be highlighted, there is also opportunity for audience discussion and for asking questions in order to further clarify any points. Suggestions or recommendations might be raised by stakeholders to enhance some points of the research project. Furthermore, a completed report of the research project will be made by the researcher in a documented form for administrative purposes by sending both a hard copy and digital file to the RC manager and engineer as project owners.

5.1.5.3 Project Closure

The step of project closure will be made once the project owner has received a completed report of the research project from the researcher. The engineer as a project owner is the person in charge of evaluating the output and outcome of the research project against the research objectives through empirical evidence resulting from the research project. Once the results and all research objectives are met, project closure can be made and approved officially by the project owner. In addition, whether the project fails or is successful, the project owner also works with the researcher to determine and highlight the lessons learned and the success factors for all stakeholders and upper supervisors.
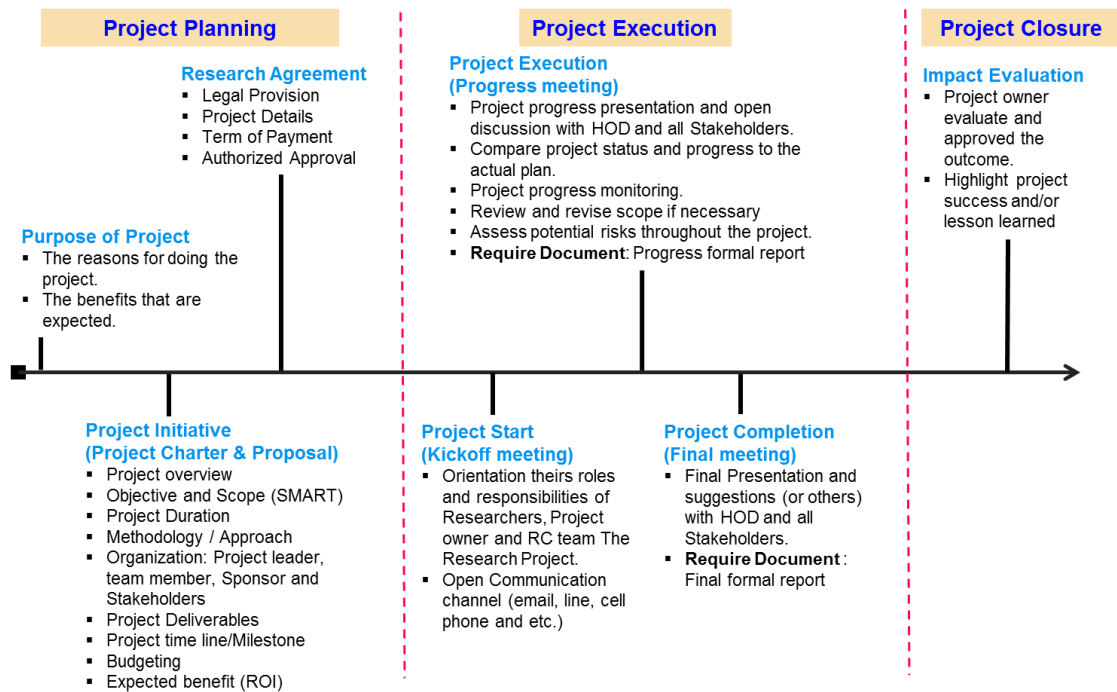
Figure 5.2 Steps in the Research Collaboration Project from Project Planning to Project Closure

5.2 The Key Determinants of Effective Operational Research Collaboration between the HDD Industry and Academia

From the study, the definition of operational research collaboration effectiveness is referred to the result of operational research collaboration that can be accomplished within agreed time frame. The definition of achievement or success is measured by the specific operational research's objective according planed resources per the industry or the company's viewpoint. The research collaboration between Western Digital and university itself is an interaction between professionals, researchers and engineers, to achieve intended goals and objectives (goal attainment) under the direction and policy of the two organizations. For running the project as a journey from start to finish, the keys determinants of effective operational researcher collaboration can be described based on the viewpoint of the key informants, policymakers, RC Manager, Researchers and Engineers, according to the following details.

5.2.1 Clear Scope, Goals, and Objectives

The clear scope, goals, and objectives of each research collaboration project are among the key factors affecting the effectiveness of operational research collaboration between universities and Western Digital Company. Goals and objectives are like a compass to determine the direction of each research collaboration project as to what was intended to achieve. A specific or clear scope and goals and objectives in each research collaboration project are defined in the project proposal and agreement by mutual agreement between the project owner and researcher. The good scope of work must be clear and measurable. While, the goals and objectives in quantitative perspective, might be aligned to the theme of quality, productivity and cost improvement that contributing from research collaboration project achievement. Engineer 1 stated that "the question of research collaboration must be clear, unambiguous and measureable." This is the same as a statement by RC Manager 2, who said that "before any research collaboration project will be started, the goal and objective must be clear and measureable."

Moreover, stated by the Engineer 3 that "in order to prevent misleading of the research topic, scope, goal and objective must be cleared before project start,". This is similar to an idea of Researcher 4, who also said that "clear scope, goal and objective are a critical point that affecting to effectiveness of research collaboration project, it's a direction to let us know where we are going to." For instance, Project Charter Number RA-H-201211-01, the Research Project Name—CO2 Cleaning Machine Noise Reduction, has been defined the objective to reduce noise level at all auto CO2 cleaning machine to less than 85 dBA.

5.2.2 Win-Win Situation (Mutual Benefit) among Stakeholders

The win-win phenomenon is a situation where mutual benefits, both official and unofficial, exist among stakeholders of research collaboration projects at organizational and individual levels through defining a clear contract, roles, responsibility, and involvement and interests. The determinant of the win-win situation among stakeholders could be described based on an empirical data and the viewpoint of key informants.

An official win-win agreement was formally agreed and documented, and all research collaboration projects are defined as the win-win agreement through the Project Charter and Research Agreement between researchers with the company's representative. The key benefits of the company will be defined in the form of project deliverables and expected benefits in terms of the return of investment, while the win or the benefit of the university and researcher will be defined a financial benefit in the form of payment terms for each millstone of the research project achievement. "We expect to gain in both tangible and intangible outcomes from research collaboration project," Policymaker 1 said. The earning amount of the university and researcher depends on the research objective, scope, and complexity of each research topic that will be described in the Project Proposal and Research Agreement. A win-win agreement tends to emphasize the objective that are definable from a quantitative viewpoint such as percentage of Productivity and Quality improvement for the wining of the company while the wining of the university will be financial earning.

Besides an official win-win agreement, the research collaboration between Western Digital Company with universities also created a situation in which all stakeholders earned other benefits both at organizational and individual levels.

Win-win situations in which mutual benefits both official and unofficial exist among stakeholders that could be described as follows.

Organizational Level

5.2.2.1 Western Digital Company

1) Close the Gap of theoretical Limitation and Workforce Shortage

The research collaboration between industry and academia is one of the channels to create connectivity between the practical and theoretical world. Engineers that work in the industry are practitioners that deal with day-to day-activities, especially problem solving. All of them are hands-on and tend to utilize their experience with a limitation of theoretical-lacking perspective to fix the problems. Therefore, the effectiveness of problem solving or improving in their area is not highly effective. Moreover, the workload of engineers is quite high due to a limitation of manpower, which leads to a limitation of time for fixing the problems or making improvements in their area. The scholars or lecturers in academia researchers

are expert in the fundamental theory in their field. The matching between both of them will be beneficial to the company's efficiency and effectiveness enhancement of problem solving and also performance improvement.

In others perspectives, the HDD industry is a technological-intensive industry where the organization needs to acquire a more competent workforce from both internal and external organizations. Research collaboration is a channel in that allows the organization to acquire a competent workforce from academia, as mentioned by policymaker 2 in the following:

> For technology point of view, our engineers' capability is not covered all elements of knowledge that related to HDD manufacturing process so that why we need supporting from external researcher or lecturer from academia to help us.

The research Collaboration coordinator 1, a staff engineer who has worked for a research collaboration organization of WD with 3 years as a process engineer and 2 years in the role of research collaboration coordinator, has also mentioned that operational research collaboration is so important to the WD organization. For his viewpoint, the research collaboration with academia enables the organization's performance development by acquiring external knowledge and transferring this to engineers and also allows the organization to utilize an externally-competent workforce, lecturer or researcher, to close the gap and overcome the competent workforce shortage as well.

2) An Economic Benefit

In addition to the company gaining effectiveness in problem solving and improving in specific areas as well as relieving manpower limitations, as mentioned above, based on empirical data the company has also gained in terms of the financial perspective more than 800 million baht as of 2015 that reflected a contribution from the research collaboration project in the form of return of investment. Moreover, the condition of investment policy by Board of Investment of Thailand (BOI) has forced the company to raise the research collaboration program. According to the BOI's incentive program to promote investment in Thailand, one

condition that intended to motivate the company to collaborate with other organizations both public and private in the research project is to step up the Skill, Technology and Innovation (STI) scheme. This policy is intended to increase the incentive of the company to develop local skills and technology and innovation by obtaining additional rights and benefits for the investment if the company's expenditure in developing skills, technology, and innovation for are exempted from import duty on machinery. As the director of finance stated, "if we spend 500 billion baht to research collaboration project in 11 years timeframe, then we will obtain an additional rights in the corporate income tax exemption for 8 years beside on existing right that we have."

5.2.2.2 Faculty or University Point of View

1) University's Mission Aligning "An academic service to society"

The research collaboration program is an opportunity to fulfill the university's mission, and one of the generic missions of an academic organization, especially of the public university, is to provide an "academic service" to society. This mission also cascades to lecturers or researchers in the university as well. The interaction between both of them is able to demonstrate as an "academic service" objectively from the university's point of view because the lecturer or researcher is directly able to deliver his or her academic capability to contribute to research collaboration success. Like the mentioned by Research 2, "We have met and discussed among lecturers in our faculty to improve a specialty in our fields that it's beneficial to faculty in order to serve society thru research collaboration with industry,"

2) Financial Benefits

Besides the benefits mentioned above, Faculty or University that made a research collaboration agreement or contract, their lecture or researcher must be involved the research collaboration program with Western Digital Company, they also gain a financial benefit as well. The earnings that are contributed from the research collaboration program also will be paid back to the university. "Some of amount of earnings about 15 percent will be contributed to university that it's a normal practice for traditional public university," Researcher 2 stated.

3) Opportunity for Graduated Student Admission

The setting of research collaboration is a chance for the interaction between researchers from the university and experienced engineers. The university has an opportunity to promote the curricula in their faculties to those engineers. Simultaneously, Western Digital Company also has implemented the scholarship program to acquire any engineering and science fields that match with the company's core business as well as to enhance the student's skill and knowledge. Many universities take advantage of this to invite experienced engineers to enroll and study in their various faculties (both master and Ph.D. levels) that match the interest of engineers. Based on empirical data, there are more than 3 students that applied to Ph.D. program and 10 students that applied to the master degree once they were invited to enroll by the lecturer or researcher from the universities. As an example of this case, Researcher 8 stated that "2 Engineers from Western Digital Company have applied and enrolled to our Faculty to study a master degree level that it's a consequence of research collaboration project with HDD industry".

4) Opportunity to train students in the real case study in the field

In the contract of research collaboration, there are open opportunities for researchers or lecturers to have students from their universities join the program as researcher assistants. The main task of the researcher assistant is to support the researcher in data collecting on the manufacturing shop floor and to do some paper work. The researcher also utilizes and assigns the researcher assistant to engage in the research setting and giving feedback information to the researcher, when any changes or deviations are found in the setting. These tasks support the university in developing the skills and knowledge of their students in the right manner and is also related to the quality of the students. The research program between universities and Western Digital Company had collaborated since 2005, until 2015 more than 500 students from universities in various majors of engineering and sciences had participated in this program as a researcher assistant: "There are a lot of opportunities of our students to learn the real case and under the working environment of the industrial world currently," Research 1 said. Additionally, Researcher 2 also stated the following: "I really delighted that the company is very supportive toward

educational stand point, it accepts all conditions that we have proposed to nominate the student to involve research project as a researcher assistant in the project proposal." He also discussed this issue further: "We propose getting 2 Bachelors, 1 Master, and 1 Doctoral degree students as the researcher's assistant, and all of them were approved by the company."

Similarly, Researcher 3 also said the following: "I bring my 11 students to get involve with research collaboration project as a researcher assistant as a part of teaching and studying process." This is the same as what Researcher 4 indicated: "I take an advantage to bring many of my students to join the researcher collaboration project as Assistant Researcher and let them know how Physics be applied to the industry".

Regarding the University's point of view, it gets the opportunity to train its student to gain direct experience from real work as Researcher Assistant because Western Digital Company allows pulling in the student to onboard as Researcher resistant with an appropriate number in each project. "Our student is received a direct experience as a Researcher assistant from research collaboration project," Researcher 8 said.

5) Source of input for curriculum development

In normal practice, any curriculum of any field in any faculty of the university needs to be reviewed and revised periodically. There are needed various sources of data and information as an input for any curriculums development. The input from the real world of the practitioner in the industry is very important information besides other sources for curriculum development. Lecturers as researchers are able to receive data and information directly on what is the movement of knowledge in the current and future applicable to the industrial world in their field and to take it back to their faculties. Then, they are able to review the curriculum so that it is aligned with those movements. This means that university is able to utilize or take advantage of the research collaboration program with industry as one of the feedback mechanisms or systems for their curriculum development. According to Researcher 3, "we look for a movement in the industry real sector especial Physics' application in the field to be an input for our curriculum development." With a close relation between universities and Western Digital Company, the key persons from the

company who work relate to research collaboration especial Policy maker 1 or RC Manager 1, are also invited by the university Digital to discuss on curriculum development. "I was invited from university to join a workshop at university to share some input for their curriculum development purpose," RC Manager said.

Individual Level

Given the mutual benefit or winning situation of key stakeholders, both engineers and researchers earn or gain a benefit which can be described in financial and non-financial forms. For non-financial benefit, to learn from each other is desirable outcome. The researcher learns the practical know-how of the manufacturing context from the engineer while the engineer learns the theoretical (know-why perspective from the researchers or lecturers, which means that there is a knowledge spillover happening among all stakeholders in this activity. Therefore, the growing of the research collaboration program is the right thing to do to fill the gap in theoretical knowledge and to relieve the manpower limitation or shortage in the industry. The engineers of a company and researchers from the university work together to achieve intended common goals. This interaction creates an environment that enhances the tacit knowledge transfer or spillover between both of them. This phenomenon occurs in the surroundings of the operational research collaboration program in the context of Western Digital (Thailand), BangPa-in factory. Moreover, the win-win situation surrounding the research collaboration project at the individual level could be described in detail as follows.

5.2.2.3 Researchers

1) Proper Financial Incentive

Basically, Lecturers or Researchers that have participated in a research collaboration project will earn compensation in a financial incentive form as well. In the contract agreement, the amount of financial benefit is clearly identified concerning how much the company will pay for any particular research collaboration project as stated by Researcher 5 "The research collaboration project with the industry is able to raise more income for researcher that a benefit in financial incentive." Researcher 2 has added: "We got a fully support in a budget from Western Digital Company upon request that able to make a satisfy compensation towards our contribution."

2) Acquiring New Knowledge and Empirical Experience

Besides gaining of financial benefit, the lecturer as researcher also is able to acquire or harvest new knowledge on the research topic. In the research execution process, researchers are permitted to review the data and information related to the research topic—both primary and secondary data. The activities that allow researchers to acquire this new knowledge and experience might happen in various forms; for example, the researcher has to visit the production line for HDD or HDD components to get an understanding of the real situation and to gain direct experience, to discuss with the engineer and technician on the shop floor, have formal meetings with the engineer and manager, etc. Those activities and situations are created as an opportunity for the researcher to gain new knowledge and experience directly. This means that the researcher is able to obtain both tacit and explicit knowledge through socialized activities with the employees of Western Digital and documented information reviews.

Moreover, the researchers also gain empirical experience through production line visiting to know and understand the real setting of the surrounding research topic that they are working on. Once the researchers go back to the university, they take that knowledge and well as empirical experience and share it with their students in the classroom when they have to lecture on the subject related to that topic, as stated by Researcher 4. "Work with Western Digital Company allows me to gain new knowledge and empirical experience that I am able to bring it back to share my students in the class." Similarly, Researcher 5 also mentioned the following: "I have to earn new knowledge surrounding research topic that able to share to my students in teaching class at university".

3) Opportunity for Paper Publishing

The lecturer has pointed out that the academic paper publishing is one of the tasks to demonstrate the performance of the lecturer toward in his/her career. Joining a research collaboration program with an industry is a chance for the lecturer as a researcher gaining an academic issue that is related to the research project. Researchers are able to pick up some issues of the research topic to write a paper and publish, but it must not violate the intellectual property agreement with the company. Generally, the content of a research collaboration project is confidential.

Paper publishing that is related to a research topic shall be permitted by the company. However, a research collaboration project is still one of the sources of academic papers for the researcher as lecturer. RC Manager 2 pointed out that "the academic paper writing and publishing is a win that researcher looking for and research collaboration project is able to serve to that. It's the same with Researcher 10 also said that "academic paper publishing might be possible for the topic that relate to research collaboration project but I do not high expect for this benefit."

Similarly, Researcher 3 also added the following: "Academic paper publishing is a benefit of researchers. I am in a process of academic paper writing that relate to my work but I need to rise the point of academic in which do not break my NDA with the company."

5.2.2.4 Engineers

1) Support Engineer's objective achievement

One of the key roles and responsibilities of the engineer in the company is to solve and fix any problems and improve the situation in order to achieve the objective and target in their responsible area with high expectation. In the situation where the engineers respond in various roles, the research collaboration project is able to close that gap by helping the engineer to solve the problem as well as improve in a specific area per his/her primary role and responsibility, which means that the research collaboration project helps him or her to achieve key performance indicators (KPIs) as well. Engineers that take responsibility for the research collaboration project are also able to obtain credit from the project achievement in general, which impacts their performance and career path finally. Engineer 3 pointed that "research collaboration project help Engineer to solve and fix the problem in their area with long term solution." The head of the department or the engineer's manager also gained a win from this viewpoint.

2) Obtaining Further Knowledge

Regarding the research collaboration setting, engineers and researchers have always interacted and socialized both formally and informally in various channels. The key topic of discussion among them is related to academic viewpoint and practical surrounding research topic. By this phenomenon, the engineer is able to obtain and absorb tacit knowledge from the researcher while the researcher

is also able to absorb and gain tacit knowledge from the engineer as well. Moreover, the official project charter and agreement of any research collaboration project also mentioned deliverable items with reference to final report and knowledge transfer through training activities. Apparently, that explicit knowledge in the form of a final report of the research collaboration project is also transferred to the engineer as a project owner and relevant parties in the organization. "Engineer who has participated research collaboration project is able to gain a deep knowledge in term of theoretical perspective that relate to the research topic," Engineering 2 stated. While Engineering 3 also mentioned that "the research collaboration project with researcher from university is a situation where engineer able to earn a knowledge especial further theoretical perspective from researcher."

3) Recognition from Management

Engineers that work in big organizations like Western Digital do not have much opportunity to be recognized by senior management. Many engineers work in the function or area where there is less chance to meet with senior management due to the span of control and the constraint of the work location. Almost 100 percent of the engineers work in other buildings that are far away from the management's office. Therefore, engineers as Research Collaboration Project owners have more opportunity to meet with Management to present their achievement to the Researcher to let the Management know that their performance is beyond routine roles and responsibilities. They have the opportunity to demonstrate their ability and performance to management through accomplishment research collaboration project presentations.

Moreover, once the event of the recognition ceremony is carried out by the company to relevant stakeholders, Engineers as research collaboration project owners and researchers are recognized by Management as well as by key stakeholders. Engineer 3 mentioned that "the win of engineer as a project owner is recognition from management and acceptation the value that they have paid the price to the research collaboration project". Similarly, Engineer 1 also said that "the win of Engineers are acknowledged and recognized by management that impacting to their visibility in the organization."

4) Opportunity of having higher education study

Regarding the circumstance of the Research Collaboration Project, Engineers and Researchers have worked and interacted closely and this accelerates the opportunity to exchange information that is beyond the research topic. Seemingly, the researcher as a lecturer at the university provides the graduate the information in various ways to let the engineer know and understand for consideration to apply and enroll. The engineers who win in this topic are measured that they intend to admit experienced to study in their faculties as well. Moreover, the engineer as a project owner of the research collaboration owner is able to utilize some parts of that topic to fulfill further study at the master or PhD degree level. Additionally, the university also has opportunity to admit qualified newly-graduated students at both master and PhD levels from Western Digital Company. Based on empirical data, there were 3 students that applied for a Ph.D. program and 10 students that applied for a Master Degree to various universities once they were invited to enroll as researchers from those universities. Moreover, the research collaboration with Western Digital Company also allows Lecturers as a Researcher to understand the movement of knowledge and technology in the current industrial world in their field and to take it back to their faculties as input for curriculum development. According to Researcher 3, "we are looking for a movement or advancement in the industrial real sector especial Physics' application in the field to be an input for our curriculum development." With a close relation between universities and Western Digital Company, the university also invites key persons of Western Digital whose work is related to research collaboration, especially Policymaker 1 or RC Manager 1, to attend a workshop for curriculum development, as the RC Manager stated: "I was invited from university to join a workshop at university to share some input for their curriculum development purpose."

5.2.3 Strong Commitment of Leadership

Strong commitment of leadership is a behavior of all stakeholder leaders that demonstrated their dedication to the research collaboration project. The strong commitment of the leader is also a key factor affecting the effectiveness of the research collaboration project as well. The research collaboration project could not

move on without the strong commitment of the leader. All of the key informants mentioned to this determinate in the same manner because the leader is the person that provides the policy and direction of the research collaboration, especially the leader of Western Digital Company as an active leader. The leader of Western Digital Company was defined as an active leader due to the research collaboration program, at the policy and direction level, was initiated and activated by Western Digital Company leader.

The research collaboration project could not be raised without the commitment from the leader. Additionally, leaders also need to know and understand the nature of the research collaboration project as well. They need to overcome the paradigm of quick-fix solutions and have enough open-mindedness to move on to basic sciences and fundamental research. Leaders also tend to emphasize long-term results rather than the short-term perspective. Policy maker 1 was a person that fully supported research collaboration with the university. He mentioned many times and opportunities driving research collaboration projects to answer basis science and fundamental research questions. This approach allowed the leader to overcome quick-fix solutions for short-term research projects, as Policy maker 1 stated: "I fully support the direction of research collaboration project in which answering a basic sciences and fundamental research question"

Policymaker 1 also demonstrated that he is committed to and supports research collaboration projects through a verity of events and activities. For instance, he visits the university to dialogue with the leader or president of the university and presents a trophy to the researcher who has a passion to drive the research collaboration project with the company. This means that Policymaker 1 has recognized the researcher in the right manner, which is beyond the contract agreement: "Policymaker 1 has visited me at university and surprised me with a special recognition by presenting me a trophy in front of my president," Researcher 1 said. Moreover, Policymaker 1 has demonstrated his commitment toward research collaboration by presenting the success to the public conference in order to show the operational research collaboration of the university with other organizations through public sharing.

5.2.4 Trust

The research collaboration project could not exist and run effectively if the stakeholders were not open-minded enough. Trust in each other is also a key determinant that affects the effectiveness of the research collaboration project. The research collaboration program between universities and Western Digital Company is a phenomenon in which data and information related to the research project are normally and routinely exchanged and transferred among engineers and researchers. Traditional and official practice, the Non-Disclosure Agreement (NDA) will be issued and signed by all researchers that are participating in the research collaboration program.

However, the NDA is just an official bond from the legal standpoint. It does not guarantee the open-mindedness among the stakeholders if there is no trust among them. Trust among stakeholders cannot arise in a short period of time of relations and without trust in each other. For the trustworthiness of the researcher, it was proved with a background and performance in the past. In the Thai culture, lecturers or researchers tend to gain high trustworthiness from society. In terms of making policy, the RC manager and engineers would trust researchers to have a fundamental of relation among them, Engineer 1 said: "Trust is a big issue, selecting the right researcher is the key., "If we do not trust each other, how we going to run a research collaboration project," Engineer 1 also added. The situation of trustworthiness is emerging in various behaviors of each other. For instance, the engineer as a research project owner lets the researcher know everything surrounding the research collaboration project. This phenomenon demonstrates high trust in the researcher. According to Researcher 2, "I am very proud that I got explanation in everything that I need to know without any concealing". Additionally, Researcher 3 also stated the following: "I like working style with this company; we very openness to share data and information to each other. I feel great and get respectively from the company". Added further by Researcher 4 was the following: "what I need to know surrounding my research topic, I got to know." Apart from that trust between each other could not be created overnight. Time is needed to know each other to build trust. "Informal activities and events should be enacted to encourage knowing each other that leading to create a trust," Researcher 1 said.

5.2.5 Characteristic of Key Stakeholders

Once two organizations, Western Digital Company and the university, have agreed on the contract to execute the operational research collaboration project, the key stakeholders for driving the project are the researcher or lecturer and the engineer, who closely work in the project from start to finish. The good characteristic of key stakeholders is also the key determinant for driving the effectiveness of the research collaboration project as well.

To work in the field of research collaboration project needs a characteristic of people who are fitting with academic work and execution. The sub-characteristics could be described in terms of the behavior, skills, and intensive knowledge surrounding the research topic.

1) Engineer

Based on the findings from the in-depth interviews, the characteristics of the engineer as a research collaboration project owner in the context of Western Digital Company can be described as follows.

2) Sense of Ownership and Accountability

The research collaboration project is a hands-on activity and a long-term project. The engineer as a project owner needs to dedicate him/herself and account for the achievement of the project. These engineers should have a sense of ownership and accountability from the beginning to the end of the project because research collaboration is not a traditional turnkey project where engineers cannot anticipate the results or excellence of the outcomes without commitment and consecration. A sense of ownership and accountability allows engineers to be able to engage with the research collaboration project effectively. Therefore, any single research collaboration project in the Western Digital Company context must be officially assigned one engineer to take ownership and accountability. "We have to officially delegate the project to Engineer who demonstrated their ownership and accountability in order to ensure they are able to hands on the project completely," Engineer 1 said.

3) Strong Background of Knowledge

The background knowledge is the experience and knowledge of the engineer related to the research collaboration project. The engineer also as an area or

function owner is a person that activates the research topic in his/her area. Therefore, he or she needs to have enough background knowledge surrounding the research topic because he/she is a primary source of data and information for the research topic. The engineers are able to answer questions in order to clarify the critical questions surrounding the research topic such as what is the problem in their area, what can and cannot be done, what are the limitation, etc. Engineer 3 and Engineer 6 had pointed out that "Engineer who was appointed to be a research collaboration project owner should have a strong background of knowledge surrounding the research topic."

4) Fast Learner

The research collaboration project for each topic in the context of Western Digital Company needs to utilize various disciplines of knowledge. Engineers that are assigned to work on research collaboration projects in an effective manner should be a person able to be a fast learner and to be able to absorb complicated information from the research setting and from the researcher. There are a lot data and information generated in the process of research which the engineer needs to capture and digest in order to understand the data and information in a short period of time. Therefore, the ability to learn quickly should become a characteristic of the engineer that works closely with the researcher to drive the research collaboration project besides their routine roles and functions. "Engineers as a project owner confront with a huge data, information and new knowledge that they need to learn quickly for making decision to move a progress," Engineer 6 said. The RC Manager pointed out that "fast capture huge data and digest new knowledge should be a characteristic of engineer who own a research collaboration project so that work smoothly with researcher."

5) Interpersonal Skill

Besides working with the researcher and researcher's assistant, engineers that "own" the research collaboration project also need to work closely with other stakeholders such as peer departments, suppliers, supervisors, and so on. They need to interact with others in the right manner so that the project can move forward effectively. Therefore, interpersonal skills are a key characteristic that engineers need to have in order to work effectively with stakeholders. Engineer 1 stated the following: "Engineer and Researcher always interact to discuss in the topic

surrounding research project. So, Interpersonal skill is the key that able to make a smooth collaboration".

Similarly, Researcher 3 mentioned that "knowledge and skill on how to interact with others is the important thing for Engineer so that they are able to work collaboratively with research project stakeholders."

6) Willing to Learn

In the research collaboration project work, engineers always face challenges in learning new things related to the research project from the researcher and the project itself. Therefore, willing to always learn new things allows the engineer to be able to acquire new knowledge that is beneficial in terms of driving the research project effectively as a research project owner. The mentioned knowledge might be generated in the process of the research project or transferred from researcher to engineer. Engineers have to internally motivate themselves to learn new things enthusiastically. Engineer 5 said, "Research collaboration project is required an engineer who always willing to learn new thing that allow them to acquire a new knowledge beneficial to drive a project accomplishment." Researcher 1, a person that was unswervingly engaged with the research collaboration project, pointed out that "willing to learn new thing is the key characteristic of engineer who are driving research collaboration project effectively."

7) Researcher

Given the key determinants related to the characteristics of the researcher that affect the research collaboration effectiveness, the findings from the in-depth interviews from the key informants are as follows.

8) Specialty

When taking into account research work, the expertise or deep knowledge of the researcher is very important and must be matched with the research topic. The matching between research topics with the specialty of the researcher is a critical job of the RC Manager to find out when the research topic is raised by the engineer. If the specialty of the researcher is not agreeable, then there is risk of failure.

Generally, the RC Manager is a responsible person to make a list of researcher expertise in each filed from various universities. By doing this, there is

allowed RC Manager to be able to match a research topic with appropriate specialty of researcher in their network list. RC Manager 2 said that "we must find out researcher who has a specialty enough in their disciplines in order to make sure the research topic could be solved in the right manner." This means that the researcher should have enough knowledge to solve the research problem in the context of Western Digital Company. Similarly, "we need to work with researchers who have in-depth knowledge in their disciplines in order to ensure the problem must be fixed with an appropriate academic standpoint," Engineer 2 said.

9) Emphatic Listening

Throughout the research collaboration process, researchers need to understand all of the details and get information surrounding the research topic from engineers and relevant staff as much as possible. At the project forming and planning stage, dialogue and discussion between the researcher and engineer is carried out frequently through face-to-face meetings in order to understand the context of the research. Emphatic listening skills are a vehicle to bring the researcher out from the academic viewpoint into the practical world of Western Digital Company. Emphatic listening practice allows the researcher to be able to diagnose effectively the research problem before execution.

According to Researcher 6, the "major skill in university of Researcher as a Lecture is speaking while working with industry is listening." By doing this, researcher should be open-minded enough to listen to others. Similarly, Researcher 9 said that "as a researcher we must listen to engineer as area owner in order to get understanding about research problem and surrounding before taking actions."

10) Fast Learner

Regarding the research collaboration project execution, researchers need to learn new things related to the HDD Hi-Technology manufacturing process and surroundings research topic, especially at the beginning. They should be able to capture, digest and learn the complicated data of the research project from various sources related to the know-how of HDD manufacturing within a short period of time. Being a fast learner is one of the characteristics of researchers that allow them to be able to drive research projects forward effectively. Researcher 2 said that "Fast Learner the new thing that beyond academic text book should be a key characteristic of Researcher. Working with industry leads us to face with new thing every day."

Basically, being a fast learner should be a general characteristic of the researcher that is working with industry. Similarly, Researcher 11 said that "we as a researcher working toward research collaboration project are encountered with practical world in HDD manufacturing that beyond our routine jobs in university, fast learner helps us to execute research work smoothly."

11) Willing to Teach

Throughout the Research Collaboration execution Process, one of the activities that should take place is teaching and educating. The researcher, as an expert that has a specialty in his or her field, ought to deliver some theoretical perspectives that are interrelated with the research topic to the engineer. By doing this, they are able to accelerate knowledge spillover from the researcher to the engineer smoothly.

However, knowledge transfer or spillover cannot effectively happen if the researcher is not willing to teach. "Researcher should not wait for asking from Engineer to teach them, willing to teach should come from inner characteristic of researcher," said Engineer 3. Moreover, the interaction between Researchers with Engineers through teaching also stimulates tacit knowledge transfer as well. Engineer 1 also said the following: "Research or Lecturer from University should give knowledge to engineer thru teaching or interacting, willing to teach is allowing them to run research collaboration project effectively.

12) Open-mindedness

In the research collaboration context, the role of the lecturer in the university might not fit the role of the researcher working in the industry sector. The rank of lecturer in Thai society and university is quite high. Generally, lecturers are respected by students and others, which can provide the academic viewpoints. Once the lecturer works in the industry sector as a researcher, the rank and status of the researcher might not be equivalent to the status of working in university. The relationship between researchers and engineers is a partnership that is not similar to the relationship between pupils and teachers in university. Therefore, researchers should be open-minded enough to accept the feeling of losing some rankings. "Lecturer should drop their academic rank and open their mind enough to work with various levels of staff in industry," Researcher 6 said. For an additional example on

this issue, Researcher 10 also mentioned the following: "If lecturer or researcher does not listen to other, there are lost opportunity to get understanding. Open-mindedness and listen enough will allow researcher to understand on what the issue is".

5.2.6 Resources

The effectiveness of researcher collaboration projects requires the availability, accessibility, flexibility and adequacy of needed resources. Given the needed resources, research collaboration projects require various resources for support, which depends on the requirements of each specific research topic. For financial resources, the company that led by Financial Director will consider and approve of resources spending, so as to ensure an adequate budget upon the proposal for the researcher. There is approved based on the return of investment analysis with clearly specific outcomes. Policymaker 2 said that "the budget will be reviewed and approved by Finance Director depends on a proposal to endure adequacy with a detail of ROI."

Besides financial resources, the tools and equipment that need to be used in each project are also important for researchers and engineers. The needed resources should be accessible, flexible, and adequate and suit the requirements of each research collaboration project. There are many sources that are available for the Researcher to access and use when required, such as the laboratory of the university and company and other available resources. "Once any research projects have required tools or equipment, relevant project owner and researcher is going to check an availability of those resources from various sources" added by Policymaker 2. However, some cases where the required tools and equipment are not available in either the laboratory of the company or the university, to seek them from other partners in their networking of collaboration is needed. Similar to the idea of Researcher 4, who mentioned that "the company already has needed measuring equipment to support my request appropriately without any lacking."

Moreover, another resource that needs to be prepared in order to support the research collaboration project is an office for the researcher. Work spaces or areas with utility should be arranged as appropriate. An office with proper utility as a privacy area will allow the researcher to be able to work smoothly. Once the researcher with his or her assistant comes to the factory as scheduled, he/she has a

work space and meeting room to meet with engineers to discuss research topics. To support this concept, the engineer 3 said that "Personal computer with office or working space is needed resources that should be arranged for researcher to avoid a difficulty to work and meet with engineer."

5.2.7 Communication

The communication between the research collaboration project stakeholders is a normal practice that allows all to understand each other. This phenomenon always happens especially between the RC manager, engineers, and researchers. The intention of communication is to create a clear understanding of the issues surrounding the research collaboration project.

Appropriate Channels and Forms of Communication

Many channels are utilized to make communication among stakeholders. The channels and forms are expanded toward stakeholders in many ways in both formal and informal such as face-to-face meeting, e-mail, SMS (Short Message Service) and phone call, etc. The key issue of communication is to make each other understand the message that is intended to be delivered to all relevant stakeholders of each research collaboration project.

Further, communication also makes the stakeholders understand each other's work style and culture perceivable through the connections among them. This is beneficial to all of them in terms of adjusting themselves for aligning with all of the parties that they are working with. Once they are connected through communication in various forms, the collaboration in working together to achieve intended goals will take place. Researcher 2 stated the following in this connection: "I feel we are working in team in which without the gap of difference organization style of culture due to we are closely communicated among team members." The mechanism of communication is implemented and in some cases they embed the trainee student into the manufacturing process for 4 days a week to work closely with the engineer and to get feedback information and to take any changes back to the researcher immediately. "We have a good linkage with front-line that allow us to be able to acquire any static and dynamic information related to research project," further added Researcher 2. By doing this, they are not disconnected with any movements on the frontline as well as not link up between researchers with engineers.

5.3 Model of Effective Operational Research Collaboration between the HDD Industry and Academia

The 3rd objective of this study was to propose a model of effective operational research collaboration between the HDD industry and academia or university in the case of Western Digital Company. The operational research collaboration effectiveness model illustrated in this study refers to the results of the operational research collaboration that can be accomplished within an agreed time frame, and achieved or successful per the specific research's objectives according to the planned resources from the company's viewpoint.

The model was formed based on the findings regarding the key determinants from the key informants' viewpoint and the researcher's interpretation using in-depth interviews. The detailed model is presented in Figure 5.3

Researcher
➢ Specialty
➢ Emphatic Listening
➢ Fast learner
➢ Interpersonal Skill
➢ Willing to teach

Engineer
➢ Sense of Ownership and Accountability
➢ Strong Background of Knowledge
➢ Fast learner
➢ Interpersonal Skill
➢ Willing to Learn

Characteristic of key stakeholders

Western Digital Company
➢ Close the Gap of theoretical Limitation and Workforce Shortage
➢ Economic Benefit

Faculty or University
➢ University's Mission Aligning
➢ Financial benefit
➢ Opportunity of graduated student admission
➢ Opportunity to train student

Organizational Level

Engineer
➢ Support Engineer's objective achievement
➢ Obtain further knowledge
➢ Recognition from Management
➢ Opportunity of High education study

Researcher
➢ Proper Financial Incentive
➢ Acquire new knowledge and empirical experience
➢ Opportunity of Paper Publishing

Individual Level

Win-Win Situation (mutual benefit)

Clear Scope, Goals and Objectives
➢ Specific
➢ Measureable

Strong commitment of leadership
➢ Overcome "quick fix solution"

Trust among stakeholders
➢ Openness for information sharing

Communication
➢ Formal and informal form
➢ Various channels

Resources
➢ Adequacy
➢ Flexibility
➢ Accessibility and availability

Research Collaboration Effectiveness

Achieve Intended Results

Accomplish within agreed timeframe

Achieve research's objectives
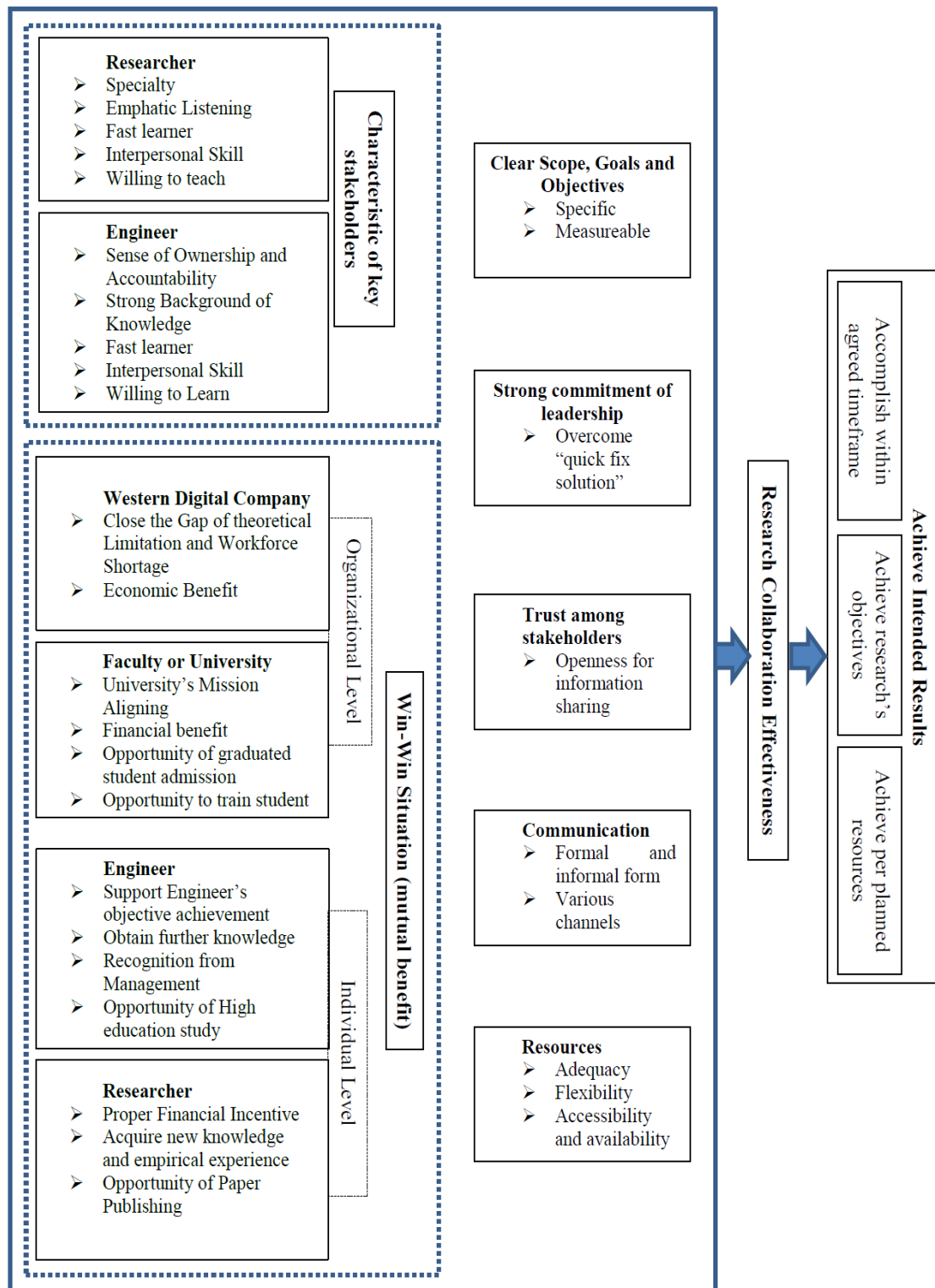
Achieve per planned resources

Figure 5.3 The Model of Effective Operational Research Collaboration between the HDD Industry and Academia

CHAPTER 6

CONCLUSIONS, DISCUSSION, CONTRIBUTIONS, AND RECOMMENDATIONS

6.1 Conclusions and Discussion

The objectives of this dissertation included three main items: first, to describe the context of the operational research collaboration programs between the HDD industry and academia; second, to explore the key determinants of effective operational research collaboration between the HDD industry and academia; and third, to propose a model of effective operational research collaboration between the HDD industry and academia. The findings of this dissertation have answered all three objectives.

6.1.1 To Explore the Context of Operational Research Collaboration between the HDD Industry and Academia. This Study is Focused in the Case of Western Digital Company in Thailand that Quite Uniqueness of the Industry

In doing this, the expectation toward research collaboration project result is quick fix solution in short term of any issues in the operations. Later, the paradigm of research collaboration between Western Digital Company BangPa-In factories has been shifted to emphasize the knowledge of fundamental or basic science research in the long term in its manufacturing context. Regarding the source of funds, 100 percent of the budget related to the research project was funded by the company so that protecting the right of intellectual property (IP) arising.

The research collaboration program between Western Digital and universities raises the mutual benefit for both and at both organizational and individual levels. For the organizational level, the company utilizes the research collaboration program to

close the gap in theoretical limitations and workforce shortages to gain economic benefits as well in the form of efficiency and effectiveness improvements in the HDD manufacturing context for their improvement and growth. It could be proved that this program has existed under the frame of resource dependency theory in which Galaskiewicz (1985, pp. 281-304) identified three arenas of inter-organizational relations: resource procurement and allocation, political advocacy, and legitimation. Resource procurement, allocation, and legitimation fields involve resource dependency issues in their descriptive framework. Furthermore, there are also utilizes research collaboration program to serve a condition of BOI's requirement and for Foreign Direct Investment (FDI) to gain Corporate income tax exception. From academia's or the university's point of view, working with the HDD industry, in this case Western Digital Company, through research collaboration programs allows them to serve the university's mission, especially regarding the academic service to society. Additionally, they also gain financial benefit, opportunity for master and PhD. student admission, opportunity to train students in real case study in the industrial sectors, sources of input for curriculum development, etc. At the individual level, working together between engineers and researchers to execute research collaboration projects accelerates knowledge transfer among them. Engineers gain theoretical knowledge from the researcher while the researcher gains practical knowledge of the HDD industry from engineers. From an individual standpoint, engineers utilize research collaboration projects to fix problems as well as to improve in their space. Moreover, as project owners, engineers are also able to take a credit for the project achievement. The company pays remuneration to the researcher in financial form at the amount agreed in each project. They also gain more knowledge from a practical perspective in the HDD industry manufacturing context in which able to bring to share their students in the class in University.

Regarding the key players that drive the research collaboration project forward, engineers and project managers as employees of the company, lecturers as researchers from the university are known as a key players as execution team. These groups of people play an important role in accomplishing the project. For some projects they also have students from their faculty get involved as a researcher's

assistant. Those groups of people are responsible for execution from the beginning of the project until it is completed as planned.

In terms of the running of the research collaboration project, there are 3 main steps that can be discussed. First is so-called "project forming and planning." This step is initiated by engineers in any functions where they are faced with some issues to solve and fix and decide to utilize an external subject matter expert through the Research Collaboration Program. They work with the RC Manager to match and determine a competent researcher from any university with their topic. Then, the three of them—the engineer as project owner, the RC manager, and the researcher—work together to clarify the purpose of the research project, and the project proposal and agreement. Second is project execution. The main players in this step are the researcher and engineer in terms of executing the project per the planned activities and scope. The official beginning of this step is during the kickoff meeting carried out by the RC manager, who incorporated with another parties to brief on the research topic and to open various communication channels among them. Then, a meeting to update the progress is conducted at planned intervals or as appropriate. Once the project is completed, the meeting among the relevant stakeholders is carried out again to review the completion of the research project where a final report is required. Then, project closure to review the impact of project against objectives. There is determined the highlight of success and lessons learned in this step as well.

Given the key determinants of the effective operational research collaboration between the HDD industry and academia, from this qualitative study could be described as follows.

6.1.2 Key Determinants

The key determinants that could be influenced or impacted toward effectiveness of research collaboration project between the HDD Industry and academia are concluded as follows.

1) Clear scope, Goals, and Objectives

The first determinates are a clear scope, goals, and objectives. For any research project that needs to be completed, it was found that a specific and clear scope, goals and objectives would be determined to set the direction of any single

project. In a practical of Western Digital Company, there is clearly defined in a form of documented information in project charter of project forming and planning step. This is aligned with a study by Waddock and Bannister (1991) where it is stated that collaborative objectives should be clear and well-defined.

2) Win-Win Situation (Mutual Benefit) among Stakeholders

Mutual benefit is a Win-Win situation where stakeholders in the research collaboration project feel obtaining something that fulfill their needs and expectations regarding both tangible and intangible things and official and un-official. In the context of the Western Digital Company research collaboration program, it was concluded that a mutual benefit in which define as a "Win-Win situation" could be existed both organizational and individual levels. For the organizational level, Western Digital is obtained in terms of financial benefit that gaining from an accomplishment of research collaboration project in a form of cost, quality and productivity continuous improvement in HDD process and also closing the gap of theoretical knowledge limitation and workforce shortage. Given the win of the university, it was found that there are also gained in terms of financial benefit in the form of remuneration. For other view point that consider as a non-financial benefit, research collaboration projects are able to align with the university's mission in the view of academic service to society. Furthermore, the university gains in terms of an opportunity of graduated student admission from the company, an opportunity to train students in real situations in the field when students have participated as a researcher's assistant and also there are able to get information as a source of input for curriculum development from the practitioner's perspective. At the individual level, it also was found that the win of both the engineer and researcher existed in the form of mutual benefits. Given the win of the researcher, they are not only gained in terms of proper financial incentive in the form of remuneration but also acquired new knowledge and empirical experience that they are able to share in their classroom as well. Moreover, the researcher also gets an opportunity to publish papers as to the content surroundings collaboration research topic. For the win of the engineer from a project owner point of view, they are utilized research collaboration project to capacitate their performance achievement per role and responsibility. Furthermore, the engineer also gains further knowledge from the researcher, is recognized by

upper-level Management, and gets an opportunity for high education study in the university in which they are made a relation.

3) Strong Commitment of Leadership

The strong commitment of leadership is the behavior of all stakeholder leaders that they have demonstrated to be dedicated and committed to the research collaboration project. In this study, it was found that leaders as policy makers and resource supporting decision-makers could be influenced toward the whole of the research collaboration process. In Western Digital Company as part of the electronics industry, the environment of the organizational context is dynamic. The change is reached the organization dramatically. Therefore, the research collaboration project could not be sustained in the organization without the commitment if the leader. They must patiently overcome the old paradigm that emphasizes a quick-fix solution in the short term view to accompany another approach that emphasizes fundamental science research for long-term solutions.

4) Trust

Trust among stakeholders is a critical point to accelerate the research collaboration process. The data and information surrounding a research topic could not be exchanged or transferred from one to another if people do not trust each other. It was obviously discovered that there is a high level of trust among stakeholders. They are willing to open and share all information related to the research topic without barriers. This phenomenon might be empowered from the non-disclosure agreement and the culture of the organization as well as the values of both sites in which aligning with many scholars have determined that trust among stakeholders could be affected toward collaboration effectiveness both organizational and individual level. It was proved that this finding, needing to trust each other, is aligned with the extensive review of Waddock and Bannister (1991).

5) Characteristics of Key Stakeholders

Given the characteristics of the key stakeholders—the engineers and researchers—in this study, it was found that there are many sub-characteristics that influenced the effectiveness of the researcher collaboration project. First, the sub-characteristics of engineers are a sense of ownership and accountability, a strong background of knowledge, being fast learner, and interpersonal skills and being

willing to learn. Second, the sub-characteristics of the researchers were specialty, emphatic listening, being a fast learner, being open-minded and willing to teach. In the industry, especially in the context of Western Digital Company, the environment of the organization is so complex and huge data. Therefore, the person that is involved in a research collaboration project needs to deal with that situation of academic and practical knowledge discussion as an engineer and researcher should be fast learners. This finding, sub-determinants that relate to characteristic of key stakeholders would help to fulfil additional determinant.

6) Resources

Needed resources that are required for driving research collaboration projects effectively could be defined as financial and non-financial resources. For non-financial resources, there are needed tools and equipment that should be specific based on each individual project requirements. In the Western Digital context, to support the varieties of research topics in the field of HDD manufacturing to drive the effectiveness of research collaboration projects, it was discovered that effective research collaboration projects must be required of availability, accessibility, flexibility, shared resources between the university with industry, and adequacy of those needed resources. Moreover, the source of resources could be shared and accessed by both internal and external companies that might be utilized the lab of their faculty and other partners in which required resources are available. This determinant or factor also has been discussed by many scholars such as Chrislip and Larson (1994), Mattessich et al. (2001), and Fyall (2003).

7) Communication

The effectiveness of a research collaboration project between industry and academia is also required effective communication among stakeholders. From this study it was found that there are many forms and channels of communication, both formal and informal, that can be carried out among stakeholders. The purpose of communication is to exchange understanding regarding the issues surrounding the research topic. Moreover, the degree of density of communication also creates a connectivity that accelerates the trustworthiness among them. Therefore, it was concluded that communication as a tool to create connectivity that leads the creation of mutual understanding should be conducted in various channels, in both formal and

informal practice. In this determinants, Pertuze, Calder, Geeitzer and Lucus (2001) also have mentioned that there should be established a strong communication linkage with the team as the best practice of industry and university collaboration.

6.1.3 The Model of Effective Operational Research Collaboration between the HDD Industry and Academia

The model of effective operational research collaboration between the HDD Industry in the case of Western Digital Company could be described in the form of quality data as follows.

From the study in the context of the HDD industry, it was concluded that the key determinants that influenced the effectiveness of research collaboration programs are: 1) Clear scope, goals, and objectives, 2) Strong commitment of leadership, 3) a Win-Win situation, 4) Trust among stakeholders, 5) Characteristics of key stakeholders, 6) Communication and 7) Resources. The sense of researcher collaboration effectiveness resulted in operational research collaboration projects that can be accomplished within the agreed time frame, achieved or successful per the specific research's objectives according to the planned resources according to the company's viewpoint.

6.2 Contributions

Given the findings against the study's objectives, the contribution of this study can be described from both theoretical and practical perspectives.

6.2.1 Contribution to the Theoretical Perspective

Regarding the theoretical perspective, the findings that were illustrated from this qualitative study revealed the key determinants at the sub-level that affected the operational research collaboration effectiveness between the industry and academia in the context of Western Digital Company. It could be contributed to inter-organizational collaboration effectiveness theories in the field of industry and academia collaboration. For instance, the determinant that relate to leadership, the results of this study could help to explain further "leadership commitment" behavior

that beside on previous study by many scholars that mentioned to strong and skillful of leadership. For an additional example, this study also revealed and explained further sub-determinants such as emphatic listening, being a fast learner, being willing to teach and learn, and having a sense of ownership related to the characteristics of the participants besides skills, knowledge, and interpersonal skills. Therefore, it can be concluded that this study could be explained further to inter-organization collaboration theory.

6.2.2 Contribution to Practical Perspective

From the practical perspective, understanding the key determinates of operational research collaboration effectiveness between industry and academia could be beneficial to practitioners or management in both the industry sector and the university in utilizing and adapting the model that was proposed and described in this study.

From the academic institution viewpoint, given the higher educational policy of Thailand, the theory of the new public service paradigm, World University Rankings and higher education institution standards announced by the Ministry of Education, there are encouraged higher education institutions to work with the private sector in various channels. However, the direction that just guided on "what is higher education institution should do?" In order to promote the new public service paradigm, there is not provided or directed clearly "how higher education institution should do?" Therefore, the outcomes of this dissertation that raised the model of effective operational research collaboration between the HDD industry and Academia would be beneficial to academic institutions in terms of applying the model in the right manner for enhancing the effectiveness of working with the private sector to meet new public service paradigm and also to align with their mission.

Moreover, it is a major trend in the context of Thailand that there are booting up collaboration between government agencies or public organizations, society and private organizations, currently the so-called "Prachar-Rat" project, to achieve intended outcomes for maximizing social well-being. For instance, additionally, the Thai cabinet also intends to promote innovation and science development policy in Thailand. There are supporting in various approaches to enhance the competitiveness

of the private sector by developing more values in their products and services utilizing innovation and science as a base. Thailand cannot produce a cheap products any more that there are need to change from production driven economy to a value-based driven economy. First, the tax measure to support this policy is taken place such as the 10-year corporate income tax exception, the 5-year tax exception for startups, etc.; second, the cabinet also supports some amount of the budget to stimulate new startups in business by utilizing the advantage of research outcomes in university to commercialization so-called "จากหิ้งสู่ห้าง" or "from on shelf to commercial department store." For driving this initiative effectively, the Research Startup Gap Fund Committee has been established to push up the research results that have been completed in laboratories of public universities or government agencies of Thailand to become products and services that are beneficial to the economy overall. This committee, led by Dr. Vorapol Socatiyanurak, is responsible for reviewing and approving the funds for any accomplished research projects based on specific criteria as follows; 1) A fund will be approved for a research topic that contributes to innovative value; 2) they must be enhanced a value of product and service that created a value to consumers; 3) they must be possible to produce in commercial and production without a huge investment; 4) they must be clarified a business plan to realize approved projects per specific time frames; and 5) the degree of collaboration with the private sector must be strong. According to Dr. Vorapol said that "Now, more than 100 research topics of various universities approved to promote business startup through collaboration between researchers in universities with private sector." Therefore, the proposed model adoption also might help to improve the effectiveness of the work collaboration between researchers of the university with startup investors in the private sector.

From the industry viewpoint, they are able to apply or adapt a proposed model to initiate or create the guideline or procedure to manage collaboration programs between organizations effectively by covering all of the key determinants that might help to enhance operational research collaboration effectiveness with academia in their context. For instance, in February 2015, the Thai government with the cabinet has approved "Talent Mobility Policy" proposed by the Ministry of Science and Technology to promote researchers' working collaboration in the industrial sector.

This initiative encourages researchers from government and university agencies work full-time in the private sector and get the official-services ages or working ages from their originated agencies. This policy also explains "what government agencies and university should do?" but it is not explained in detail "how to do?" to work collaboration with the private sector. Therefore, understanding and applying the proposed model could support this initiative in the right manner to accelerate project achievement per the desired results and outcomes. Furthermore, it also would help industrial development in value creation through inter-organization collaboration related to value through research collaboration creation that meets both sites (academia and industry) mission.

6.3 Recommendations for Future Study

Regarding future study related to this field, it might be applied to other theoretical viewpoints besides the resource-based view or resource dependency theory. For instance, it might be focused on the effectiveness of policy implementation through the policy evaluation process. Further, in this study only covered the case studied and focused on one organization in the HDD industry in Thailand. Therefore, it is still have opportunity or chance for other industries that they also have a collaboration program with the university as well. Additionally, this study only applied the qualitative method and it would be better if all of the key determinants could be proved using the qualitative method with a wide range of study in this area. Additionally, the effeteness of the proposed model implemented in the HDD manufacturing context might be studied. Furthermore, during the interviewing, some findings beyond the scope of this study were found, for instance, when a company is going to merge with another company. Therefore, future study might focus on the key success factors of the merging of two successful companies. Moreover, in Thailand's context, the government has initiated various programs to promote collaboration between the public and private sectors as mentioned. Therefore, study in this area could be beneficial to fill out the practical and theoretical perspectives in this field.

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APPENDICES

QUESTIONNAIRES STRUCTURE FOR INTERVIEWING THE LEADERS OF THE HARD DISK DRIVE INDUSTRY AS A POLICY MAKER
(In-depth Interview Questions)
To Answer the Research Questions

1. Please introduce yourself, your brief biography and your company profile such as vision, mission as well as your company product and overall performance of your company.

2. Could you please express the origin of the policy of operational research collaboration program between your organizations with lecture/researcher of the agreed university for research collaboration?

3. How do you establish the overall purpose or objective of doing research collaboration program between your organization with lecturer/researcher of university?

4. As a leader/management, how are your contributing to the operational research collaboration between your organization with lecturer/research of university?

5. Do you think that the objectives and goals establishment of operational research collaboration between your organization and university that clear research topic, mutual agreement and measureable are important factors in making operational research collaboration effectiveness?

6. Do you think that making a research agreement between your organization and university that shares a win-win agreement is a key factor affecting to operational research collaboration effectiveness?

7. Do you think that the strong role and leadership commitment involves in operational research collaboration between your organizations and university on the topic is an important factor in making operational research collaboration to produce effective results?

8. Do you think that the trust between your organization which proven the performance of lecturer or researcher in the past and the reputation of the affiliated university are an important factors in making the operational research collaboration work together to produce effective results?

9. Do you think that the unique characteristics of the individual are the researcher or lecturer, manager or project coordinator and engineer who doing the research work together such as the knowledge, the skills needed is an important factor in making research collaboration work together to produce effective results?

10. Do you think that the resources needed to do research such as laboratory equipment as well as adequate support systems are an important factor in making research collaboration work together to produce effective results?

11. Do you think that effective communication between those involved in operational research collaboration such as lecturers or researchers, engineers and project managers or coordinators is an important factor in making research collaboration work together to produce effective results?

12. Do you think that there are other factors that make the research collaboration between your organization and university to produce effective result?

QUESTIONNAIRES STRUCTURE FOR INTERVIEWING
THE PROJECT MANAGER OR COORDINATOR OF
THE HARD DISK DRIVE INDUSTRY
AS A POLICY MANAGER
(In-depth Interview Questions)
To Answer the Research Questions

1. Please introduce yourself, brief your biography and your company profile such as vision, mission as well as your company product and overall performance of your company.

2. Could you please express the origin of the policy of operational research collaboration program between your organizations with lecturer/researcher of the agreed university for research collaboration?

3. Could you please describe your roles and responsibilities of doing research collaboration program between your organization with lecturer/researcher of university?

4. Could you please express the purpose and objective of operational research collaboration program between your organization with lecture or researcher of university?

5. As a project manager, how are your contributing to the operational research collaboration between your organization with lecturer/research of university?

6. Do you think that the objective and goal establishment of operational research collaboration between your organization and university that clear research topic, mutual agreement and measureable are important factors in making operational research collaboration effectiveness?

7. Do you think that making a research agreement between your organization and university that shares a win-win agreement is a key factor affecting to operational research collaboration effectiveness?

8. Do you think that the strong role and leadership commitment involves in operational research collaboration between your organizations and university on the topic is an important factor in making operational research collaboration to produce effective results?

9. Do you think that the trust between your organization which proven the performance of lecturer or researcher in the past and the reputation of the affiliated university are an important factors in making the operational research collaboration work together to produce effective results?

10. Do you think that the unique characteristics of the individual are the researcher or lecturer, manager or project coordinator and engineer who doing the research work together such as the knowledge, the skills needed is an important factor in making research collaboration work together to produce effective results?

11. Do you think that the resources needed to do research such as laboratory equipment as well as adequate support systems are an important factor in making research collaboration work together to produce effective results?

12. Do you think that effective communication between those involved in operational research collaboration such as lecturers or researchers, engineers and project managers or coordinators is an important factor in making research collaboration work together to produce effective results?

13. Do you think that there are other factors that make the research collaboration between your organization and university to produce effective result?

QUESTIONNAIRES STRUCTURE FOR INTERVIEWING THE ENGINEER OF THE HARD DISK DRIVE INDUSTEY AS A POLICY OWNER
(In-depth Interview Questions)
To Answer the Research Questions

1. Please introduce yourself, brief your biography and your company profile such as vision, mission as well as your company product and overall performance of your company.

2. Could you please express the origin of the policy of operational research collaboration program between your organizations with lecturer/researcher of the agreed university for research collaboration?

3. Could you please describe your roles and responsibilities of doing research collaboration program between your organization with lecturer/researcher of university?

4. Could you please express the purpose and objective of operational research collaboration program between your organization with lecture or researcher of university?

5. Do you think that the objective and goal establishment of operational research collaboration between your organization and university that clear research topic, mutual agreement and measureable are important factors in making operational research collaboration effectiveness?

6. Do you think that making a research agreement between your organization and university that shares a win-win agreement is a key factor affecting to operational research collaboration effectiveness?

7. Do you think that the strong role and leadership commitment involves in operational research collaboration between your organizations and university on the topic is an important factor in making operational research collaboration to produce effective results?

8. Do you think that the trust between your organization which proven the performance of lecturer or researcher in the past and the reputation of the affiliated university are an important factors in making the operational research collaboration work together to produce effective results?

9. Do you think that the unique characteristics of the individual are the researcher or lecturer, manager or project coordinator and engineer who doing the research work together such as the knowledge, the skills needed is an important factor in making research collaboration work together to produce effective results?

10. Do you think that the resources needed to do research such as laboratory equipment as well as adequate support systems are an important factor in making research collaboration work together to produce effective results?

11. Do you think that effective communication between those involved in operational research collaboration such as lecturers or researchers, engineers and project managers or coordinators is an important factor in making research collaboration work together to produce effective results?

12. Do you think that there are other factors that make the research collaboration between your organization and university to produce effective result?

**QUESTIONNAIRES STRUCTURE FOR INTERVIEWING
THE LECTURER OR RESEARCHER OF UNIVERSITR
WHO DO A RESEARCH COLLABORATION WITH
THE HARD DISK DRIVE INDUSTRY**
To Answer the Research Questions

1. Please introduce yourself, your brief biography and your company profile such as vision, mission as well as your department profile such as vision mission as well as your faculty and well-known researches which you had done with outside organization.

2. Could you please express the origin of the policy of operational research collaboration program between your university or faculty with the Hard Dusk Drive industry for operational research collaboration?

3. Could you please describe about your role as a researcher involved in operational research collaboration between your organization with engineers in the Hard Disk Drive industry.

4. Could you please express the overall purpose or objective of doing research collaboration program between your department and the Hard Disk Drive industry?

5. Do you think that the objectives and goals establishment of operational research collaboration between your organization and the Hard Disk Drive industry that clear research topic, mutual agreement and measureable are important factors in making operational research collaboration effectiveness?

6. Do you think that making a research agreement between your organization and the Hard Disk Drive industry that shares a win-win agreement is a key factor affecting to operational research collaboration effectiveness?

7. Do you think that the strong role and leadership commitment involves in operational research collaboration between your organizations and the Hard Disk Drive industry on the topic is an important factor in making operational research collaboration to produce effective results?

8. Do you think that the trust between your organization which proven the performance of lecturer or researcher in the past and the reputation of the affiliated university and the Hard Disk Drive industry are an important factors in making the operational research collaboration work together to produce effective results?

9. Do you think that the unique characteristics of the individual are the researcher or lecturer, manager or project coordinator and engineer who doing the research work together such as the knowledge, the skills needed is an important factor in making research collaboration work together to produce effective results?

10. Do you think the resources needed to do research such as laboratory equipment as well as adequate support systems are an important factor in making research collaboration work together to produce effective results?

11. Do you think that effective communication between those involved in collaborative research such as lecturers or researchers, engineers and project managers or coordinators is an important factor in making research collaboration work together to produce effective results?

12. Do you think that there are other factors that make the joint research between your department or university with the Hard Disk Drive industry more effective?

โครงสร้างคำถามสำหรับการสัมภาษณ์ผู้บริหารของภาคอุตสาหกรรม Hard Disk Drive
ที่เป็นผู้กำหนดนโยบาย
(In-depth Interview Questions)
เพื่อตอบคำถามการวิจัย

1. ขอให้ท่านแนะนำประวัติส่วนตัวโดยย่อ ประวัติของบริษัทหรือหน่วยงานของท่าน เช่น วิสัยทัศน์ พันธะกิจ และผลิตภัณฑ์ที่ท่านผลิต ตลอดจนผลการดำเนินงานในด้านต่าง ๆ ของบริษัท หรือหน่วยงานของท่าน

2. ขอให้ท่านกรุณาเล่าถึง จุดเริ่มต้น ที่มาที่ไปของนโยบายในการทำวิจัยร่วมกันระหว่าง หน่วยงานของของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยที่ได้มีข้อตกลงร่วมมือกัน

3. ท่านมีการกำหนดวัตถุประสงค์ หรือ จุดมุ่งหมายโดยรวมในการทำวิจัยร่วมกันระหว่าง หน่วยงานของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยไว้อย่างไร

4. ในฐานะที่เป็นผู้นำหรือผู้บริหาร ท่านมีส่วนในการสนับสนุนการทำวิจัยร่วมกัน ระหว่างหน่วยงานของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยในรูปแบบใดบ้าง

5. ท่านคิดว่าการกำหนดวัตถุประสงค์และเป้าหมายของการทำวิจัยร่วมกันระหว่าง หน่วยงานของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยในแต่ละหัวข้อการวิจัยที่ชัดเจน ยอมรับ ร่วมกัน และวัดผลได้ เป็นปัจจัยสำคัญในการทำให้การวิจัยในหัวข้อนั้น ๆ เกิดผลลัพธ์ที่ดี มี ประสิทธิผล

6. ท่านคิดว่า การทำข้อตกลงการทำวิจัยระหว่างหน่วยงานหรือบริษัทของท่านกับอาจารย์ หรือนักวิจัยจากมหาวิทยาลัยที่ก่อให้เกิดผลประโยชน์ร่วมกัน หรือ Win-Win Agreement เป็นปัจจัย สำคัญที่ทำให้การทำวิจัยในหัวข้อการวิจัยนั้น ๆ เกิดผลลัพธ์ที่ดี มีประสิทธิผล

7. ท่านคิดว่า บทบาทที่เข้มแข็ง มีความมุ่งมั่นของผู้นำที่เกี่ยวข้องกับการทำวิจัยร่วมกัน ระหว่างหน่วยงานหรือบริษัทของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยในหัวข้อการวิจัยนั้นๆ เป็นปัจจัยสำคัญที่ทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

8. ท่านคิดว่า ความไว้วางใจกันระหว่างหน่วยงาน ที่พิสูจน์จากผลงานของอาจารย์หรือ นักวิจัยในอดีต และชื่อเสียงของมหาวิทยาลัยที่สังกัดเป็นปัจจัยที่สำคัญทำให้การทำวิจัยร่วมกันเกิด ผลลัพธ์ที่ดี มีประสิทธิผล

9.	ท่านคิดว่า คุณลักษณะเฉพาะของบุคคล คือนักวิจัย หรืออาจารย์ ผู้จัดการหรือผู้ประสานงานโครงการ และวิศวกร ที่ทำวิจัยร่วมกัน เช่น ความรู้ ทักษะที่จำเป็น เป็นปัจจัยสำคัญที่ทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

10.	ท่านคิดว่า ทรัพยากรที่จำเป็นต้องใช้ในการทำวิจัย เช่น เครื่องมือ ห้องปฏิบัติการต่าง ๆ ตลอดจนระบบที่สนับสนุนที่เพียงพอ เป็นปัจจัยสำคัญที่ทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

11.	ท่านคิดว่า การสื่อสารที่ดีมีประสิทธิผลระหว่างผู้ที่มีส่วนเกี่ยวข้องกับการทำวิจัยร่วมกัน เช่น อาจารย์หรือนักวิจัย วิศวกร ตลอดจนผู้จัดการหรือผู้ประสานงานโครงการ เป็นปัจจัยสำคัญที่ทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

12.	ท่านคิดว่า มีปัจจัยอื่น ๆ อีกหรือไม่ที่ทำให้ทำการวิจัยร่วมกัน ระหว่างหน่วยงานหรือบริษัทของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัย เกิดผลลัพธ์ที่ดี มีประสิทธิผล

โครงสร้างคำถามสำหรับการสัมภาษณ์ผู้จัดการหรือผู้ประสานงานขององค์กร
ภาคอุตสาหกรรม Hard Disk Drive ที่เป็นผู้จัดการโครงการตามนโยบาย
(In-depth Interview Questions)
เพื่อตอบคำถามการวิจัย

1. ขอให้ท่านแนะนำประวัติส่วนตัวโดยย่อ ประวัติของบริษัทหรือหน่วยงานของท่าน เช่น วิสัยทัศน์ พันธะกิจ และผลิตภัณฑ์ที่ท่านผลิต ตลอดจนผลการดำเนินงานในด้านต่าง ๆ ของบริษัท หรือหน่วยงานของท่าน

2. ขอให้ท่านกรุณาเล่าถึง จุดเริ่มต้น ที่มาที่ไปของนโยบายในการทำวิจัยร่วมกันระหว่าง หน่วยงานของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยที่ได้มีข้อตกลงร่วมมือกัน

3. ขอให้ท่านเล่าถึง บทบาทหน้าที่ความรับผิดชอบของท่านที่เกี่ยวข้องกับ การทำวิจัย ร่วมกันระหว่างหน่วยงานของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยที่ได้มีข้อตกลงร่วมมือกัน

4. ขอให้ท่านเล่าถึงวัตถุประสงค์ หรือ จุดมุ่งหมายโดยรวมในการทำวิจัยร่วมกันระหว่าง หน่วยงานของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัย

5. ในฐานะที่เป็นผู้จัดการหรือผู้ประสานงานโครงการ ท่านมีส่วนในการสนับสนุนการทำ วิจัยร่วมกันระหว่างหน่วยงานของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยในรูปแบบใดบ้าง

6. ท่านคิดว่าการกำหนดวัตถุประสงค์และเป้าหมายของการทำวิจัยร่วมกันระหว่าง หน่วยงานของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยในแต่ละหัวข้อการวิจัยที่ชัดเจน ยอมรับ ร่วมกัน และวัดผลได้ เป็นปัจจัยสำคัญในการทำให้การวิจัยในหัวข้อนั้น ๆ เกิดผลลัพธ์ที่ดี มี ประสิทธิผล

7. ท่านคิดว่า การทำข้อตกลงการทำวิจัยระหว่างหน่วยงานหรือบริษัทของท่านกับอาจารย์ หรือนักวิจัยจากมหาวิทยาลัยที่ก่อให้เกิดผลประโยชน์ร่วมกัน หรือ Win-Win Agreement เป็นปัจจัย สำคัญที่ทำให้การทำวิจัยในหัวข้อการวิจัยนั้น ๆ เกิดผลลัพธ์ที่ดี มีประสิทธิผล

8. ท่านคิดว่า บทบาทที่เข้มแข็ง มีความมุ่งมั่นของผู้นำที่เกี่ยวข้องกับการทำวิจัยร่วมกัน ระหว่างหน่วยงานหรือบริษัทของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยในหัวข้อการวิจัยนั้น ๆ เป็นปัจจัยสำคัญที่ทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

9. ท่านคิดว่า ความไว้วางใจกันระหว่างหน่วยงาน ที่พิสูจน์จากผลงานของอาจารย์หรือ
นักวิจัยในอดีต และชื่อเสียงของมหาวิทยาลัยที่สังกัดเป็นปัจจัยที่สำคัญทำให้การทำวิจัยร่วมกันเกิด
ผลลัพธ์ที่ดี มีประสิทธิผล

10. ท่านคิดว่า คุณลักษณะเฉพาะของบุคคล คือนักวิจัย หรืออาจารย์ ผู้จัดการหรือผู้
ประสานงานโครงการ และวิศวกร ที่ทำวิจัยร่วมกัน เช่น ความรู้ ทักษะที่จำเป็น เป็นปัจจัยสำคัญที่ทำ
ให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

11. ท่านคิดว่า ทรัพยากรที่จำเป็นต้องใช้ในการทำวิจัย เช่น เครื่องมือ ห้องปฏิบัติการต่าง ๆ
ตลอดจนระบบที่สนับสนุนที่เพียงพอ เป็นปัจจัยสำคัญที่ทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มี
ประสิทธิผล

12. ท่านคิดว่า การสื่อสารที่ดีมีประสิทธิผลระหว่างผู้ที่มีส่วนเกี่ยวข้องกับการทำวิจัย
ร่วมกัน เช่น อาจารย์หรือนักวิจัย วิศวกร ตลอดจนผู้จัดการหรือผู้ประสานงานโครงการ เป็นปัจจัย
สำคัญที่ทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

13. ท่านคิดว่า มีปัจจัยอื่น ๆ อีกหรือไม่ที่ทำให้ทำการวิจัยร่วมกัน ระหว่างหน่วยงานหรือ
บริษัทของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัย เกิดผลลัพธ์ที่ดี มีประสิทธิผล

โครงสร้างคำถามสำหรับการสัมภาษณ์วิศวกรขององค์กรภาคอุตสาหกรรม Hard Disk Drive ที่ทำวิจัยร่วมกันกับนักวิจัยหรืออาจารย์จากมหาวิทยาลัย

(In-depth Interview Question)
เพื่อตอบคำถามการวิจัย

1. ขอให้ท่านแนะนำประวัติส่วนตัวโดยย่อ ประวัติของบริษัทหรือหน่วยงานของท่าน เช่น วิสัยทัศน์ พันธะกิจ และผลิตภัณฑ์ที่ท่านผลิต ตลอดจนผลการดำเนินงานในด้านต่าง ๆ ของบริษัทหรือหน่วยงานของท่าน

2. ขอให้ท่านกรุณาเล่าถึง จุดเริ่มต้น ที่มาที่ไปถึงการได้รับมอบหมายในการทำวิจัยร่วมกันระหว่างตัวท่านหรือหน่วยงานของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยที่ได้มีข้อตกลงร่วมมือกัน

3. ขอให้ท่านเล่าถึง บทบาทหน้าที่ความรับผิดชอบของท่านในฐานะที่เป็นวิศวกรที่เกี่ยวข้องกับการทำวิจัยร่วมกันระหว่างหน่วยงานของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยที่ได้มีข้อตกลงการทำวิจัยร่วมกัน

4. ขอให้ท่านเล่าถึงวัตถุประสงค์ หรือ จุดมุ่งหมายของโครงการการทำวิจัยร่วมกันระหว่างหน่วยงานของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัย

5. ท่านคิดว่าการกำหนดวัตถุประสงค์และเป้าหมายของการทำวิจัยร่วมกันระหว่างหน่วยงานของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยในแต่ละหัวข้อการวิจัยที่ชัดเจน ยอมรับร่วมกัน และวัดผลได้ เป็นปัจจัยสำคัญในการทำให้การวิจัยในหัวข้อนั้น ๆ เกิดผลลัพธ์ที่ดี มีประสิทธิผล

6. ท่านคิดว่า การทำข้อตกลงการทำวิจัยระหว่างหน่วยงานหรือบริษัทของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยที่ก่อให้เกิดผลประโยชน์ร่วมกัน หรือ Win-Win Agreement เป็นปัจจัยสำคัญที่ทำให้การทำวิจัยในหัวข้อการวิจัยนั้น ๆ เกิดผลลัพธ์ที่ดี มีประสิทธิผล

7. ท่านคิดว่า บทบาทที่เข้มแข็ง มีความมุ่งมั่นของผู้นำที่เกี่ยวข้องกับการทำวิจัยร่วมกันระหว่างหน่วยงานหรือบริษัทของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัยในหัวข้อการวิจัยนั้น ๆ เป็นปัจจัยสำคัญที่ทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

8. ท่านคิดว่า ความไว้วางใจกันระหว่างหน่วยงาน ที่พิสูจน์จากผลงานของอาจารย์หรือนักวิจัยในอดีต และชื่อเสียงของมหาวิทยาลัยที่สังกัดเป็นปัจจัยที่สำคัญทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

9. ท่านคิดว่า คุณลักษณะเฉพาะของบุคคล คือนักวิจัย หรืออาจารย์ ผู้จัดการหรือผู้ประสานงานโครงการ และวิศวกร ที่ทำวิจัยร่วมกัน เช่น ความรู้ ทักษะที่จำเป็น เป็นปัจจัยสำคัญที่ทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

10. ท่านคิดว่า ทรัพยากรที่จำเป็นต้องใช้ในการทำวิจัย เช่น เครื่องมือ ห้องปฏิบัติการต่าง ๆ ตลอดจนระบบที่สนับสนุนที่เพียงพอ เป็นปัจจัยสำคัญที่ทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

11. ท่านคิดว่า การสื่อสารที่ดีมีประสิทธิผลระหว่างผู้ที่มีส่วนเกี่ยวข้องกับการทำวิจัยร่วมกัน เช่น อาจารย์หรือนักวิจัย วิศวกร ตลอดจนผู้จัดการหรือผู้ประสานงานโครงการ เป็นปัจจัยสำคัญที่ทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

12. ท่านคิดว่า มีปัจจัยอื่น ๆ อีกหรือไม่ที่ทำให้ทำการวิจัยร่วมกัน ระหว่างหน่วยงานหรือบริษัทของท่านกับอาจารย์หรือนักวิจัยจากมหาวิทยาลัย เกิดผลลัพธ์ที่ดี มีประสิทธิผล

โครงสร้างคำถามสำหรับการสัมภาษณ์อาจารย์จากมหาวิทยาลัยที่ทำวิจัยร่วมกับ
อุตสาหกรรม Hard Disk Drive
(In-depth Interview Questions)
เพื่อตอบคำถามการวิจัย

1. ขอให้ท่านแนะนำประวัติส่วนตัวโดยย่อ ประวัติของหน่วยงานของท่าน เช่น วิสัยทัศน์ พันธะกิจ และคณะหรือ สาขาที่ท่านสังกัด ตลอดจนผลการดำเนินงานในด้านการทำวิจัยร่วมกับ หน่วยงานภายนอก

2. ขอให้ท่านกรุณาเล่าถึง จุดเริ่มต้น ที่มาที่ไปถึงการได้รับมอบหมายในการทำวิจัยร่วมกัน ระหว่างหน่วยงาน คณะ หรือ มหาวิทยาลัยของท่านกับวิศวกรในภาคอุตสาหกรรม Hard Disk Drive ที่ได้มีข้อตกลงร่วมมือกัน

3. ขอให้ท่านเล่าถึง บทบาทหน้าที่ความรับผิดชอบของท่านในฐานะที่เป็นนักวิจัยที่ เกี่ยวข้องกับการทำวิจัยร่วมกันระหว่างหน่วยงานของท่านกับวิศวกรในภาคอุตสาหกรรม Hard Disk Drive ที่ได้มีข้อตกลงร่วมมือกัน

4. ขอให้ท่านเล่าถึงวัตถุประสงค์ หรือ จุดมุ่งหมายของโครงการการทำวิจัยร่วมกันระหว่าง หน่วยงานของท่านกับภาคอุตสาหกรรม Hard Disk Drive

5. ท่านคิดว่าการกำหนดวัตถุประสงค์และเป้าหมายของการทำวิจัยร่วมกันระหว่างท่าน หรือหน่วยงานของท่านกับภาคอุตสาหกรรม Hard Disk Drive ในแต่ละหัวข้อของการวิจัยที่ชัดเจน ยอมรับร่วมกัน และวัดผลได้ เป็นปัจจัยสำคัญในการทำให้การวิจัยในหัวข้อนั้น ๆ เกิดผลลัพธ์ที่ดี มี ประสิทธิผล

6. ท่านคิดว่า การทำข้อตกลงการทำวิจัยระหว่างท่านหรือหน่วยงานของท่านกับ ภาคอุตสาหกรรม Hard Disk Drive ก่อให้เกิดผลประโยชน์ร่วมกัน หรือ Win-Win Agreement เป็น ปัจจัยสำคัญที่ทำให้การทำวิจัยในหัวข้อการวิจัยนั้น ๆ เกิดผลลัพธ์ที่ดี มีประสิทธิผล

7. ท่านคิดว่า บทบาทที่เข้มแข็ง มีความมุ่งมั่นของผู้นำที่เกี่ยวข้องกับการทำวิจัยร่วมกัน ระหว่างหน่วยงาน คณะ หรือ มหาวิทยาลัยของท่านกับภาคอุตสาหกรรม Hard Disk Drive ในหัวข้อ การวิจัยนั้นๆ เป็นปัจจัยสำคัญที่ทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

8.　ท่านคิดว่า ความไว้วางใจกันระหว่างท่าน ที่พิสูจน์จากผลงานของท่านในบทบาทของ
นักวิจัยในอดีต และชื่อเสียงของมหาวิทยาลัยที่สังกัดเป็นปัจจัยที่สำคัญทำให้การทำวิจัยร่วมกันเกิด
ผลลัพธ์ที่ดี มีประสิทธิผล

9.　ท่านคิดว่า คุณลักษณะเฉพาะของบุคคล คือนักวิจัย หรืออาจารย์ ผู้จัดการหรือผู้
ประสานงานโครงการ และวิศวกร ที่ทำวิจัยร่วมกัน เช่น ความรู้ ทักษะที่จำเป็น เป็นปัจจัยสำคัญที่ทำ
ให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

10.　ท่านคิดว่า ทรัพยากรที่จำเป็นต้องใช้ในการทำวิจัย เช่น เครื่องมือ ห้องปฏิบัติการต่าง ๆ
ตลอดจนระบบที่สนับสนุนที่เพียงพอ เป็นปัจจัยสำคัญที่ทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มี
ประสิทธิผล

11.　ท่านคิดว่า การสื่อสารที่ดีมีประสิทธิผลระหว่างผู้ที่มีส่วนเกี่ยวข้องกับการทำวิจัย
ร่วมกัน เช่น อาจารย์หรือนักวิจัย วิศวกร ตลอดจนผู้จัดการหรือผู้ประสานงานโครงการ เป็นปัจจัย
สำคัญที่ทำให้การทำวิจัยร่วมกันเกิดผลลัพธ์ที่ดี มีประสิทธิผล

12.　ท่านคิดว่า มีปัจจัยอื่น　ๆ　อีกหรือไม่ที่ทำให้ทำการวิจัยร่วมกัน ระหว่างท่านหรือ
หน่วยงานของท่าน กับภาคอุตสาหกรรม Hard Disk Drive เกิดผลลัพธ์ที่ดี มีประสิทธิผล

ที่ ศธ. 0526.02(3)/ ๓๖๕

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            คณะรัฐประศาสนศาสตร์ ได้พิจารณาเห็นว่าหน่วยงานของท่านมีผู้ที่เชี่ยวชาญ
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รายละเอียดใดที่พอจะเปิดเผยให้นักศึกษาทราบได้ ขอความกรุณาอำนวยความสะดวกให้ด้วย ทั้งนี้ท่านสามารถ
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