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運用層級分析法推衍智慧財產行銷策略--

以交通大學為例

Deriving an Intellectual Property Marketing Strategy for

National Chiao Tung University ---

Using Analytical Hierarchy Process Approach

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Abstract

Intangible assets play an essential role at organizations. It could create more value than tangible assets which refer to land, equipment, plant et cetera. Universities usually have a lot of R&D results which are industry wants to gain. After the legislation asserted university could own its intellectual property (IP), there are more and more TTOs (Technology Transfer Offices) or TLOs (Technology Licensing Offices) established. These offices are the bridge between the university and industry, doing the university/industry technology transfer (UITT).

Due to the different considerations between university and industry, this study focuses on the academic aspect to view what factors (or criteria) are important to the success of technology transfer and how much they are important. After understanding these rankings, IP marketing strategies would be constructed, it would be the effective way to help university to promote their intellectual property.

Keywords: Intellectual Property, Technology Transfer, Marketing Strategy

運用層級分析法推衍智慧財產行銷策略---

以交通大學爲例

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摘要

無形資產在組織中扮演舉足輕重的角色。它能創造比土地、機器設備等有形資產更多的價值。學校裡通常擁有許多業界想要獲得的研發成果。在法令鬆綁後學校可以擁有自身的智慧財產權，也接著出現越來越多的技術移轉中心。這些技轉中心是學校與業界間的橋樑，負責執行學校與業界之間的技術移轉工作。

由於學術界與業界各有不同的考量，本研究著重於學術界的觀點，探究影響技術移轉的各因素間相對的重要程度。藉此推衍出相關的行銷策略以作爲學校推廣研發成果的有效方式。

關鍵字：智慧財產、技術移轉、行銷策略

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Chia-Ju Hsu

HsinChu, June 21, 2005

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CHAPTER 1 INTRODUCTION

The development of Taiwan IC industry has moved in a rapid pace from manufacturing to design, shift from the follower to become the leader in the industry. The strength in mass production has been utilized and more diversity demands of customization which weakens the strength of traditional mass production. Less time-spending for time-to-market, enterprises devote to cost-down and short producing period. More globalization and alliances, more competitions exist between businesses. Nowadays, enterprises pay more attention on intangible assets which can create higher profits. The patent is the most important intangible asset in the organizations. For universities, there are many outstanding faculty members and rich resource for developing the useful technology. Once the R&D results come out, the academia would like to patent it and transfer it to industry. This study tries to construct the strategies in how to market or promote the intellectual property in university to the industry. Through understanding weight of each criterion which affected successful technology transfer helps both university and industry realize the importance ranking of factors at university aspect. From an industrial aspect, it could help them find useful technology and get revenue through commercialization. It also benefits the university because of the more technology transferring; the more monetary income could fund the further research. That would be a win-win solution.

This chapter consists of four sections. The first one introduces the development of IC industry. The second one covers the problem discussion. The third part illustrates research motivation and purpose. The last one forms the framework of this thesis.

1.1 Background

In the past, enterprises depended on the tangible assets like land and machines as the competitive advantages. Those who had more tangible assets were more powerful in the marketplace. Along with knowledge economy age approaching, the value of intangible assets is more important than the early ages. Knowledge workers create high benefits to company because of their intelligence. The intelligence in the brain needs no big space for storing, but creates high profits to the company. The intelligence is called intellectual property (IP) which includes patents, copyrights, trade secrets and trademarks. Patent, one of these properties, is especially significant to the IC industry, it spurs researchers to innovate new technology and bring the progressive power for the entire industry.

1.2 Problem Identification

Inventors always want to market their technology to produce physical products in order to be used by costumers. The completed process results in a success of innovation. Either faculties of university or engineers of company would like to see their new ideas be used for manufacturing new products, and then they can gain additional profit from their innovation. Thus, the marketing process is important to each innovator since they want to market their innovation. Many inventions belong to National Chiao Tung University (NCTU), and hopefully they will be used by the industry through using effective marketing ways, which is the purpose of this study.

As there is limited resource of Technology Licensing Office (TLO), the arrangement of the resource is a very important issue in order to boost the usage of inventions. According to the interviews, most of faculties think there is a lot work needed to be done to innovation promotion. It is not only a big issue for NCTU, but also for other universities. Marketing strategies are needed to promote goods and services, so do research results.

1.3 Research Motivation and Research Purpose

Since 1960s, Taiwan's IC industry development has been moving in a rapid pace, transferring from the OEM role to self-brand made; the typical examples like Acer and ASUS. Enterprises focus on their intangible assets, to understand self-own assets value. Through the patent analysis could know the competitive ability of rival company will be discovered and infringement will also be avoided. The academia has many outstanding faculties and plenty resources. The prior strength of academic organizations is the devotion to study, to research and to contribute to the industry. But the problem is there is no effective mechanism for marketing these research results.

National Chiao Tung University (NCTU) is one of the best research universities in Taiwan; it has been picked up as the case study sample. Interview and questionnaire are used to find out several ways to do the effective promotion of research result for NCTU. The sample is divided into two main groups, technology licensing officials and faculties. The quantitative data of questionnaire are used to find out the different thoughts between these two groups. The qualitative information, which consists of several open questions, is used to construct the marketing strategies.

A preemptive strategic move is the pioneering implementation of a strategy into a business area. Because it is the first, generates an asset or competence that forms the basis of a sustainable competitive advantage. For a preemptive move to create "first-mover advantages," competitors must inhibit or prevent from duplicating or countering it (Aaker, 2001).

Intellectual property can be regarded as a "product" because it can be traded. So, the marketing concepts are important to intellectual property, too. Marketing stars with the fact of human needs and wants (Kotler, 1994). Among the process of technology transfer (can be regarded as transaction), the vender (university) should understand what the customer (industry) needs. This study would construct the IP marketing strategy for

NCTU, in order to transfer its-owned IP to the industry. Through this process, companies would get the new technology and build more convenient and useful product to customers. And the profit of school is the royalty or licensing fee or the fund for further research from the industry.

1.4 Research Content

Chapter 2 covers the literature reviews which conclude intellectual property, technology transfer and marketing strategy. That illustrates several terminology and concepts. It also lists key factors of technology transfer. Chapter 3 presents the research process and methodology. The algorithm used in this study is called Analytical Hierarchy Process approach. Chapter 4 shows the results, the analysis and the findings. This chapter also concludes the analysis of the results from the different aspects. And the last chapter, chapter 5 consists of discussions and conclusions, providing marketing strategies and recommendations.

CHAPTER 2 LITERATURE REVIEW

2.1 The Development of Taiwan IC industry

Taiwan's IC industry began in the 1960s with IC packaging. Since Taiwan had little IC technology in the 1960s, packaging was used as a test case to demonstrate that there was a viable and sustainable market. By 1970, the government supported several laboratories to transfer the necessary technologies to build the fabrication and manufacturing facilities like the Industrial Technology Research Institute (ITRI) which is the fundamental institution of IC industry. In the industry, TSMC and UMC are the first two enterprises which are sponsored by the government to develop IC business, and as far as now, they are still the benchmarking enterprises in Taiwan IC industry. By the 1980's, IC fabrication sites and IC design laboratories completed the supply chain, forming the first original IC industry in the Hsinchu Science Park (Lin and Trappey, 1997).

During the 1990's, Taiwan expanded the industry by adding several supportive industries to the supply chain aggressively. The end result was the creation of a comprehensive semiconductor manufacturing supply chain with an infrastructure which consisted of design houses, semiconductors and other component manufactures, masking process plants, testing companies, and a wide range of component packaging lines (Chen and Trappey, 2001). Figure 1 indicates that the focus was in the chip foundry development (Chang, 2001).

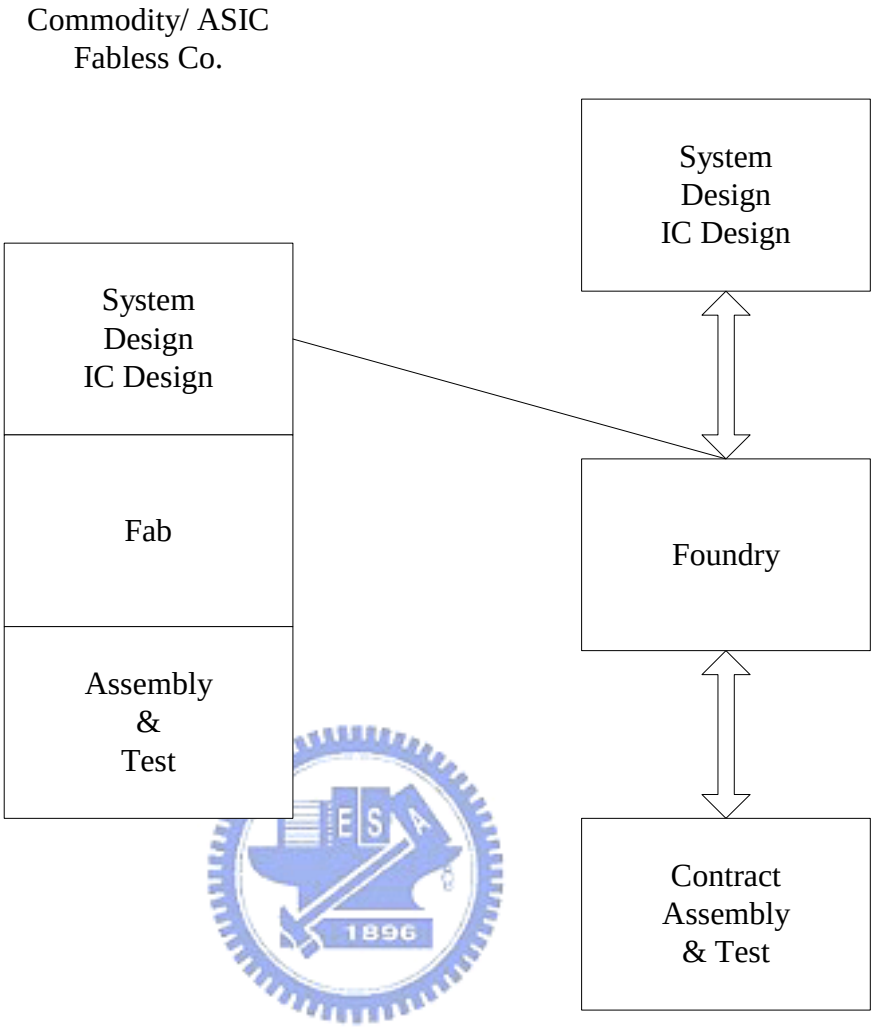


Figure 1 The infrastructure for chip foundries

Source: Chang, 2001

The current vision is to promote the creation of intellectual property across the supply chain. Taiwan's traditional role as a manufacturing center is changing, businesses are facing new challenges, and entrepreneurs are recognizing new opportunities. The national initiative addresses this dynamic by using Taiwan's manufacturing strength as an engine to drive new designs. Whereas the past emphasis has been on production, the new emphasis is on the creation of intellectual property, products and self-owned brands. The goal is to develop the Taiwan System-on-Chip (SoC) infrastructure. The infrastructure will better enable the global supply chain to source regional designs, mix-and-match intellectual property, manufacture, and test integrated circuits. Figure 2 indicates the change from chip foundries with OEM manufacturing to the System-on-Chip design supporting the view that Taiwan IC industry is entering a new

era in its industrial history (Chang, 2001).

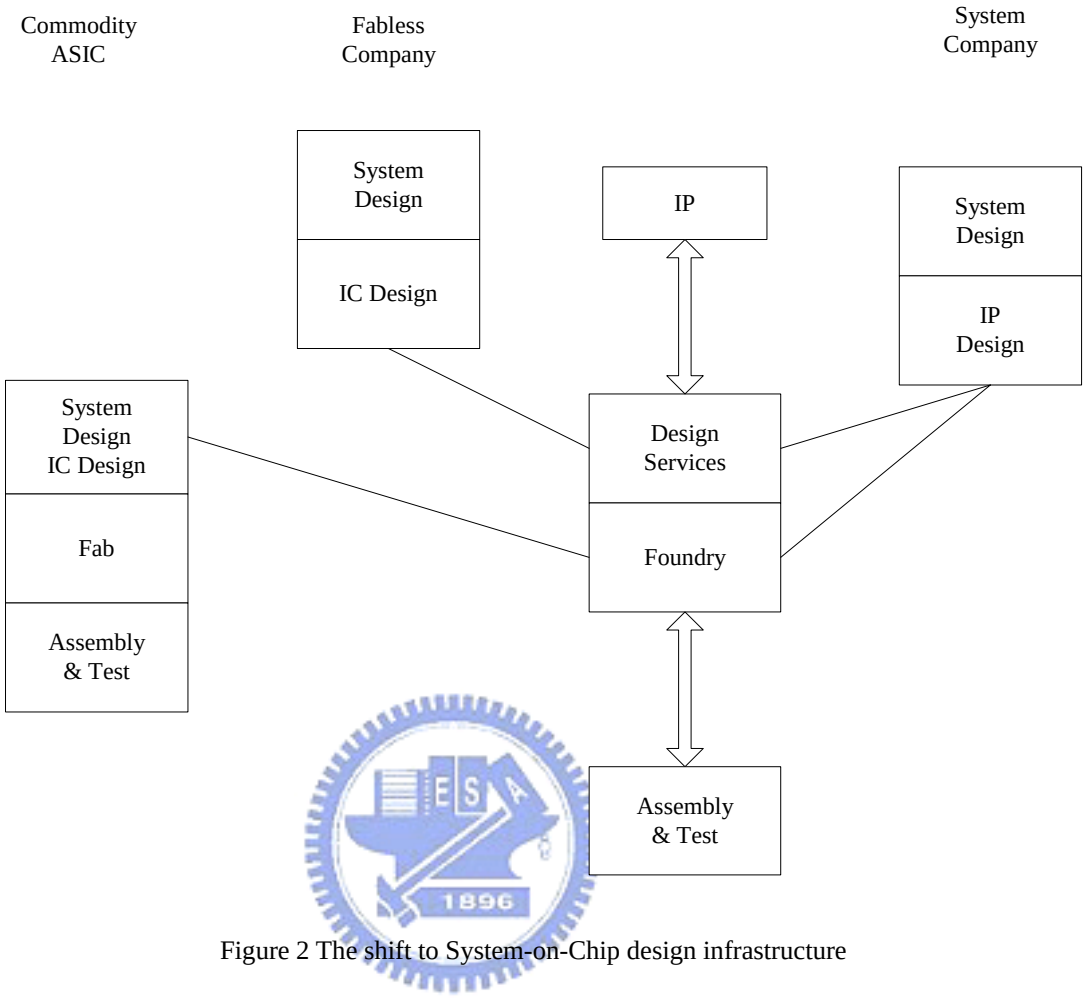


Figure 2 The shift to System-on-Chip design infrastructure

Source: Chang, 2001

2.2 Intellectual Property

Intellectual property refers to creations of the mind: inventions, literary and artistic works, and symbols, names, images, and designs used in commerce (extracted from WIPO website). Intellectual Property usually refers to patents, trademarks, copyrights and trade secrets or know-how.

Intellectual property is divided into two categories: Industrial property, which includes inventions (patents), trademarks, industrial designs, and geographic indications of source; and Copyright, which includes literary and artistic works such as novels,

poems and plays, films, musical works, artistic works such as drawings, paintings, photographs and sculptures, and architectural designs. Rights related to copyright include those of performing artists in their performances, producers of phonograms in their recordings, and those of broadcasters in their radio and television programs (Megantz, 2002).

2.2.1 Patents

A patent is a legal exclusive right for a limited term granted for an invention, which is a product or a process that provides a new way of doing something, or offers a new technical solution to a problem. A patent provides legal protection for the invention as described in the patent claims. The protection is granted for a limited period, depends on which patent it is, usually 20 years (extracted from USPTO website). A patent is the grant of a property right by a government to the inventor and the right given by the patent grant is the right to exclude others of making, selling or using the invention without authorization from the owner.

Patent protection means that the invention cannot be commercially made, used, distributed or sold without the patent owner's consent. These patent rights are usually enforced in a court, holds the authority to prohibit infringement. Conversely, a court can also declare a patent invalid upon a successful challenge by a third party.

There are three types of patent: invention patents, utility patents, and new design patents, which are categorized by the degree of the innovation, the first one represents the most innovative one. Patentability means three characteristics of patent granted, which includes usefulness, novelty, and non-obviousness. Usefulness means it is practicable to the legal industrial or commercial use. Novelty means it is new, differs in something form the publicly known or existing knowledge in the field. Persons work in the field would not consider the invention obviously could be regard as the

non-obviousness.

2.2.2 Trademarks

A trademark is a word, name, symbol or device which is used in trade with goods to indicate the source of the goods and to distinguish them from the goods of others. It is the powerful distinctions for business let consumers differentiate the various goods. A service mark is the same as a trademark except that it identifies and distinguishes the source of a service rather than a product. The terms “trademark” and “mark” are commonly used to refer to both trademarks and service mark.

The owner of a trademark can exclude others from using the similar trademark on similar or related goods or services if it is possibly make consumers feel confused (Stim, 2001). Trademark protection is granted to the first people selling or providing goods and services using the mark. If there is no commercial use, the owner could not keep the right.

2.2.3 Copyrights

Copyright is a form of protection provided to the authors of “original works of authorship” including literary, dramatic, musical, artistic, and certain other intellectual works, both published and unpublished. The Copyright Act generally gives the owner of copyright the exclusive right to reproduce the copyrighted work, to prepare derivative works, to distribute copies or phone records of the copyrighted work, to perform the copyrighted work publicly, or to display the copyrighted work publicly.

Copyright protection is acquired once an original work is finished in a certain perceptible form. The copyright protects the form of expression rather than the subject matter of the writing. The originality is required for copyright granted, it means the author did not copy something from others. It would not provide the exclusive right for the idea concern, this is the difference from patent right (Stim, 2001).

2.2.4 Trade Secrets

A trade secret is any type of business information that gives the company owns competitive advantage over the others who do not have this. Trade secret protection is acquired if the information is unknown to competitors and the information must be confidential and treated like a secret. The owner has the obligation to protect it, not show it publicly and be sure has some process to keep it. The protection of trade secret could last forever as long as the secret is kept confidential (Stim, 2001). The most famous one people always talking about is the Coca-Cola recipe.

The choice for patent or trade secret protection is a trade-off. Patent filing needs to be disclosed the information of invention. However, the confidentiality to trade secret is the essentiality. Some invention could not meet the patentability instead of seeking the protection of trade secret is the usual way for business. The protected periods are also different for patent and trade secret. There is a limited time for patent protection, no more than 20 years; on the contrary, there is no time limit for trade secret as long as it is kept by certain confidential way.

2.3 The Value of Intellectual Property Rights

A basic knowledge of intellectual property rights allows innovators to protect their business, by applying of patents, or trade marks, or design registrations, by keeping records which prove ownership of design right or copyright and by proper handling of confidential information. Knight (1996) noted that once the rights have been secured, they can be used in three ways. Firstly, if your product is being copied, you can consider legal action. Secondly, if you can not supply all markets, for example, one having incompatible specialized requirements to your own, or overseas, you can grant a license to another company in return for a royalty payment. And the last, intellectual property

rights (IPRs) also provide a way of controlling business associates, such as use of confidential information by a supplier of maintenance services for your product.

Overall, IPRs allow an innovative company to control and benefit from its ideas, even in other countries. Finally, avoid being sued yourself for infringement of someone else's intellectual property without permission (Smith and Parr, 1994, 1995).

2.4 The Development and Trend of Technology Transfer

The concept of technology transfer is transferred form advanced countries like US, Germany and Japan. There are many factors which affect the success of technology transfer process, and these will be mentioned at 2.6. This section will present the development and trend of technology transfer of USA and Taiwan.

2.4.1 The Development of USA Technology Transfer

In 1980, the US Congress attempted to remove potential obstacles to university/industry technology transfer (UITT) by passing the Bayh-Dole Act. Bayh-Dole removed many restrictions on licensing, allowed universities own its research results which sponsored by federal grants. This legislation asserted that the ownership and intellectual property management of university would accelerate the commercialization of new technology and promote economic development. After this legislation, many universities established the technology transfer offices (TTOs) to manage, protect and promote the intellectual property. The role of the TTO is to facilitate technology to industry and gain the licensing fee or/and royalty to assist in doing the further research.

2.4.2 The Development of Taiwan Technology Transfer

Taiwan was affected by the Bayh-Dole Act also legislates for the university could own its intellectual property which was subsidized by the government. The Science and Technology fundamental Law claimed that:" The investment of science and technology

development which were subsidized by the government, should be depended on the evaluation or the examination for objects. The intellectual property and the achievement could be completely or partially owned by the research organization, it is not limited by the government-owned property law."

As the same effect as in USA, many technology transfer organizations were started. In NCTU, it was called Technology Licensing Office. It consisted of technology consultant, legal consultant and other managers. The three main functions of the TLO are: manage and protect the research results; promote the research results and technology transfer and licensing

TLO plays an indispensable role of the university. Financial support by government has declined; universities have been advised to earn part of their research and development expenditure through technology transfer. That is the main reason of more and more technology transfer.

2.4.3 Current Trend

Innovation can be regarded as a continuum process, from the radical to incremental (Mohr, Sengupta, and Slater, 2005). Most radical innovations are developed by R&D groups, maybe in companies, universities or research laboratories. These R&D groups had not thought about the particular commercial application in the market during the development process. In this situation, it is the supply-side market, revolutionary process. This market is referred to as "technology-push" situation.

On the other hand, incremental innovations are the continuations of existing methods or practices and may involve extension of products which are already on the market. They are evolutionary as opposed to revolutionary. Incremental innovations occur in demand-side, customer pull markets, in which product characteristics are well defined and customers can realize their needs.

The product life cycle has been depicted at Figure 3 (Kenny, 1988). This model can be applied to almost every mass-produce products. Typically, research expenditure at the beginning of the cycle is greatest. Universities are the most common sites for the research and development. At the testing, evaluation and commercialization phases, the industry has taken the responsibility to do. There are less and less time and money expenditures of industry toward the end of the product life cycle, as the phase maintenance and retirement.

Form the figure 3, the gap between university and industry is clear to see. What needs to do is to incorporate with a technological push from universities and a marketing pull from industry. Universities are culturally, economically and technologically oriented departmental structure. As the joint of state and federal initiatives, the academic response could be the establishment of multidiscipline centers. The funding sources have instituted block grants that require close interaction among various university departments and colleges to encourage the establishment of multidiscipline centers.

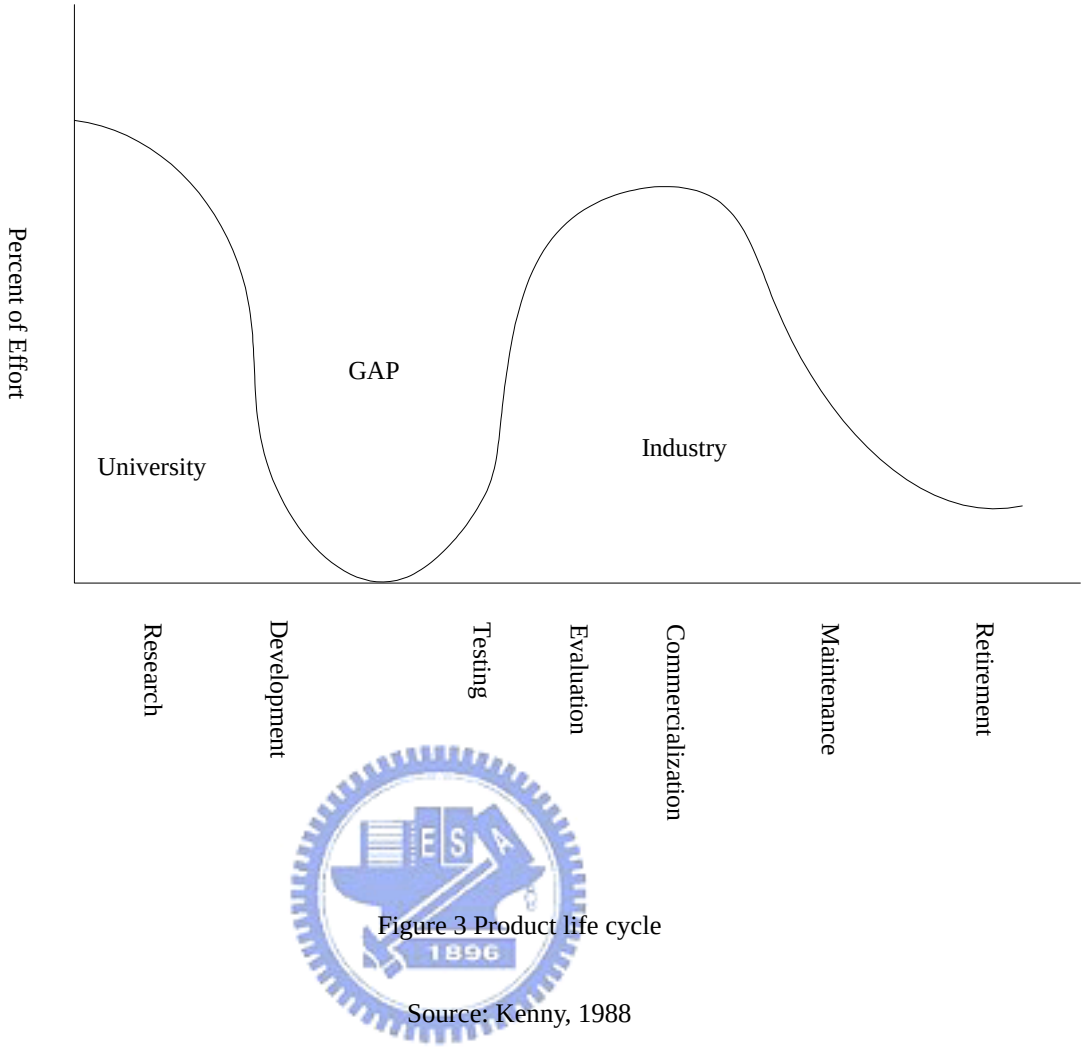


Figure 3 Product life cycle

Source: Kenny, 1988

The current trend is to recognize technology is the power as important as capital, labor and materials. From the international viewpoint, the strength of military has been changed to economic strength.

2.4.3 How to Do Technology Transfer

According to theory, there are several procedures of technology transfer process from the initial scientific discovery to the licensing to firms. It is regard as a continuous activity among university, TTO and firm.

Figure 4 illustrates a series of the process which begins with the scientific discovery that refers to R&D results of researchers (Siegel et al., 2004). The dotted line means members are involved in the stage.

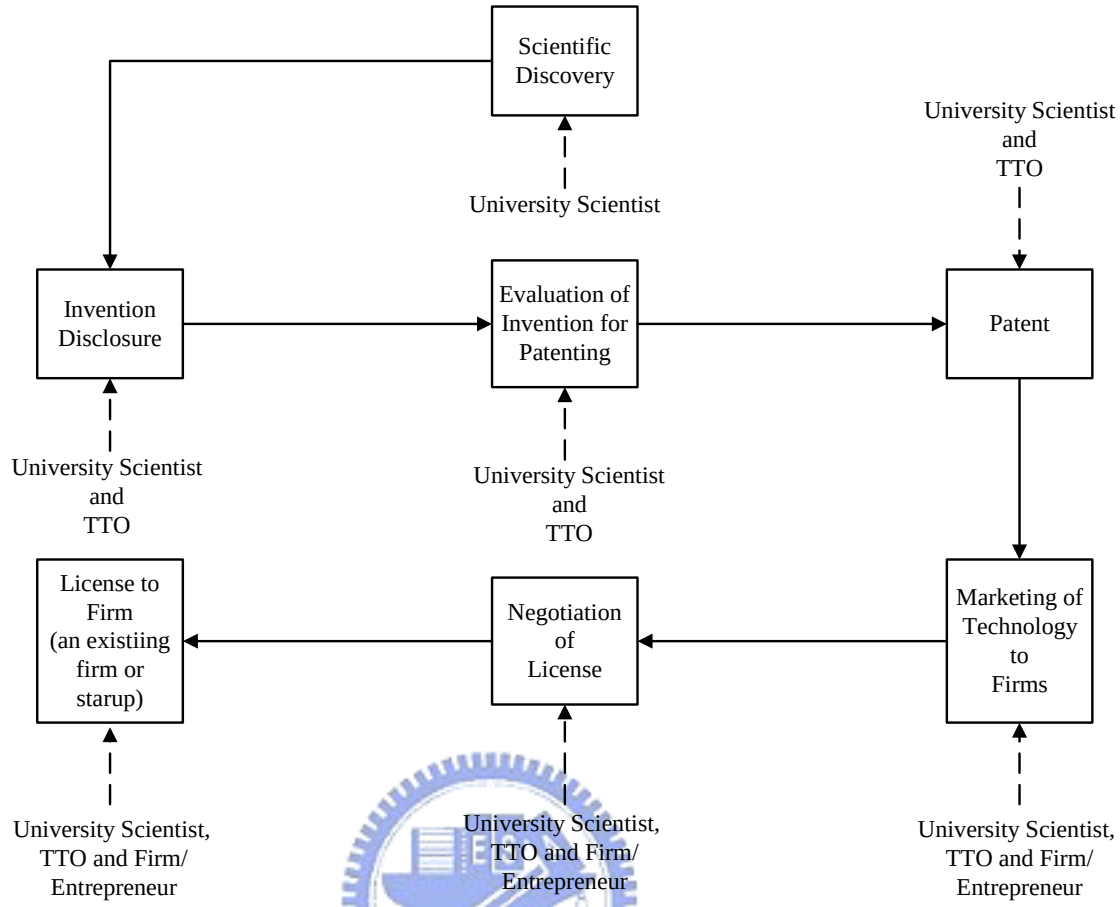


Figure 4 How a technology is transferred from a university to a firm

Source: Siegel et al., 2004

After discovering the scientific findings, disclosure the invention is the next step in order to evaluate for patenting or not. At this time, TTO begins involved in this activity and provided professional advice and suggestions for technical and legal consultation, TTO officials will help academic to decide which one is the mechanism to protect intellectual property. In other cases, the TTO must make a judgment regarding commercialization potential prior to interest being expressed by industry.

The main job for TTO is the marketing and promotion of technology. Sometimes, faculty members can help identify potential corporate licensees; it is the reason why academics would involve in this stage. The potential licensees were found, the next motion is the negotiation with these members. The licensing agreement consisted of

several issues; this agreement could include such benefits to the university as royalties, licensing fee or an equity stake in a startup.

At the final stage, the technology is converted into a commercialized product. The university may continue its involvement with the firm, for instance, by devoting resources to the maintenance of licensing agreements. Moreover, in the case of startups, faculty members may serve as technical advisors or on boards of directors, and may also have an equity stake in the startup.

2.5 Terminology of Technology Transfer

Technology accumulated knowledge, knowledge created technology. The accumulation of know-how is significant to high-tech development. Especially the Bayh-Dole Act and other advanced nations legislation effect, the Science and Technology fundamental Law asserted to release the ownership of the R&D achievement to the university. The R&D results could be transferred from university to industry (Donald et al., 2004). Universities receive the monetary reward and the industry gets the technology, it is the win-win approach to both university and industry.

Technology transfer is the most popular way for university to do promote their research results. The following sections will be illustrated several definitions for the clear explanation:

2.5.1 Definition of Technology

One approach to define technology is to derive the concept from the Greek root. The classical Greek origins of the technology are $\tau\varepsilon\chi\eta\nu\varepsilon$ (‘techne’) and $\lambda o\gamma o\sigma$ (‘logos’). The word $\tau\varepsilon\chi\eta\nu\varepsilon$ can be interpreted as skills or technique. The word $\lambda o\gamma o\sigma$ can be interpreted as knowledge or science. Accordingly, technology can be viewed as knowledge of skills or techniques or a science of skills or techniques.

Webster’s dictionary defined the word technology in several ways: 1. knowledge that deals with industrial arts, applied science or engineering; 2. terminology of art or

science; or 3. a technological process, invention, method or some of ways a social group provides themselves the material objects (Narayanan, 2001).

Sharif and Ramanathan (1987) defined technology from the point of view of developing country oriented technology transfer research. They divided technology into four main components: ‘technoware’, ‘infoware’, ‘humanware’ and ‘orgaware’. ‘Technoware’ refers to technology substance. ‘Infoware’ means all information related technology. ‘Humanware’ refers to human resource. And ‘Orgaware’ means organizational culture.

In defining technology, it is also important to identify various external factors which focus on the relationships between technology and the economy affecting technological development. The knowledge component of technology can be transferred through social interactions. This aspect makes it necessary to combine the component approach and the social approach to define technology. Technology comprises the ability to recognize technical problems, the ability to develop new concepts and tangible solutions to technical problems, and the ability to exploit the concepts and tangibles in an effective way (Autio and Leamanen, 1995).

Min Chen (1995) noted that the concept of technology and technology transfer has been defined in different ways and evaluated against a variety of criteria. In spite of these differences, many researchers and specialists tend to agree that technology can best be defined specifically as a new and more efficient way of achieving economic gains that facilitate or even revolutionize economic development. It is a process by which expertise and technological know-how could pass from owner to another user because of the economic benefits it could generate.

2.5.2 Definition of Technology Transfer

A general definition of technology transfer can be constructed by taking a look at the Latin origins of the ‘transfer’. In Latin, *trans* means over, or across the border, and

ferre means to carry. The word *trans* suggests that during the process of carrying. Accordingly, technology transfer can be viewed as an active process, during which technology is carried across of two entities. These entities can be countries, companies, or even individuals.

Most definitions of technology transfer did not take the time dimension into account. It is typical for the traditional definitions of technology transfer to regard technology as something which does not change during the transfer process. However, things could be changed over time, even the technology could. If the time dimension is not taken into account, many important technology transfer mechanisms are excluded from the range of possible technology transfer mechanisms. The interaction aspect needs to be emphasized in defining innovation-oriented technology transfer. In brief, the definition of technology transfer is intentional, goal-oriented interaction between two or more social entities (Autio and Leamanen, 1995).

Hameri (1996) noted that technology transfer is an active and intentional process (it included licensing, foreign investments and buying motions) to spread or acquire knowledge, experience and the related works.

Cutler (1991) pointed out that a series of steps to acquire and implement technology from outside is usually referred to as technology transfer. These steps consisted of recognition, evaluation, acquisition, enhancement, and implementation.

2.5.3 Definition of Technology Transfer Mechanism

A definition for technology transfer mechanism can be based on the definition of technology transfer. Autio and Leamanen (1995) defined technology transfer mechanism as any specific form of interaction between two or more social entities during which technology is transferred. The range of technology transfer mechanism covers all possible forms of interaction during which technology transfer occurs.

Kedia and Bhagat (1988) pointed out the process of technology transfer is

composed of the transfer of a systematically developed set of organized information, skills, rights and services from a supplier organization to a recipient organization.

2.5.4 Definition of Technology Transfer Channel

The definition of technology transfer channel can be based on the definitions of technology transfer and technology transfer mechanism. However, Autio and Leamanen (1995) pointed out that the distinction between the technology transfer mechanism and the technology transfer channel is not always clear. Depending on the scope of view, some technology transfer channel can be viewed as technology transfer mechanism, and vice versa. From the point of view of technological development, technology transfer is often such an integrated activity that it is very difficult to distinguish transfer phenomena from the other phenomena under evaluation. The various technological development activities within the transfer process can be viewed as technology transfer channels or mechanisms. Their study classified technology transfer channels into three types: contract research, R&D consortia and spin-off companies.

2.5.5 Definition of Technology Transfer Approach

According to Kedia and Bhagat (1988), there are basically three major approaches towards technology transfer. The first approach examines the process by which a technology is transferred, the types of technology that are likely to be absorbed more smoothly by recipients, and the continuing relationships of the two parties as contracted by initial negotiations. This approach tends to put an emphasis on process, for example, the way in which person-involved, product-involved and process-involved technologies are transferred.

The second approach tends to concentrate on the absorptive capacities of the recipients. Absorptive capacity is often defined as a kind of perceived ‘fit’ between the supplier and the recipient. This usually refers to the ability of a recipient to operate the technology, to generate new productive capacity and to make technological innovations.

The third approach studies the effectiveness of transfer by looking at a whole range of factors, such as governmental policies, industry characteristics, technological maturity, technological sophistication of supplier and recipient organizations, cultural type, etc.

It is worthy mentioned the success of technology transfer is unique to each case. Generally speaking, technology transfer can take various forms; including licensing or cross-licensing of patents and know-how, contribution of technology to non-equity and equity joint ventures and counter-trade.

2.6 Key Factors of Technology Transfer

Autio and Laamanen (1995) did the research about measurement and evaluation of technology transfer. They reviewed the mechanisms and indicators and classified indicators into three categories: inputs indicators, process indicators and outputs indicators. The input indicators precede the development phase; the process indicators focus on the development phase; and the outputs indicators focus on the results of the development phase.

Baranson (1966) proposed the difficulties involved in international technology transfer are a function of: the quantum and complexity of the technology components; the engineering gap between transferor and transferee; the economic gap between advanced and developing countries; and the policy of economic autarky in force deny importing products to offset the domestic deficiencies.

Davidson and Mcfetridge (1984) noted the determinants of the mode of technology transfer. They pointed out the newer, less widely used and no substituted technology and less experiences of technology transfer are likely burdened by high measurement costs, uncertainty and the need to make transaction-specific investments. The advantages of inner technology transfer will decline its costs for the outer technology transfer. The numbers of transfers are expected in the future will increase the amount of new

invention that the transferor produced.

Ounjian and Carne (1987) classified the factors that facilitate technology transfer and factors that inhibit it into four categories, table 1 put in it.

Table 1 Factors that facilitate or inhibit technology transfer

Source: Ounjian and Carne (1987)

	Facilitating factors	Inhibiting factors
The nature of the technology to be transferred	a. Receiver familiar with technology b. Market pull c. Transfer is timely d. Quick and early success in showing technical feasibility e. Selection of the right application f. Offers obvious economic advantage	a. New technology b. Technology push c. Technology is complex d. Indirect transfer
The characteristics of the recipient	a. Technical expertise complements of giver b. Management supportive c. Early involvement with researchers on the invention d. Sense of ownership of research program	a. In a survival mode b. Not involved at all in the research development c. Groups involved in indirect transfer have conflicting goals

	e. Adequate resources to receive and develop f. Willing to exchange staff to make transfer work g. Product champion h. Geographically or better culturally close to giver	
The characteristics of the technology giver	a. Management supportive b. Adequate resources to research c. Adequate resources to transfer d. Provide adequate documentation of results and/or training e. Willing to exchange staff to make transfer work f. Research champion	a. More interested in research than in solving business unit's problems b. Does not offer range of technical options to receiver
The nature of the communications between the two organizations	a. History of positive relationships b. Common goals established	a. Lack of respect for each other b. Responsibilities not clear

	c. Sense of a team exists between giver and receiver	c. Does not know customers' needs d. Potential benefits the technology offers are not understood

Madu (1989) pointed out the critical factors for successful technology transfer to developing countries. Table 2 is the summarized content.

Table 2 Critical factors for successful technology transfer

Factors	Explanations
Needs and Objectives	The participants must identify the agreeable needs and objectives. The objectives have to be realistic and achievable.
Capabilities	Capabilities can be in terms of human resources, capital, natural resources, land and others.
Education, Training, Research and Development	The appropriate education system will enhance the capabilities to technology transfer.
Identification and implementation of appropriate technology	The core of technology transfer process is technology. Identified and implemented the appropriate technology will promote the success.
Management process	In order for the implementation of new technology to be effective, managers must be innovation-oriented. The dynamic organizational culture will enable innovators to implement change in an orderly manner.

The role of public policy	Stable foreign exchange and flexible joint venture policy will enable the large foreign investments to be benefit to technology transfer.

Smilor and Gibson (1991) used in-depth interviews, archival, and survey data collected in the Microelectronics and Computer Technology Corporation (MCC), suggested that communication, distance, equivocalness and motivation are the four central to technology transfer processes within and between organizations. Therefore, the higher or more active the communication links, the more likely the chance of technology transfer. The more consortium researchers and personnel understand the values, attitudes and ways of doing things means the shorter is the distance, the greater the chance of technology transfer. Technology that is low in equivocalness means it is easy to be understood and demonstrated. The lower the level of equivocalness, the more likely the technology will be transferred. Motivation refers to incentives and recognition of the technology transfer. The greater the degree of incentives, the higher the motivation for those engaged in the process.

Cutler (1991) pointed out several reasons exist for successful technology transfer from the Herrick Laboratories: a. Faculty and research staff are familiar with industrial needs. b. Have specialized facilities that do not exist in many laboratories. c. Monthly reports and regular meetings with industrial sponsors. d. A desire to increase productivity, reliability and world-wide competitiveness. e. An Industrial Advisory Committee which could help keeps the laboratories attuned to industry's needs. f. An atmosphere of cooperation and synergy among the laboratories.

Chen (1995) pointed out the technology transfer has been defined in different ways and evaluated against a variety of criteria. The effectiveness of transfer by looking at a whole range of factors, such as governmental policies, industry characteristics, technological maturity, technological sophistication of supplier and receiver

organizations, cultural constraints, etc. However, the success of technology transfer is unique to each case.

Teece (1977) researched the costs of transferring technology from two categories: technology/transfer characteristics and, technology receiver and host country characteristics. The model he made is consisted of seven variables and one random error. Each variable will be illustrated as the following table:

Technology/transfer characteristics	Receiver and host country characteristics
The number of previous applications or start-ups that the technology of the transfer has undergone	The number of years of manufacturing experience that the recipient of transfer has accumulated
The age of the technology in years	The ratio of R&D to sales for the recipient of the transfer
	The volume of sales of the recipient of the transfer
	The number of firms identified by the giver as having the identical and competitive technology
	The level of GNP per capita of the host country

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Research Issue and Framework

The purpose of this study is to develop the effective IP marketing strategies for NCTU. As the limited resources of TLO are the critical factors to limit the success, new ways of working have to be developed. How to arrange these resources to promote R&D results that could save the time used and improve effectiveness is the purpose of this study. NCTU technology transferring process has been illustrated as figure 5. There are patent creations (or technology innovations) from the faculties in NCTU.

Technology Licensing Office plays the role to promote these research results to the industry. They would like to use ways like licensing or technical collaboration to transfer university-owned patents and receiving the royalty or licensing fee from the industry. With the revenue increasing, NCTU has rich fund afford to the advanced R&D.

Figure 5 NCTU technology transferring process

The result of data analysis is to prioritize the ranking of each indicator which affect the technology transfer. Figure 6 shows the process and structure of the methodology that begins with the research issue identification then methods of investigations through literature reviews. Experts' opinions are the essential information of the survey design, sample selection and data collection. AHP is the core calculation approach to generate the rankings and weights of criteria in this study.

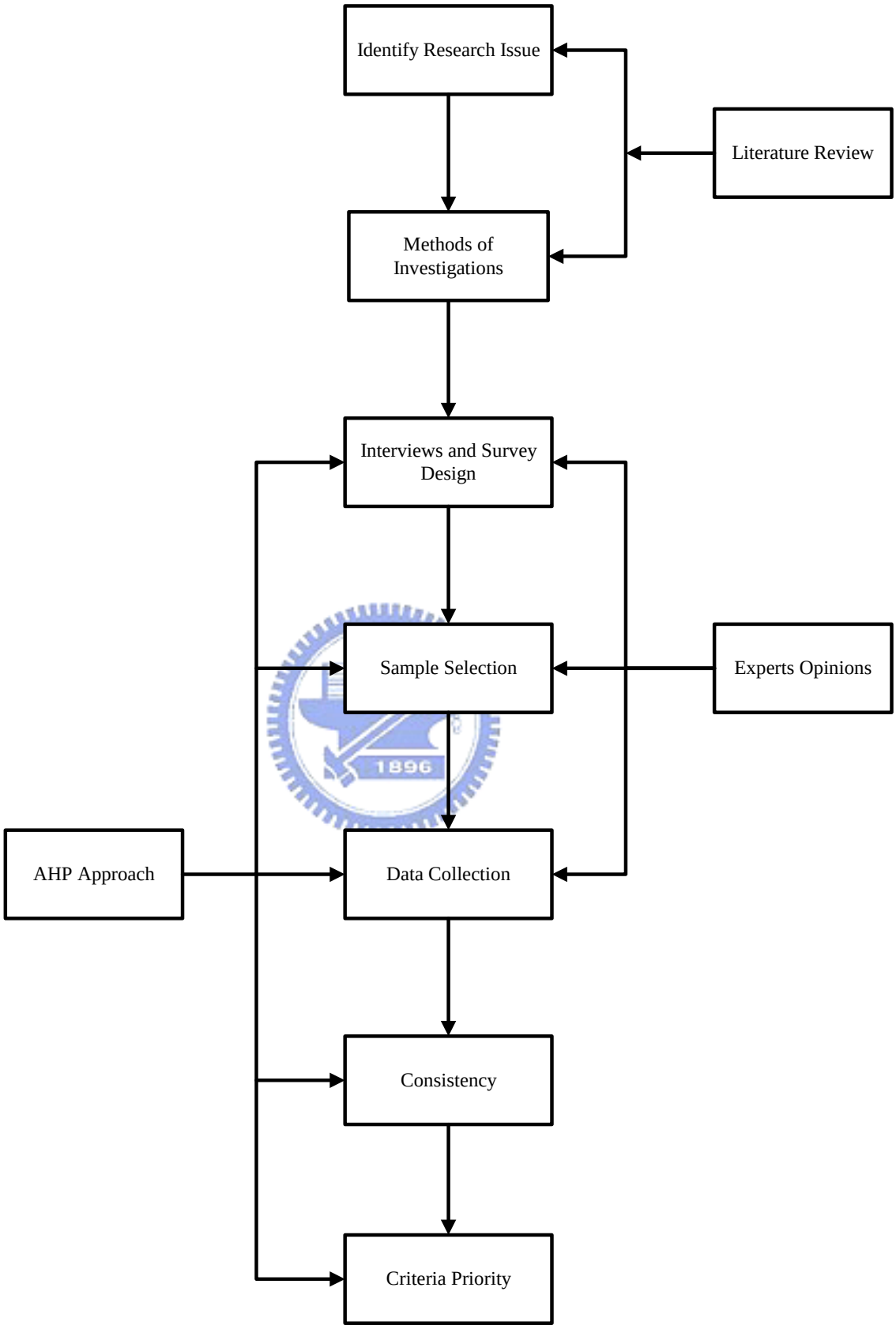


Figure 6 The process and structure of the methodology

3.2 Research Method

3.2.1 Interview and Questionnaire

The choice of research method is strongly depended on time, cost, and the purpose of research. Many choices of research methods can be classified based on how much knowledge is possessed in the problem area (Cox, et al. 1995).

Experts' opinions are very important to this study. It can be regarded as the core of this study. Because of all the samples are professional people and the questionnaire is different from the usual form. One by one face to face interview is the good way to ensure the validity and correctness (Kerlinger and Lee, 2000). The questionnaire form is attached at the appendix A and B, English version and Chinese version respectively.

Before the interview, use phone call to contact these experts firstly. Through the short introduction let them know the purpose of this study and ask them to do the interviews. After making sure time and place, usually in their research room in university, the 20 to 30 minutes interview will be started. Within the face to face interview, explaining each criteria of this study is the essential step. The purpose of this procedure is to let them understand each meaning of criteria and eliminating the vagueness and ambiguity. If the respondent had any question, he or she can ask immediately. These steps can ensure each interview is correct and valid.

3.2.2 Algorithm

This study is a multi-criteria problem. Decision makers could use several MCDM methods to solve this kind of issue. MCDM refers to Multi-Criteria Decision Making; it means the decision maker must consider all of the criteria that would affect his goal (Saaty, 1990). Infer to this study, the goal is how to transfer technology successfully, and the decision maker has to think about all criteria which could generate effectiveness.

The decision making process of human beings is very complicated. There are many factors of the single goal. Thus, the MCDM methods are more and more important to nowadays the world vary from minute to minute.

AHP (Analytic Hierarchy Process) is one method of MCDM. Its core concept is the hierarchical analysis. A question more complex decision maker more needs the hierarchy structure the analysis. Hierarchy process could help decision makers analyze their problems systematically. The problem is divided into several hierarchies or levels, and decision makers could solve the problem step by step (Saaty, 1990).

Figure 7 illustrated the structure of AHP. Decision goal is the mission that executives want to achieve or the problem they would like to solve. In order to simplify the problem, it is divided into several criteria. These criteria represent categories which affect the decision. They are classified according to the demand of executives. And the sub-criteria represent the detailed factors of the preceding level.

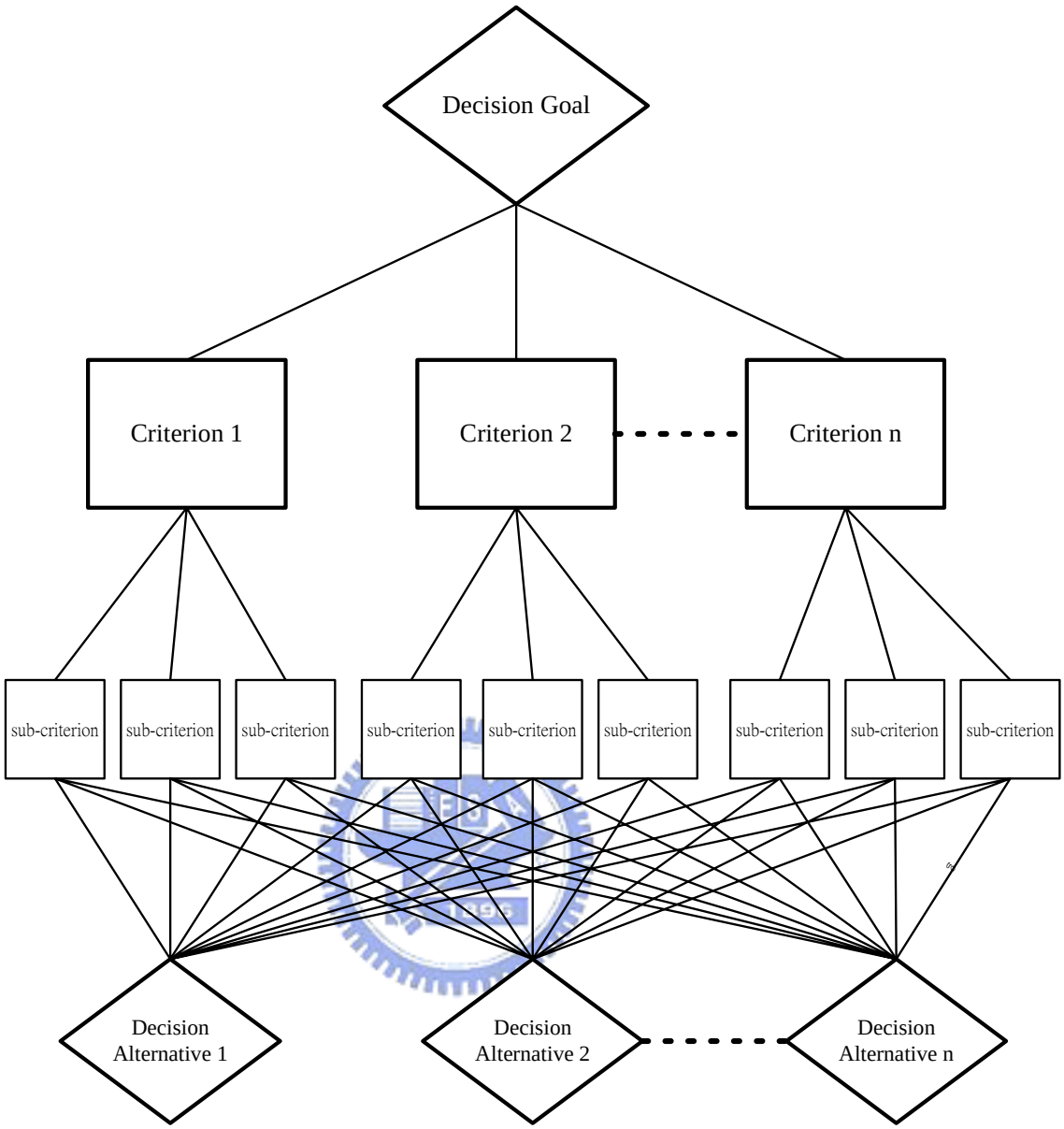


Figure 7 The structure of AHP

Source: Saaty, 1990

AHP technique helps decision maker to calculate the weight of each criterion and sub-criterion, let the decision makers know which indicator is more important (or influential) than the other. It also means the most influential factor would be considered firstly when arranging resources (Saaty, 1990). Infer to this study, decision maker would understand which indicator is more influential and how influential to the successful technology transfer and put more resources to the important part of the

whole process.

Madu (1989) proposed several techniques for technology transfer; and AHP is one of these methods. It requires the priorities for the different technologies which are based on the experts' judgments, and then the better alternative is selected according to this quantitative solution of these rankings.

Survey is the effective and efficient method to collect data. Similarly, it also uses survey to get the pairwise comparison data of AHP approach in this study.

3.3 Thesis Hierarchy

According to the above illustrations, the hierarchy of this study is represented in figure 8, and figure 9 is the revised model which is clear for looking. It is derived from Autio and Laamanen's reaearch (1995), who did literature reviews of technology transfer mechanisms and indicators and proposed a systematic structure of these indicators. Considering more specific identification of each criterion and sub-criterion, several identifications had been revised for this study. Table 3 illustrated the explanation of each criterion.

The goal of this study is how to transfer technology successfully. Three criteria are represented as inputs, process and outputs respectively. And the sub-criteria are derived from these three categories respectively.

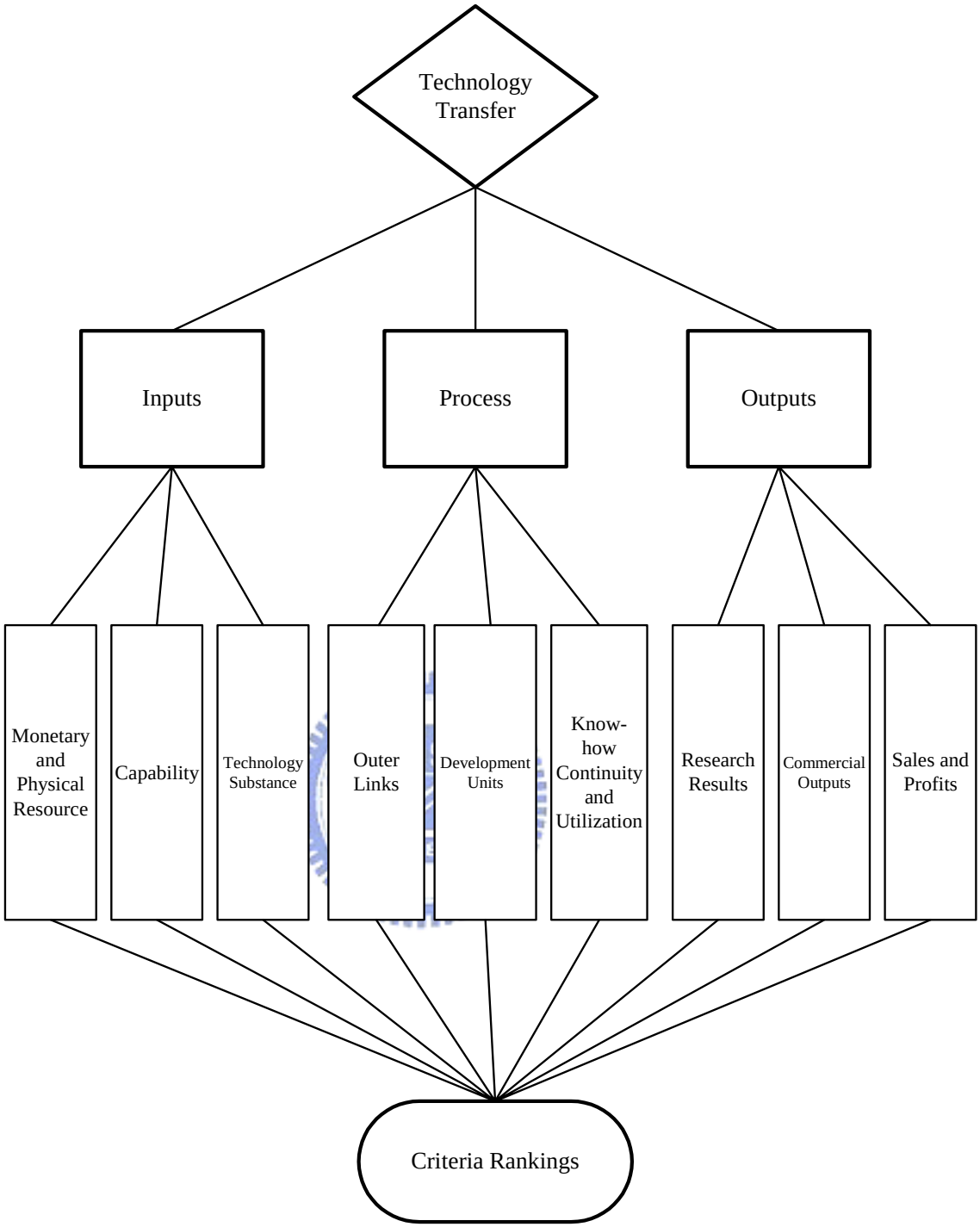


Figure 8 Thesis hierarchy of AHP

Revise of Autio and Laamanen's model (1995)

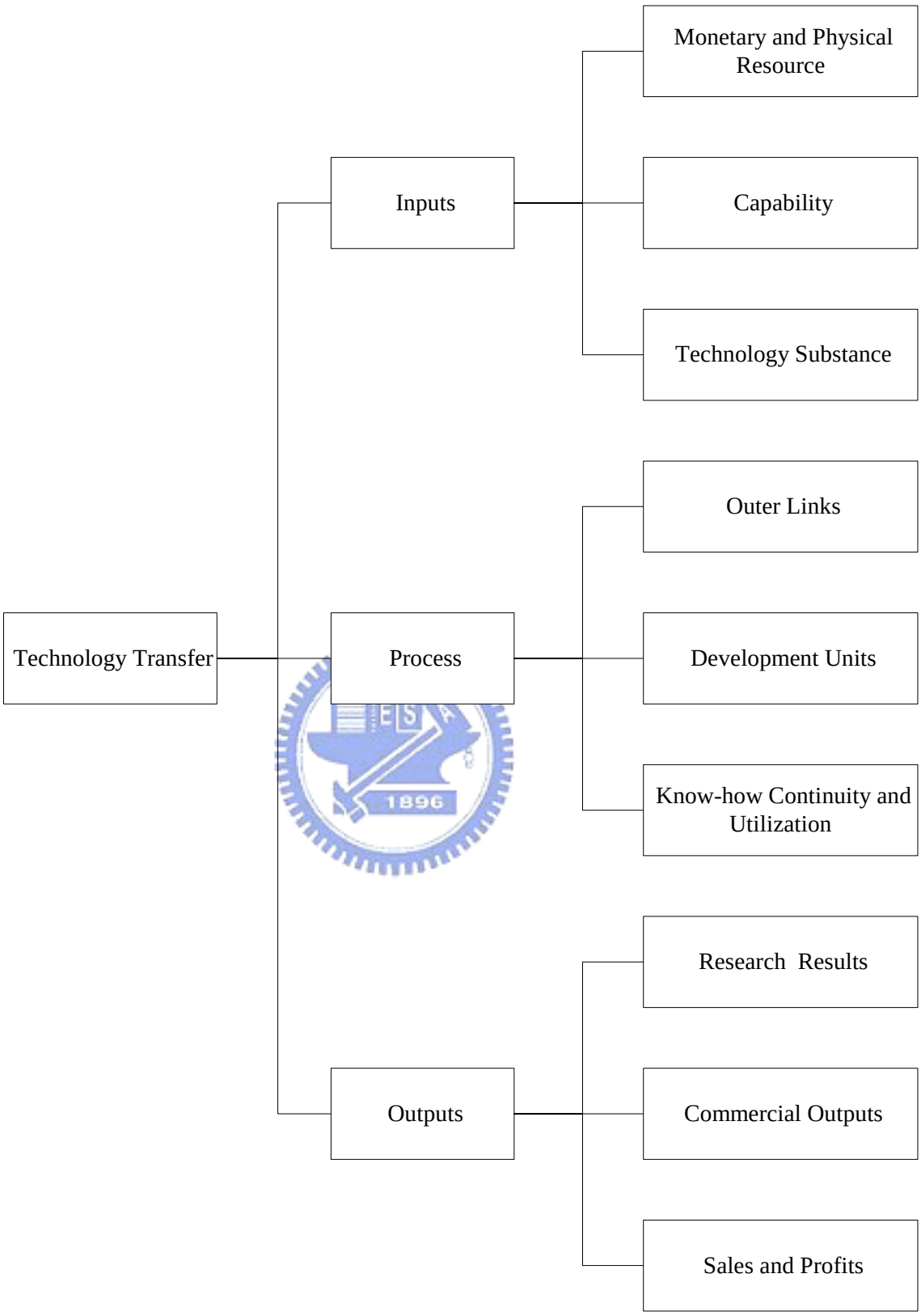


Figure 9 The revised model of thesis hierarchy

Table 3 Explanation of each criterion

Criteria	Sub-criteria
Inputs	Monetary and Physical Resource: refer to the R&D expenditures, the cost of applying patents, purchasing and maintenance of the facilities.
	Capability: refers to human resource, especially for R&D engineers. Legal consultants and other administrative members are the secondary considerations.
	Technology Substance: refers to the type of technology, how innovative the technology is, related information and mechanism.
Process	Outer Links: refer to the resource utilization of outer organizations. For example, the resource of spin-offs and incubators.
	Development Units: refer to the establishment of new development or promotion unit inside organization to exploit the research results.
	Know-how Continuity and Utilization: refer to the transfer and utilization of development capabilities during the process of technology transfer.
Outputs	Research Results: refer to the ‘raw’, or pre-competitive outputs, for instance, articles published, reports submitted, the granted patents, number of licenses, etc.
	Commercial Outputs: refer to the commercialization outcome of the research results, such as royalties, new products or new processes.

	Sales and Profits: refer to the accumulation of financial and physical resources during the transfer process. For example, annual and cumulative sales and profits generated by the spin-offs, the amount of venture capital, etc.

3.4 Calculations of AHP

Step 1: Generate the hierarchy

This thesis hierarchy of AHP was shown at figure 8 and figure 9 above.

Step 2: Survey (nine-point scale)

The nine-point scale is used for AHP pairwise comparisons. Pairwise comparisons refer to compare one by one to represent the preference (or importance) of judgments. Table 4 shows intensity of importance of AHP pairwise comparisons. It illustrates the meanings, definitions and detailed explanations for number 1 to 9.

Table 4 Intensity of importance of AHP pairwise comparisons

Source: Saaty, 1990

Intensity of importance	Definition	Explanation
Equally 1	Equal importance of both elements	Two elements contribute equally to the property
Moderately 3	Weak importance of one element over another	Experience and judgment slightly favor one element over another
Strongly 5	Essential or strong importance of one element over another	Experience and judgment strongly favor one element over another

Very Strongly 7	Demonstrated importance of one element over another	An element is strongly favored and its dominance is demonstrated in practice
Extremely Preferred 9	Absolute importance of one element over another	The evidence favoring one element over another is of the highest possible order of confirmation
2,4,6,8	Intermediate values between two near judgments	Compromise is needed between two judgments

Saaty(1990) proposed several reasons to illustrate why nine-point scale is used. First, the qualitative distinctions are meaningful when the items are compared with the same order of magnitude. Second, human ability to make qualitative distinctions is well represented by five attributes: equal, weak, strong, very strong, and absolute. When we need the greater precision, we can make compromises between two attributes, it means that is total nine attributes. Last, the psychological limit is suggested to be 7 ± 2 items in a simultaneous comparison. Thus, if the nine attributes are all slightly different from each other, then we need up to 9 points to distinguish these differences.

Table 5 showed the form of AHP questionnaire. Here is the example for total three criteria are used to pair compare, and it is generated 3 pairwise comparisons. If the expert regards the inputs criteria as weak important than process criteria, he will make a mark at the left side 3:1 box, and so on.

Table 5 The form of AHP questionnaire

Source: Saaty, 1990

Criteria	Prefer the left criteria than right									Prefer the right criteria than left								Criteria
	9:1	8:1	7:1	6:1	5:1	4:1	3:1	2:1	1:1	1:2	1:3	1:4	1:5	1:6	1:7	1:8	1:9	
Inputs							☒											Process
Inputs																		Outputs
Process																		Outputs

The original AHP nine-point scale questionnaire is difficult to answer for respondents. That is because the ratio is easy to confuse people; it means respondents are not easily to distinguish the slight difference between 2 items; the difference is usually not up to 7:1 even 9:1.

Based on the above reasons, the questionnaire is modified to the following pattern to clear and easy to answer for respondents; in addition, it does not lose the nine-point scale meaning.

Table 6 shows the importance ratio for inputs: process: outputs are 4:7:9, in the other word, outputs is 9/7 times important to process and is 9/4 times important to inputs. This modified table is not only easy to answer for respondents but also clear to calculate the pair comparison for researcher.

Table 6 The modified nine-point scale comparisons

Criterion	Importance (bigger number, more important)
Inputs	1 2 3 **4** 5 6 7 8 9
Process	1 2 3 4 5 6 **7** 8 9
Outputs	1 2 3 4 5 6 7 8 **9**

Step 3: Show the results of pairwise comparisons as a matrix.

According to table 6, pairwise comparison of three criteria is finished. The positive reciprocal matrix is used to represent the results. Positive reciprocal matrix refers to the element a_{ji} is the reciprocal value of the element a_{ij}; $a_{ji} = \frac{1}{a_{ij}}$. Figure 10 shows the matrix of table 6.

	Inputs	Pr*ocess*	*Outputs*
Inputs	1	4/7	4/9
Pr*ocess*	7/4	1	7/9
Outputs	9/4	9/7	1

Figure 10 Matrix form of 3×3 comparisons

Step 4: Calculate the eigenvalue (λ_{max}), CI, CR

Use MATLAB to calculate the eigenvalue of matrix is efficient. CI and CR are two indexes to measure the consistency of experts' judgments, for example, as the logic A > B, B > C, then A > C. CI (Consistency Index) $= \frac{\lambda_{max} - m}{m-1}$, λ_{max} refers to the biggest eigenvalue of the matrix; m refers to the numbers of criteria. CR (Consistency Ratio) = CI / RI, RI (Random Index) refers to the consistency index of a randomly generated reciprocal matrix form the 1 to 9. Table 7 shows the RI range from Saaty's book. The lower case n refers to $n\times n$ matrix form. In this study, it infer to 3×3 matrix form. CR equal or less to 0.1 is considered acceptable (Saaty, 1990).

Table 7 The mean consistency index of randomly generated matrices

Source: Saaty, 1990

The Mean Consistency Index of Randomly Generated Matrices															
n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Step 5: Calculate the weights

Weights are calculated by using EXCEL; it is also could be verified by the software named “Expert Choice”, which could calculate both weights and consistency index. The results have integrated several experts’ judgments; it also means there is one matrix at the end of calculation. This matrix represents the integrated weights of experts. Geometric Mean (GM) is used to represent the entries of the last matrix.

The following table showed the information about calculating weights. A_{ij} refers to the ratio of criterion i and criterion j of integrated all experts’ judgments.

$A_{ij} = \sqrt[s]{\prod_{t=1}^{s} a_{ij}}$, $t = 1 \sim s$, t refers to the numbers of experts; in this case, s = 18 persons.

$GM_n = \sqrt[m]{\prod_{i=1}^{m} A_{ni}}$, $n = 1 \sim m$, n refers to the numbers of criteria; in this case, n = 3 criteria.

$$\text{SGM} = \sum_{n=1}^{3} GM_n$$

The last column, Weight, which is normalized for the sum of W_n is 1. W_n refers to the weight of criterion n.

Criterion	Criterion 1	Criterion 2	Criterion 3	GM	Weight
Criterion 1	A_{11}	A_{12}	A_{13}	GM_1	$W_1=GM_1/SGM$
Criterion 2	A_{21}	A_{22}	A_{23}	GM_2	$W_2=GM_2/SGM$
Criterion 3	A_{31}	A_{32}	A_{33}	GM_3	$W_3=GM_3/SGM$
SUM				SGM	1

3.5 Sample Selection

According to Lin (2003), in common, 10 to 15 persons were selected for the experts investigated. The expert questionnaire is used for this study. The respondent called as expert means he or she is familiar with technology transfer and the mechanism of university. The faculties or researchers, technical and legal consultants of TLO and Incubator are the samples of this thesis. It is because these members will provide opinions from the university aspect. The most of faculties and researchers are from NCTU; this is representative because NCTU is one of the best research universities in Taiwan. It is located near the Hsin Chu Science Park, has both plenty of physical and software resources. The most important reason for choosing NCTU as a base of evaluation is the variety of research results and experiences of technology transfer.

3.5.1 Data Collection

Both of qualitative and quantitative data are important to decision making. Qualitative data consist of words which provide the whole view of issue. Quantitative data consist of numbers which could be calculated with mathematic approach. Quantitative data are clearer than qualitative data because it is understood easily. Formulas and calculation steps could be used to make people understand each characteristic of variable.

3.5.2 Pre-test

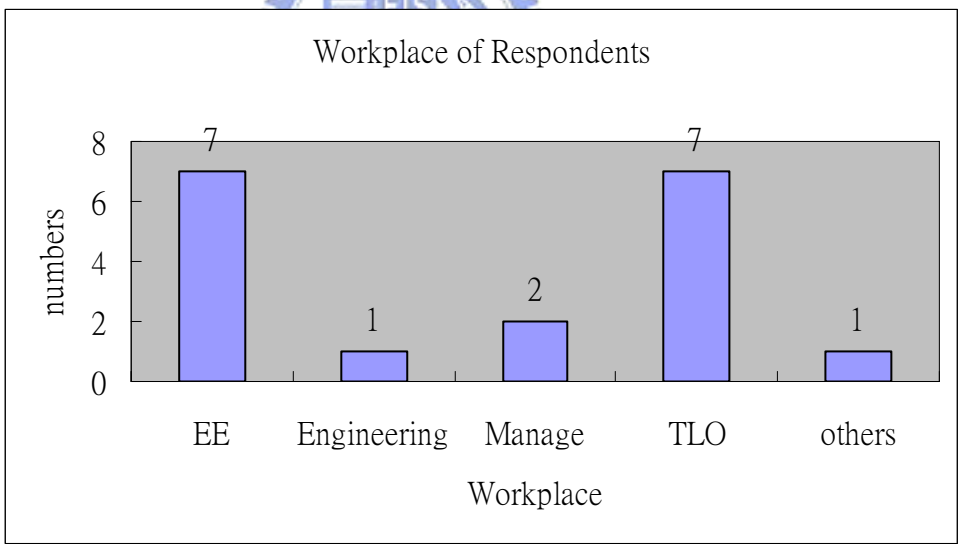
There are two purposes of pre-test. First, it is used to test the validity and reliability. Second, is also the purpose of this pre-test, to reduce the ambiguity and vagueness of the description of questionnaire. The experts' opinions are used in this study. Before asking for experts' opinions, several related person who are found to be the pre-test samples because finding results is not the purpose of pre-test in this thesis.

The pre-test is conducted by two TLO members consist of one legal consultant and one technical consultant, one former patent engineer who is a master major in technology management, one PHD student who's major in EE and one master student is also major in EE. After pre-test, the questionnaire is modified to be clear and easy to answer.

CHAPTER 4 RESEARCH RESULTS

4.1 Background of Respondents

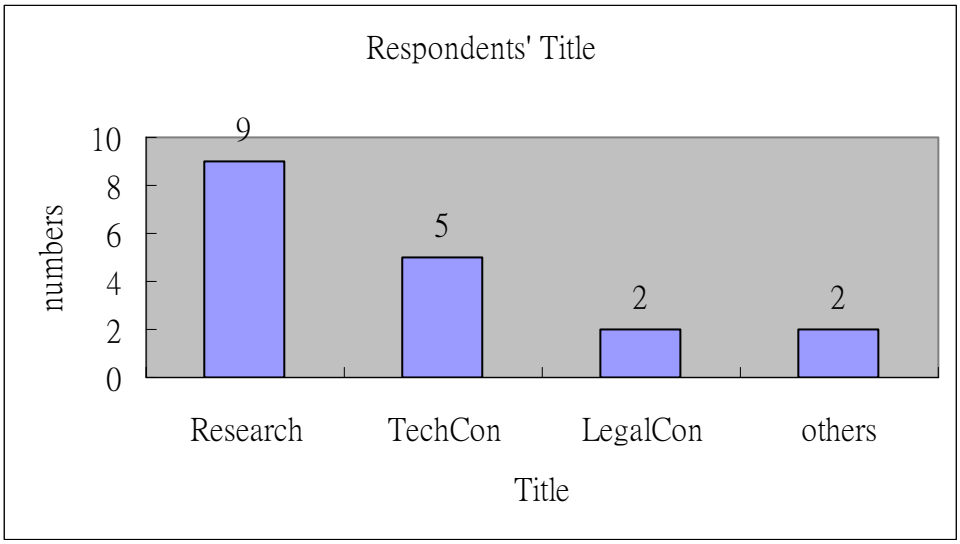
There are eighteen respondents of the questionnaire; some of them not only offered the quantitative data but also the qualitative response. The main respondents are from NCTU except for one person who is the manager of IP at NTHU. Our faculties or researchers are more than a half of samples, counted as 10, consisted of seven from Institution of EE, one from the Institution of Engineering, two belong the Institution of Management. Figure 11 is the bar chart of workplace status. There are seven TLO members; they are samples most understanding about technology transfer process. One person belongs to “others” is the Project Manager of Incubator.



EE:	Institution of Electronic and Engineering
Engineering:	Institution of Engineering
Manage:	Institution of Management
TLO:	Technology Licensing Office
Others:	Incubator of NCTU

Figure 11 Bar chart of respondents' workplace

Figure 12 is the bar chart of respondents' title status. It consisted of researchers, technical consultants, legal consultants IP manager, and administrative officials who are classified in others. Researchers are the maximum of respondents because they research and develop the raw materials for technology transfer. These research results are the essential materials to the whole process of technology transfer. These people provided the different aspects of technology transfer from TLO officials. And this is the essential content will be shown in this study. It also means these opinions could be constructed as a synthetic view of this thesis.



Research:	Researchers (or faculties)
TechCon:	Technological Consultant
LegalCon:	Legal Consultant
Others:	One IP manager, one financial official

Figure 12 Bar chart of respondents' title

Figure 13 shows the status of respondents' seniority. On average, researchers have more seniority than TLO members, this result can be understood that is because they have done research many years since they are faculties. And one research result has been cost several years until it has been finished. The status of TLO members and faculties are shown at table 8 and 9 respectively to figure out the differences between them.

Basically, the experts of this study are chosen with the rule of experience for technology transfer. Only two samples had not experienced at technology transfer. One is the administrative official of TLO. She is responsible for the financial and administrative matters in the office. Although she chose had not experienced at technology transfer, she understands the process of technology transfer is the fact. That is the reason to add her opinions into this study. In table 8, TT means the experience of technology transfer. The question was asked to respondents is: "Have you ever had experience of technology transfer?" This question is used to ensure the experts understand technology transfer and they did it before.

The other one chose no experience of technology transfer is the vice-president, Mr. Chen, of NCTU. This is the unique sample. He is the vice-president, understands the procedure of university. He had more than 16 year's seniority at his research and he is willing to provide suggestions, so his opinion is added into this study.

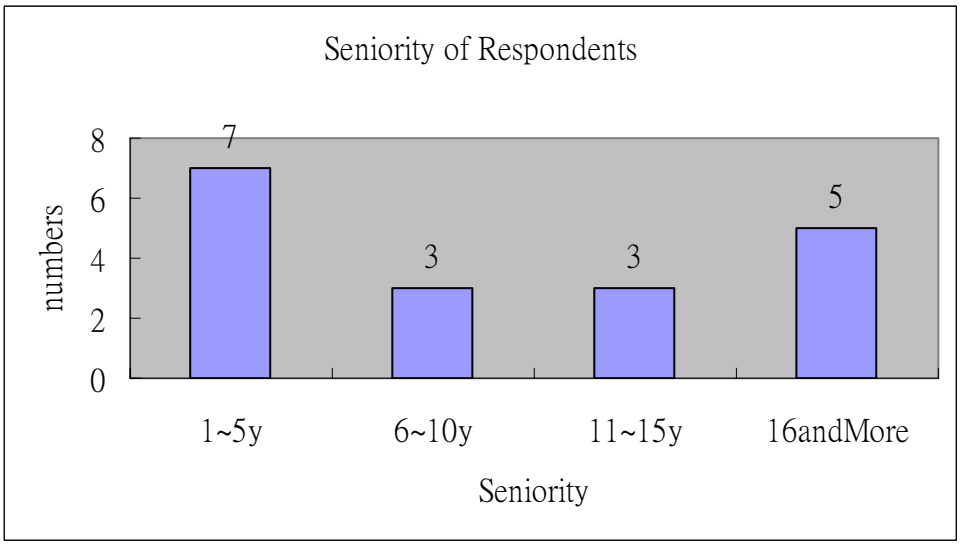


Figure 13 Bar chart of respondents' seniority

Table 8 Information of TLO members

Title	Technical Consultant	Legal Consultant	Others	SUM
	4	2	2	8
Seniority	1~5years	6~10years		
	7	1		8
TT	Yes	No		
	7	1		8

Table 9 Information of faculties

Workplace	EE	Engineering	Management	SUM
	7	1	2	10
Title	Research	Technical Consultant		
	9	1		10
Seniority	6~10years	11~15years	16andMore	
	2	3	5	10
TT	Yes	No		
	9	1		10

4.2 Data Analysis

There are two main tools used to analyze the data, the MATLAB and EXCEL software. MATLAB is an efficient tool to calculate the eigenvalue of a matrix. The eigenvalue is used to analyze the consistency of the subjective judgment. EXCEL has powerful ability of calculation, it is used to classify data, calculate weights and draw the charts.

4.2.1 Validity of Results

Validity refers to the ability of measuring what is the researcher intend to measure. The results of questionnaire consisted of several experts' judgments; it is valid to measure the issue of this thesis.

4.2.2 Reliability of Results

The concept of reliability is the accuracy and correctness of the investigation. It means no matter what how many times the respondents do this questionnaire, the answer is always the same as he did last time. Consistency Ratio (CR) is used to

illustrate the reliability of the investigation, CR < 0.1 means the judgment is reasonable and reliable (Saaty, 1990).

4.3 Analysis of Results

The results analysis will be shown at this section. It consisted of four parts. The first part is overall experts' opinions that mean the average of all samples. The second is faculty members' view. TLO members' view is put as the third part. Both of the second and third parts will be compared further to find out the differences between them. And this is the fourth section named as cross-analysis which lists the individual rank, criterion and weight value. Listing this information is helpful to find out the distinction between these two groups.

4.3.1 Overall experts

The overall experts' weights of each criterion will be shown as Figure 14. Tabular form is shown as table 10.

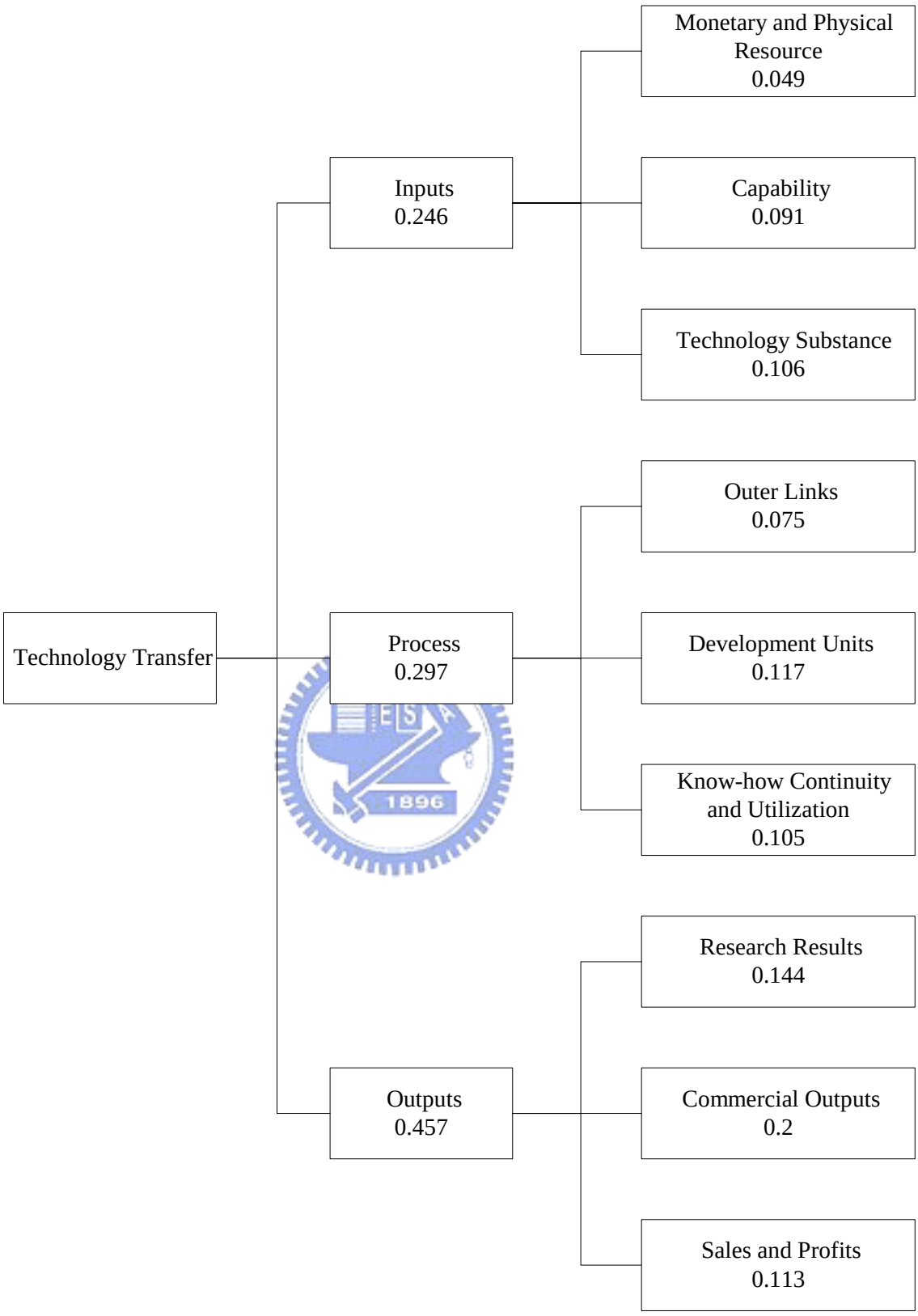
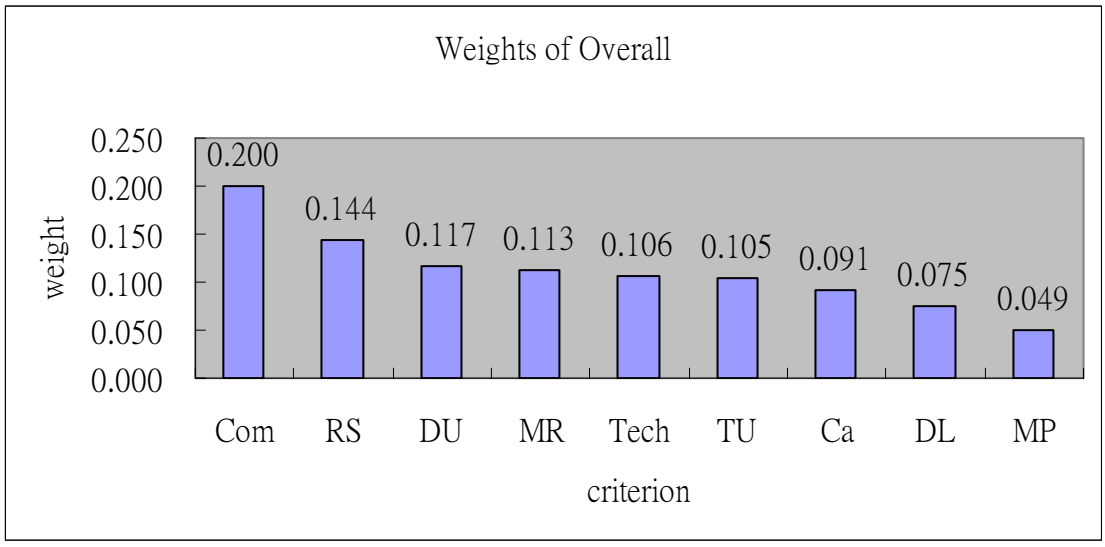


Figure 14 Weights of each criterion and sub-criterion

Table 10 Rankings of criteria

Criterion	Sub-criterion	Weights	Rankings
Inputs(0.246)	Monetary and Physical Resource	0.049	9
	Capability	0.091	7
	Technology Substance	0.106	5
Process(0.297)	Outer Links	0.075	8
	Development Units	0.117	3
	Know-how Continuity and Utilization	0.105	6
Outputs(0.457)	Research Results	0.144	2
	Commercial Outputs	0.2	1
	Sales and Profits	0.113	4

The bar chart of these weights and rankings are shown at Figure 15 in order.

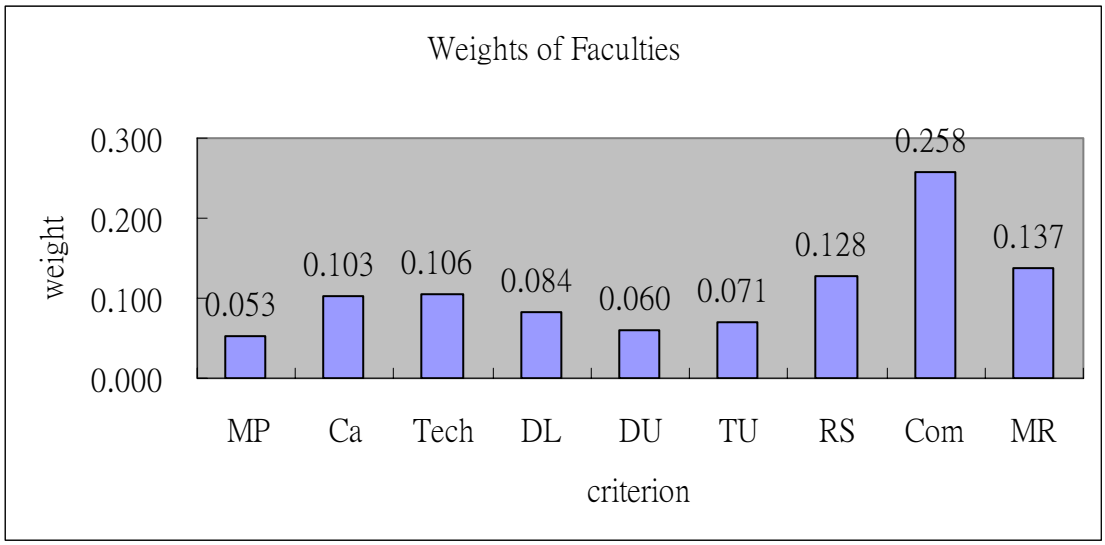


Rank	Code	Criterion
1	Com	Commercial Outputs
2	Rs	Research Results
3	DU	Development Units
4	MR	Sales and Profits
5	Tech	Technology Substance
6	TU	Know-how Continuity and Utilization
7	Ca	Capability
8	DL	Outer Links
9	MP	Monetary and Physical Resource

Figure 15 Weights and rankings of overall

4.3.2 Faculty members

The results from faculties' view are illustrated by Figure 16. The most important criterion is the "Commercial Outputs"; it shows the large amount of difference with others. The most three important factors are "Commercial Outputs", " Sales and Profits" and "Research Results"; weighted 0.258, 0.137 and 0.128, respectively.



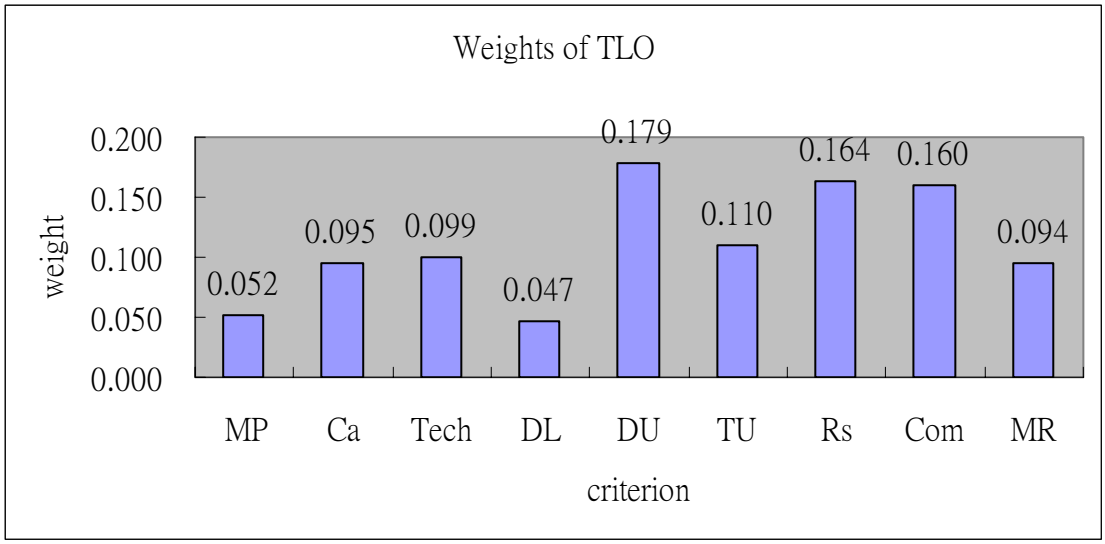
Code	Criterion
MP	Monetary and Physical Resource
Ca	Capability
Tech	Technology Substance
DL	Outer links
DU	Development Units
TU	Know-how Continuity and Utilization
Rs	Research Results
Com	Commercial Outputs
MR	Research Results

Figure 16 Rankings of criteria from faculties' view

4.3.3 TLO members

The rankings of criteria from TLO members' aspect is shown as Figure 17. The first ranking of criterion is the "Development Units". The most three important factors are "Development Units", "Research Results" and "Commercial Outputs". However,

there is little difference between them, each weight of them are 0.179, 0.164 and 0.16, respectively.



Code	Criterion
MP	Monetary and Physical Resource
Ca	Capability
Tech	Technology Substance
DL	Outer Links
DU	Development Units
TU	Know-how Continuity and Utilization
Rs	Research Results
Com	Commercial Outputs
MR	Sales and Profits

Figure 17 Rankings of criteria from TLO members' view

4.3.4 Cross-analysis

The different thinking between faculties and TLO members is the essential issue of this study. From this issue, what the distinction is and how to resolve and find some solutions are derived. The questionnaire helped measure the difference through the quantitative data. The rank of criteria, criterion and weight of criterion are shown at Table 11. It has been divided into two groups which are faculty and TLO. According to this table analysis, the different considerations between them are clear to see.

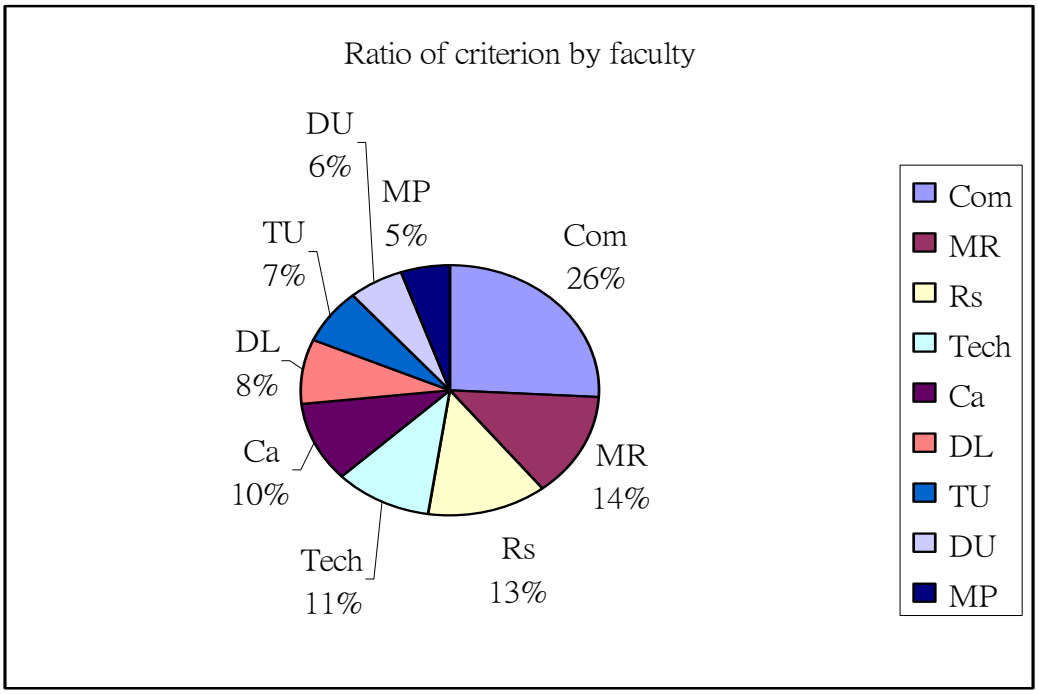
Table 11 Rank, criterion and weight of faculty and TLO

	Faculty		TLO	
Rank	Criterion	Weight	Criterion	Weight
1	Commercial Outputs	0.258	Development Units	0.179
2	Sales and Profits	0.137	Research Results	0.164
3	Research Results	0.128	Commercial Outputs	0.16
4	Technology Substance	0.106	Know-how Continuity and Utilization	0.11
5	Capability	0.103	Technology Substance	0.099
6	Outer Links	0.084	Capability	0.095
7	Know-how Continuity and Utilization	0.071	Sales and Profits	0.094

8	Development Units	0.06	Monetary and Physical Resource	0.052
9	Monetary and Physical Resource	0.053	Outer Links	0.047

In addition to the difference, there are also some commons between them. Both of the groups consider “Commercial Outputs” and “Research Results” among the three most important criteria just with the different orders. Faculties think “Commercial Outputs” is the first priority and “Research Results” is the third one. On the other hand, TLO regard “Commercial Outputs” as the third priority and “Research Results” as the second rank.

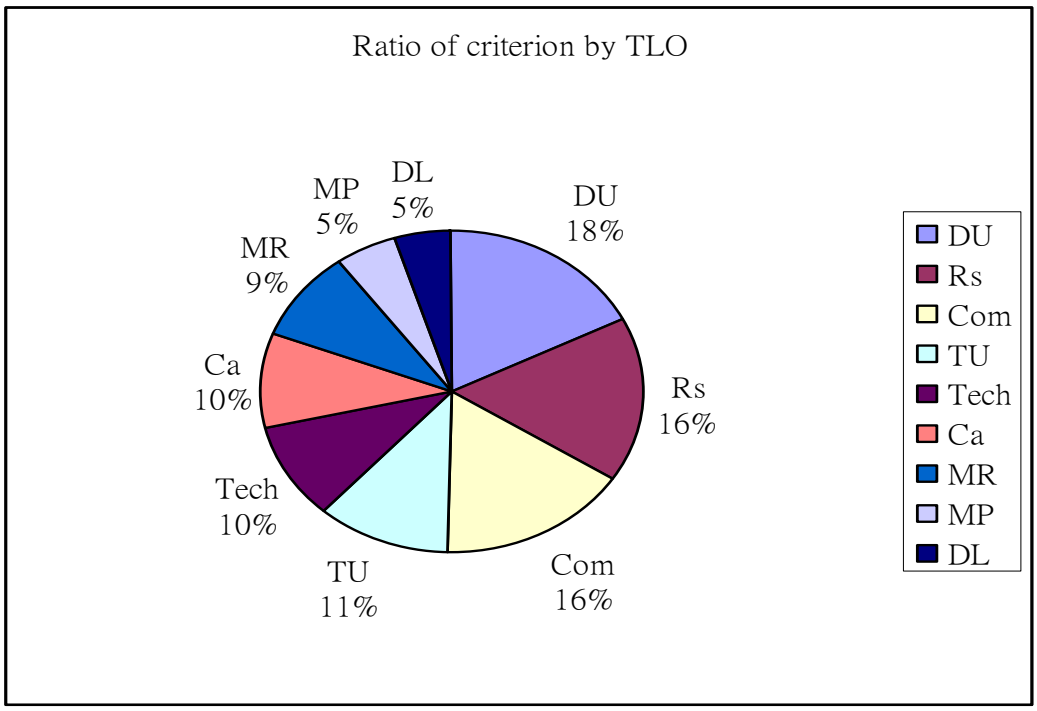
Figure 18 and 19 illustrated the ratio of criterion by these two groups. The percentages of the three most significant criteria sums exceed a half of total both in faculty and TLO views. In figure 18, faculties’ view, “Commercial Outputs” took 26% as the majority; the second is “Sales and Profits” as 14% and the third is “Research Results” took 13%. Sum of these three criteria took 53% of all.



Com	Commercial Outputs
MR	Sales and Profits
Rs	Research Results
Tech	Technology Substance
Ca	Capability
DL	Outer Links
TU	Know-how Continuity and Utilization
DU	Development Units
MP	Monetary and Physical Resource

Figure 18 Ratio of criterion by faculty

Compared to figure 18, figure 19 showed the ratio by TLO members. The majority is “Development Units” took 18%; the second is “Research Results” took 16% and “Commercial Outputs”, which took 16% actually had tiny difference with the second, is at the third priority. Sum of these three most significant criteria is 50%, a half of total.



DU	Development Units
Rs	Research Results
Com	Commercial Outputs
TU	Know-how Continuity and Utilization
Tech	Technology Substance
Ca	Capability
MR	Sales and Profits
MP	Monetary and Physical Resource
DL	Outer Links

Figure 19 Ratio of criterion by TLO

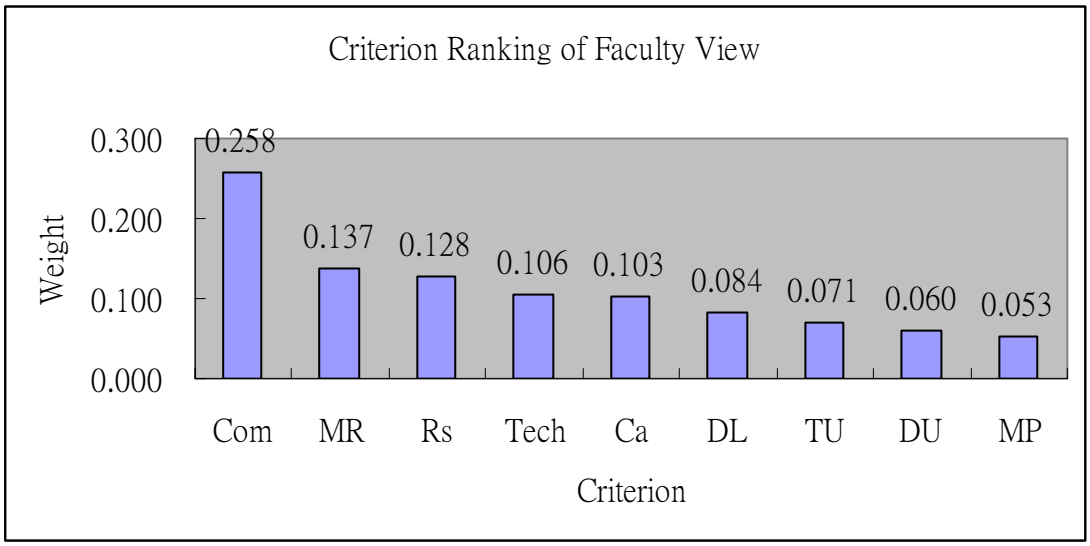
CHAPTER 5 DISCUSSIONS AND CONCLUSIONS

5.1 Summery of Conclusions

This chapter consisted of conclusions and recommendations for this study. The qualitative information of the questionnaire would be shown at this section. There are two questions putted in the questionnaire; the first one is “Do you have any suggestion or recommendation to NCTU technology transfer process?” The purpose of this question is to diagnose how faculties feel about the technology transfer process of NCTU, provide some suggestions to the mechanism, additionally. The second question: “What kind of marketing strategy you think is effective to promote the research results of NCTU?” is used to ask for specific ways to promote the technology innovations.

5.1.1 Conclusions of faculties’ aspect

The weights of criteria from faculties’ view and the sequencing are shown as figure 20.



Code of Criterion	
Com	Commercial Outputs
MR	Sales and Profits
Rs	Research Results
Tech	Technology Substance
Ca	Capability
DL	Outer Links
TU	Know-how Continuity and Utilization
DU	Development Units
MP	Monetary and Physical Resource

Figure 20 Rankings from faculties

The most important criterion for faculties is “Commercial outputs” weighted as 0.258 and it is the most significant than the other criteria. It showed the most importance to faculties. According to interviews, the commercialization has been regarded as a threshold of successful technology transfer. And it has a more important reason is that after commercializing products, university will get the royalty from the industry.

“Monetary and resource” criterion is the second important to faculties, weights as 0.137. And the third one is “Research Results” refers to the raw material of research results. The most three important criteria belong to the “Outputs” category; it is the sufficient evidence to show faculties regard the outputs as the most important stage. Some faculties said they do not think the infrastructure is the critical issue to NCTU. Actually, there are plenty resource both in hardware and software including excellent human resource. And this thinking has reflected as the last criterion is “Monetary and Physical Resource”, weights 0.053.

The least two important criteria besides monetary and physical resource are “Development Units” and “Know-how Continuity and Utilization”, weight as 0.06 and 0.071. It is interesting and worthy to mention is both of these two criteria belong to the “Process” category. “Development Units” refers to the inner units which are devoted to promote the results. For example, the organizational construction of NCTU, some research centers, TLO and laboratories could be regarded as the promotion units inner university. Most faculties do not understand the technology transfer mechanism of TLO. They even complained TLO members did not tell them about how to transfer technology through TLO. This is the reason they thought the inner units are not important to the success of technology transfer. They can do it by themselves instead of TLO.

The mechanism of “Know-how Continuity and Utilization” is usually the informal type at NCTU, even at other universities. There are many laboratories in the Institution of Electronics and Engineering which produced the most of research results. However, most of them did not have the database or mechanism to construct know-how and knowledge. As the students graduated, the know-how was disappeared. The mentor mechanism just kept the fragmental parts. It is the reason now not the critical issue to technology transfers. But it does not mean the know-how continuity and utilization is not important to university, on the contrast, it is. If the database built up, it will be certainly more critical to the success of technology transfer than it is now.

“Technology Substance” and “Capability” are at the similar weights; they are 0.106 and 0.103 respectively. The president Chang said ”To assess the substance of technology is easier than to assess its developmental potential.” So how good the technology substance is is not important to the transfer process. The potential is important we have to consider. Faculties recommend that the mechanism for assessing technology should be constructed as soon as possible. It is helpful to the technology or

portfolio construction. And the portfolio or package transfers are more successful than the single technology. Many faculties even the TLO members agree there are many excellent researchers at NCTU. They are intelligent, diligent and create a lot of advanced research. But the university lacks some intermediators, in this study it called as Portfolio Constructor.

Figure 21 shows the relationship of licensor, TLO and licensee. The real lines represent the traditional relationship among them. TLO owns technologists responsible for assessing technology, for instance, patent or not, transfer or not, etc. Market researcher who is responsible for investigating what technology is needed for industry, but less exist at TLO, however his importance has been more and more considered. The dotted lines are the suggestions that considered to be added. The Portfolio Constructor is the critical role because he can understand both of the technology and the demand. Then he is capable to link them, to apply the technology to products. That is why the intermediator is so important.

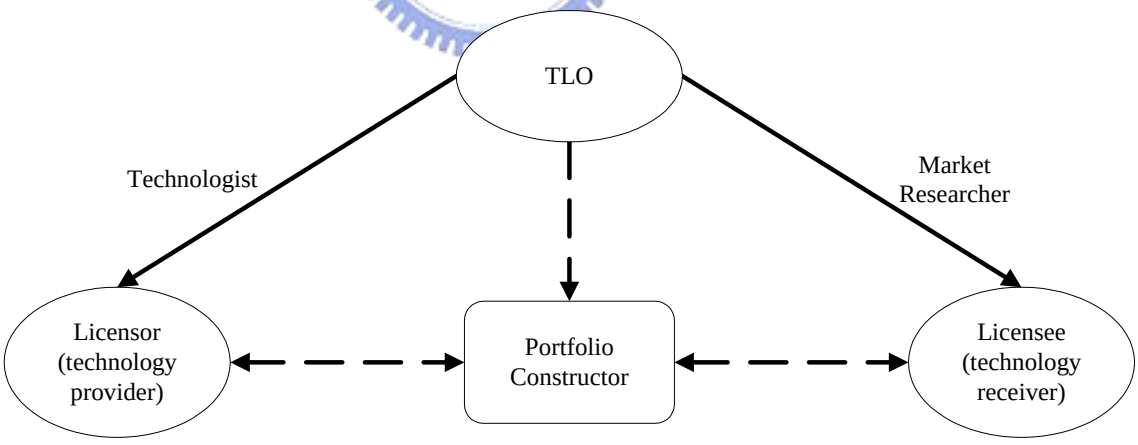
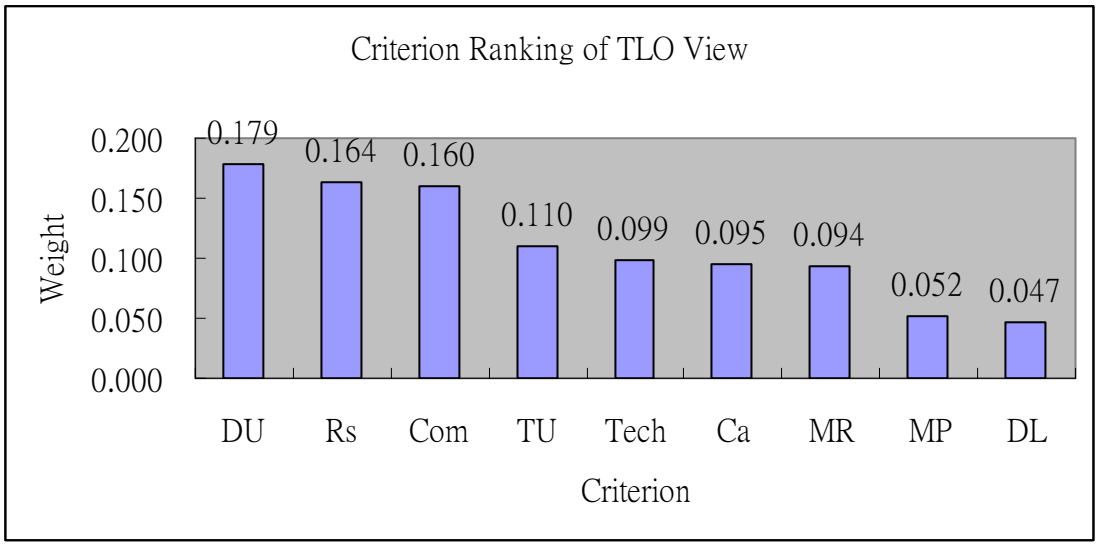


Figure 21 Portfolio constructor role in TLO

The above statement is about the faculties' view. The TLO's view will be shown in the next section.

5.1.2 Conclusions of TLO's aspect

Compared to faculties, there is Figure 22 to show the rankings of TLO members.



Code of Criterion	
DU	Development Units
Rs	Research Results
Com	Commercial Outputs
TU	Know-how Continuity and Utilization
Tech	Technology Substance
Ca	Capability
MR	Sales and Profits
MP	Monetary and Physical Resource
DL	Outer Links

Figure 22 Rankings from TLO

The most important criterion to TLO is "Development units". Development units refer to the promotion units in the university, TLO is one of these units. Interestingly, TLO members think this is the most important to the success of technology transfer.

Although there are some research centers also do promotion for themselves, they have less professional officials than TLO. TLO is the most significant unit for promotion is obviously.

“Research results” is the second rank of TLO officials. Research results refer to the raw materials of the research that faculties did. It could also be regarded as the origin of technology transfer. If there were no research results, there is nothing could be transferred. It could be the reason why TLO thinks it is important. On the other hand, according to the interview with president Chang, NCTU is one of the best research universities in Taiwan, “we have to devote to the academic research not the technology transfer” he said. “Having the advanced results could have the chance for technology transfer” he emphasized.

TLO is independent of NCTU; it is sponsored by National Science Council. The original thought is to build up the outsourcing company to promote technology. It keeps going to achieve this goal. After 1990, National Science Council released the IP rights to universities; NCTU has been responsible for its own IPRs. There is no much funds sponsored university for maintaining the patents. And this is the main reason for university to promote research results positively. Through the commercialization, university would gain the royalty from industry.

The least important criterion to TLO is “Outer Links”. This could reflect the faculties’ thinking about there is less outer links TLO did. “Outer Links” refer to the link with outer units, just like the Incubator and industry. Several faculties suggest that TLO should create the network and database storing industry research and investigation. Then faculties would like to contact with TLO actively because there is a lot of resource about industry in TLO database. It would spur the motivation of faculties to do technology transfer through the formal channel instead of the private way.

5.1.3 The difference between faculty and TLO

According to the above results and analyses, there are some difference between faculty and TLO, and these could generate some conflicts between them. Table 12 illustrated these differences.

Table 12 Differences between faculty and TLO

Items	Faculty	TLO
The motivation of technology transfer	Familiar friends or graduated students motivation. Active.	The main goal of operating. Passive.
Time consuming	As short as possible	On average 3 to 6 months
Specialized field	Research	Legal consultation, negotiation skills
The way to do technology transfer	In private way	Conferences, exhibitions

Faculties usually transfer the technology into the existing firms which were founded by their friends or the graduated students. It generates because the pull of the market needs. The firm founders understand what kind of know-how that market wants, and they would recall which research their teacher did. Due to this status, faculty and firm negotiate in their private way; this way has been regarded as the effective approach. It is time saving, and clear to satisfy supply and demand. In contrast with faculties, TLO officials are at the passive status; they waited for faculties if they want to transfer technology through TLO instead of active asking.

The other reason that faculty would not transfer technology through TLO is the time consuming. On average, it would cost 3 to 6 months for TLO to do transfer per case. The whole process consisted of evaluation, negotiation, contract construction; these matters are time-consumed. But TLO has professional officials consist of legal consultants, technological consultants and IP managers; who could ensure the reasonable and fair negotiation.

Another way that TLO would use to promote the R&D results is the conferences and exhibitions. Every year, they hold the exhibitions to show the research results to industry. Unfortunately, according to interviews to TLO officials, this way is not efficient. Some faculties reflected the reason that exhibition is not efficient is not well organized. They suggested TLO could imitate the way ITRI did. ITRI published periodical which contained transferable technology and sent it to industry. The periodical also contained the information of innovator and who could be contacted with if they were interested in the technology. This is the positive way to let industry know how many and which type of technology they could transfer from ITRI.

5.2 Contributions

This study provided the quantitative data to show the difference between TLO and faculties. It is benefit for both them to know each other's considerations. For industry, they will more understand the technology transfer mechanism of the university.

5.3 Strategy construction and recommendations

Try to establish marketing strategy of IP is the main goal of this study. It could be divided into three stages. Individual issue of each stage is shown as table 13.

The short-term target includes: A. Organize the existing research results: encourage faculty members to package technology to the portfolio. They can organize all of their academic research, create database to store these information. B. TLO should recruit

diversified staffs. These professionals should consist of technologists, market researchers and the most important portfolio constructors. On the other hand, it is worth to do is to separate TLO from NCTU, like foreign universities, to be an independent SBU, maybe become a private company managed by professional CEO (Brett, Gibson and Smilor, 1991). The advantage to do this is this unit could have more flexibility than the bureaucratic organization. But the latter should belong to the issue of middle stage because it is time-consuming.

The above-mentioned about the faculty should create their research portfolio. It evolved into the middle stage; TLO could integrate faculties' entire database to establish the patent portfolio for NCTU. This is also a database could be searched by industry, interacted with outer organizations. It could be regarded as a communication platform between university and industry. There are plenty information about transferable technology at this platform. It could be searched by innovator, type of technology, the developed institution even the information about the created lab. And this is the concept for IP reuse.

It is essential to contact with industry to understand market demand. According to the research of Thursby et al. (2001), of 300 respondents, nearly half of two-thirds did not want to license from universities because the development of university technologies is the early stage technology, even no prototype. There is less marketable chance for this so early technology. This is the strong evidence for university should actively contact with industry and know what they need and want. Several faculties said if there was much information about the market, faculties will have willing to transfer technology through TLO.

This situation inferred an issue about how to collaboration with industry. The developed technology of university is usually the early stage development; industry could not take it to market. The research in universities usually cost 3 to 10 years; but

the short product life cycle made industry take only 3 to 6 months from R&D to market. Industry would like to transfer the practical use IP, not the initial idea. This is the obstacle to promote IP of university. Based on this reason, TLO should do the market research to find some potential candidates who are willing to collaborate with university to develop the middle stage technology instead of the short practical use technology. University and industry could build up the long and stable relationships. The premise is there is the clear technology portfolio providing to industry. Let them know how the university will proceed and this way would stimulate the cooperation with both each other.

The short-term and middle stages are about self-jobs within university. It is not sufficient to develop the competitive country. The longer goal is to build a complete model in Taiwan. In the same words, this model could be duplicated to other universities. In the long term, all of these individual databases should be integrated to one common model. This would be called as the IP mall or IP reuse platform. It will be a strong advantage to Taiwan competes against the other countries.

Table 13 Roadmap for Technology Transfer

Stage	Main Issue
Short-term	1. Organize the existing research results
	2. Recruit diversified staff for TLO
Middle stage	1. Develop the patent portfolio for NCTU
	2. Establish SBU for TT
	3. Establish IP platform for IP reuse
Long-term	1. Duplicate model to other universities
	2. Combine several universities' model to effective one

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United States Patent and Trademark Office (USPTO) http://www.uspto.gov/

World Intellectual Property Organization (WIPO) http://www.wipo.int

Appendix A: English Version of the Questionnaire

Analysis of Importance of Technology Transfer Factors

This is a questionnaire which is used to measure importance of technology transfer factors. Through literature reviews, factors that affect technology transfer are classified. The purpose of this questionnaire is to ask for experts' judgments to prioritize the rankings of factors.

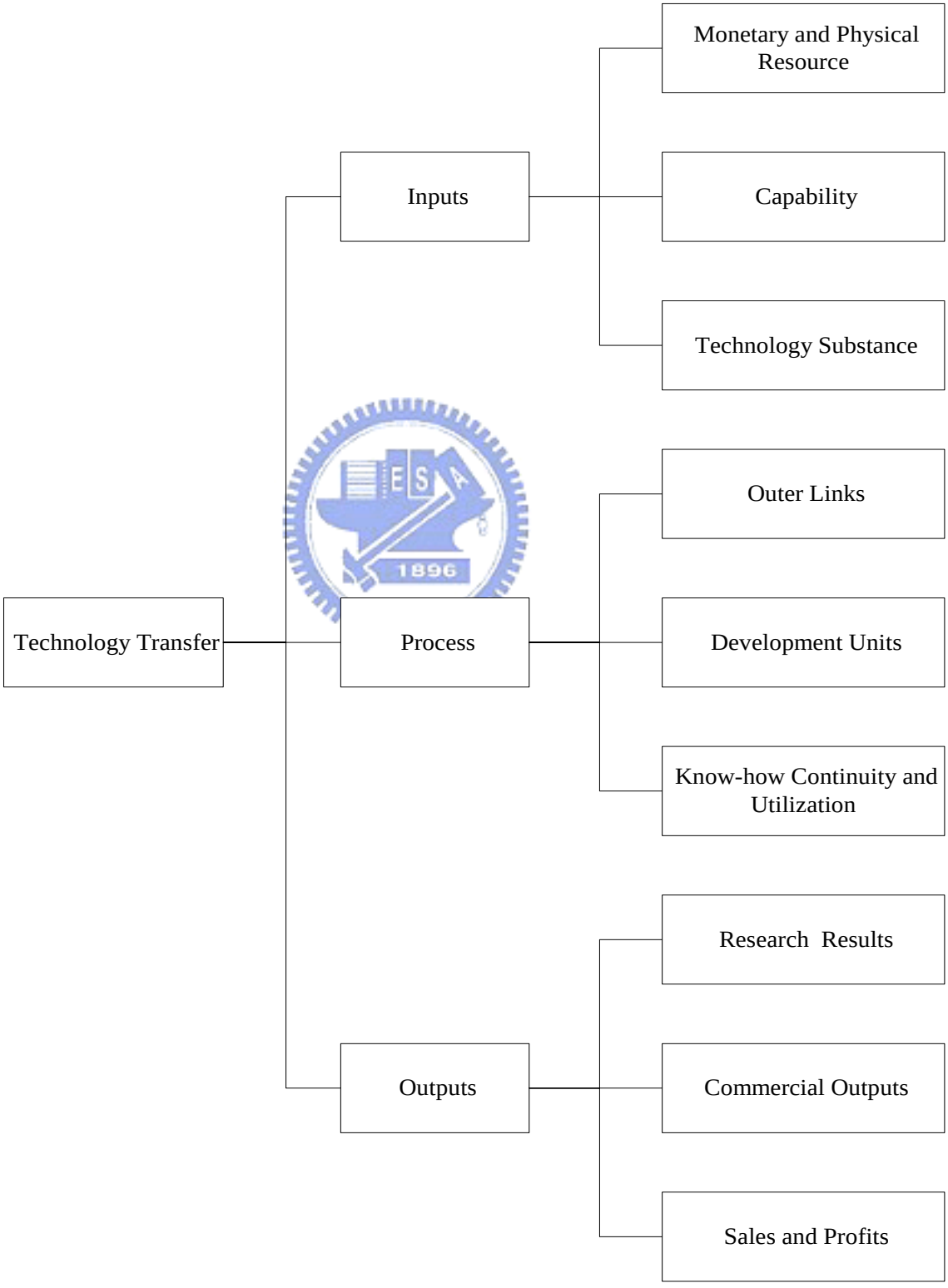
The information of questionnaire is provided to this mater thesis only, it would not be provided to other use, please answer it without doubt and conscientiously. If any suggestion, please give advice without hesitance. The results will be provided to you if you were interested in it.

Thank you very much.

NCTU Department of Management Science

Thesis advisor: Dr. Trappey
Master student: Chia-Ju Hsu

「Technology Transfer」 refers a continuous process which promotes the R&D results to the industry and gains revenue. The following figure shows the criteria and sub-criteria of technology transfer.



Please judge the relative importance between criteria, circle the number in the table.

Criterion	Importance Degree [Lager number means more important]								
Inputs	1	2	3	4	5	6	7	8	9
Process	1	2	3	4	5	6	7	8	9
Outputs	1	2	3	4	5	6	7	8	9

Sub-Criterion	Importance Degree [Lager number means more important]								
Monetary and Physical Resource	1	2	3	4	5	6	7	8	9
Capability	1	2	3	4	5	6	7	8	9
Technology Substance	1	2	3	4	5	6	7	8	9

Sub-Criterion	Importance Degree [Lager number means more important]								
Outer links	1	2	3	4	5	6	7	8	9
Development Units	1	2	3	4	5	6	7	8	9
Know-how Continuity and Utilization	1	2	3	4	5	6	7	8	9

Sub-Criterion	Importance Degree [Lager number means more important]								
Research Results	1	2	3	4	5	6	7	8	9
Commercial Outputs	1	2	3	4	5	6	7	8	9
Sales and Profits	1	2	3	4	5	6	7	8	9

Questions：

1. Do you have any suggestion or recommendation to NCTU technology transfer process?
2. What kind of marketing strategy you think is effective to promote the research results of NCTU?

Information about Expert：

1. Work Place: ☐EE College ☐Engineering College
   ☐Management College ☐TLO
   ☐Others: _____

2. Title: ☐Researcher ☐Technical Consultant
   ☐Legal Consultant ☐Others: _____

3. Seniority of Professional Field：☐1～5 years ☐6～10 years
   ☐11～15 years ☐16 years and more

4. Have ever participated in technology transfer: ☐Yes ☐No

The end of questionnaire, thank you very much!

Appendix B: Chinese Version of the Questionnaire

技術移轉因素的重要性分析

敬啟者：

這是一份有關技術移轉因素重要性分析的問卷，本研究透過文獻探討整理出**影響技術移轉的關鍵因素**，這份問卷旨在透過各位專家的意見判斷各因素之間的重要性排序。

本問卷僅供此碩士論文作為學術上的使用，不會做研究外之利用，請專家安心填答，您的意見對於本研究之成敗影響甚鉅，因此，懇請您撥冗填答，有任何建議更期望您能不吝提出指教。最後對於您的參與本研究不勝感激，若有需要研究成果，本研究將會不吝惜提供研究成果給專家們參考。感謝您!

順 頌

時 祺

國立交通大學管理科學研究所

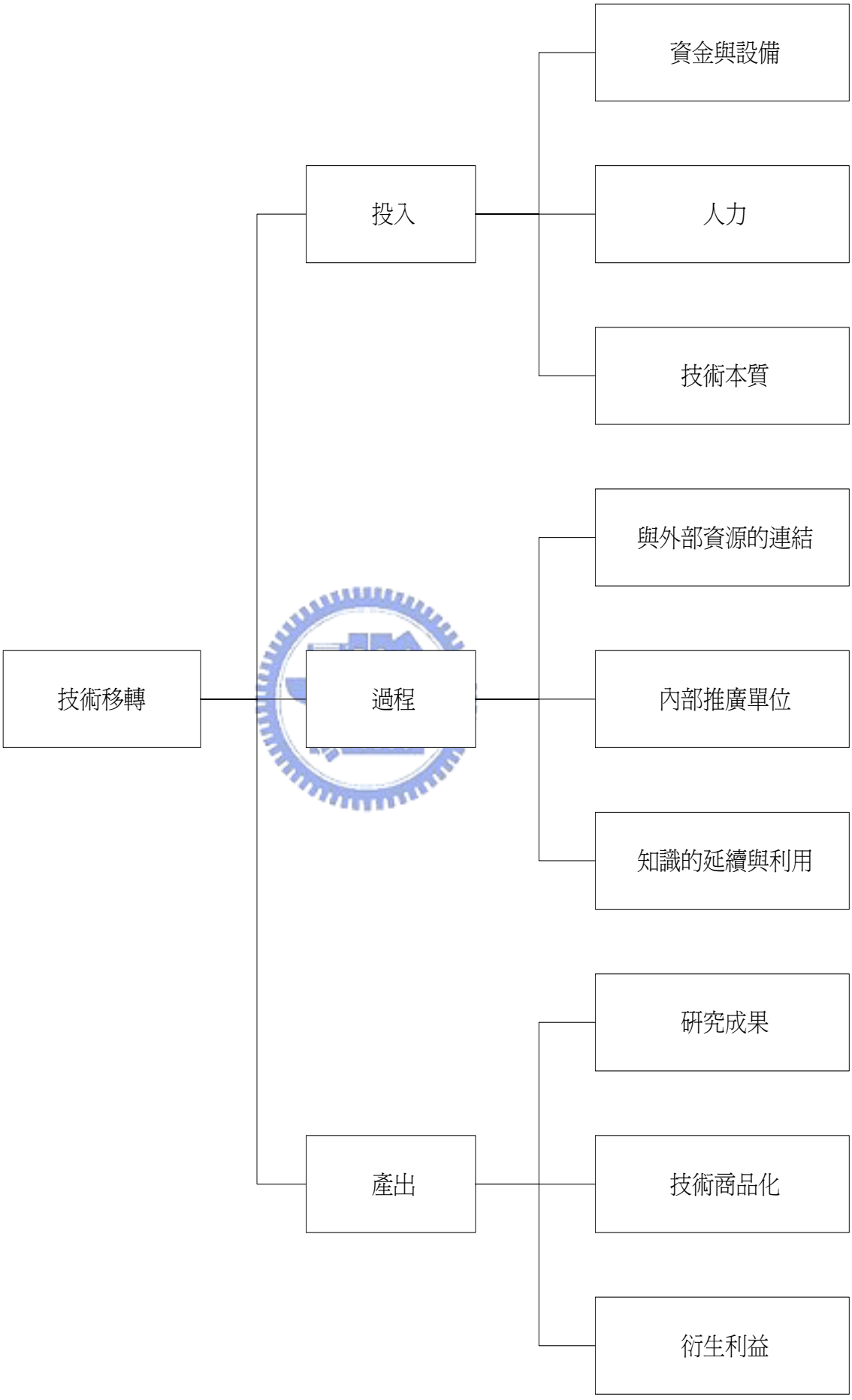
指導老師: 張力元 教授

研究生: 許嘉如

「**技術移轉**」表示**將研究成果推廣至產業界使其產生利益的連續過程，**

成功的技術移轉可爲學校帶來收益，有助於進一步的技術研發。

下圖顯示影響技術移轉的重要因素：


技術移轉
投入
過程
產出
資金與設備
人力
技術本質
與外部資源的連結
內部推廣單位
知識的延續與利用
研究成果
技術商品化
衍生利益

請相互比較各項目之間的**『相對重要程度』**，1 代表相對最不重要，9 代表相對最重要。

類別	**說明**
投入	指『**研發階段**』投入的所有實體與非實體資源，包含**資金、設備、人力**與**所研發的技術類型**。
過程	指如何將投入轉換爲產出的一些作法，例如**利用外部資源、內部建立推廣研發成果的單位**。
產出	包含**研發的成果、商品化與相關的衍生利益**，例如**衍生利益金**的收入、**衍生公司**。

類別	**重要程度** [數字越大代表相對越重要]								
投入	1	2	3	4	5	6	7	8	9
過程	1	2	3	4	5	6	7	8	9
產出	1	2	3	4	5	6	7	8	9

因素	**說明**
資金與設備	指『**研發階段**』的投入，例如**研發成本、購買設備與維護費用、申請專利與維護費用**
人力	主要指『**研發人力**』，其次包含一般**行政人員、法務顧問、技術顧問等**的時間、勞力與薪資成本。
技術本質	投入的**技術型態**，例如先進技術、基礎技術或是已商業化的技術。

因素	**重要程度** [數字越大代表相對越重要]								
資金與設備	1	2	3	4	5	6	7	8	9
人力	1	2	3	4	5	6	7	8	9
技術本質	1	2	3	4	5	6	7	8	9

因素	說明
與外部資源的連結	指利用『**組織外部』的現有資源**，例如**衍生公司或育成中心**。
內部推廣單位	指『**自身組織內』建立的單位**，例如**推廣研發成果的單位**。
知識的延續與利用	指『**知識的延續與擴散能力**』。
因素	**重要程度** [數字越大代表相對越重要]
與外部資源的連結	1 2 3 4 5 6 7 8 9
內部推廣單位	1 2 3 4 5 6 7 8 9
知識的延續與利用	1 2 3 4 5 6 7 8 9
因素	**說明**
研究成果	例如**研究報告、發明與創新的數量、獲准的專利數、授權的數量**。
技術商品化	例如收取的**權利金、技術應用的廣度**或**產品可延伸的廣度**。
衍生利益	例如**衍生公司的數量、客戶數、衍生公司的營收、創投注入的金額**。
因素	**重要程度** [數字越大代表相對越重要]
研究成果	1 2 3 4 5 6 7 8 9
技術商品化	1 2 3 4 5 6 7 8 9
衍生利益	1 2 3 4 5 6 7 8 9

問題一：請問您對於目前的技轉機制有何建議或感想？

問題二：您認爲有什麼有效的方式可以幫助學校推廣研發成果？

專家基本資料：

1.服務單位：□電資學院　□工學院　□管理學院　□TLO

□其他：_____

2.職稱：□研究者　□技術顧問　□法務顧問

□其他：_____

3.專長領域的研究年資：□1～5 年　□6～10 年　□11～15 年

□16 年以上

4.是否曾參與過技術移轉：□是　□否

問卷到此結束，非常感謝您的填答，謝謝!

Appendix C: Information of experts

No.	Title	Name
1	President of NCTU	Chun-Yen Chang
2	President of Taichung Healthcare & Management University, Chair Professor of NCTU Computer & Information Science	Wen-Hsiang Tsai
3	Vice-president of NCTU	Long-Ing Chen
4	Dean of R&D Office	Yi-Bing Lin
5	Dean of EE college	Chung-Yu Wu
6	Director of TLO	Ching-Yao Huang
7	Project Manager of Incubator	Jian-Cheng Chen
8	Director of Electronics and Engineering Department	Chen-Yi Lee
9	Professor of Electronics and Engineering Department, The first Director of NCTU TLO	David Lin
10	Manager of TLO	Alpha Chang
11	Legal Manager of TLO	Fang-Chia Lu
12	Legal Manager of TLO	Shan-Yu Zhou
13	Manager of TT platform	Yi-Fen Wu
14	Patent Manger of TLO	Yi-Wen Chen
15	Promotion Specialist	Ya-Hui Lee
16	Administrator of TLO	Yi-Ju Wu
17	IP coordinator of NTHU	Zhao-Zhi Hsueh
18	Technical Director of Patent Office, Master student in TM Department	Chia-Han Yang

Appendix D: Interview Record

The following statement is some important issue extracted from the original interviews with TLO members. The record of faculties was illustrated at the thesis content.

In 2000, the release of legislation let Taiwan universities can own its intellectual property. Many universities through the cooperation with industry to commercialize the technology because they think this is the most effective way to do the commercialization. But the university can just get the initial income call as cooperation income through this way. So, universities prefer the technology transfer, can get the licensing fee and royalty and the patent ownership belongs to university. There is one method derived from the moderate thinking: technology transfer is used at the initial stage, university gets licensing fee; until to the commercialization stage royalty generated and university transfer the ownership to industry.

There is the other cooperation way is the National Science Council and industry fund the research and development, university provides human resource. In this situation, patent ownership belongs to government then it can be licensed to company. Exclusive licenses or ownership transfers need the permit from the sponsored organization. Transfer the ownership and patent auction are the following issues in the future; this is helpful to the university to cover the costs of patent maintenance. Doing the transfer can get cash or stocks, but university can not deal with the stocks.

How to assess for technology transfer? In general, TLO wants to transfer all of the existing technology in university. The main issue is when to do it. It depends on the willing of R&D group, the technology maturity and the market demand.

How to encourage the faculty to do transfer through TLO? A. Provide some related courses for researchers. B. Analyze the advantage and explain some failure examples

that do transfer by themselves. C. Establish the intranet to connect faculties and TLO.

Faculties will be hesitated if it cost long time to transfer, so TLO must transfer technology as soon as possible. And no matter what kind of technology, as long as the faculty has willing to transfer, TLO has to do it. The good news is if the faculty had a successful experience transfer through TLO, they will do it again.