

University-Industry-Government Partnership in Taiwan: A Case Study of National Cheng Kung University

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Abstract

Government plays a key role in university-industry collaboration. As a public university, National Cheng Kung University (NCKU) is the most successful Taiwanese university in promoting university-industry collaboration. This case study shows that an interdisciplinary platform can effectively stimulate long-term collaborative relationships between research and development (R&D) teams and enterprise, and infusion of professional personnel can positively facilitate technology transfer and business incubation. Universities can use online platforms to display R&D results that have potential for commercialization and provide inspection and testing services to support the commercial activities of small and medium enterprises (SMEs). Additionally, a service combining patenting, technology transfer, and business incubation should be implemented.

Keywords: Government Policy, University-Industry Collaboration, Patenting, Technology Transfer, Business Incubation

1. Introduction

University missions have been widely discussed and have progressed from teaching and research to public service since the late 1970s. This means that besides sharing existing knowledge and advancing new knowledge, universities have a tertiary mission of importance; transferring the knowledge and resources of academia to the public, and generating technological spillover through university-industry collaboration (Etzkowitz & Leydesdorff, 2000; Leydesdorff & Meyer, 2003; Mansfield, 1995; Sorensen & Chambers, 2008). The mechanisms of collaboration include the recruitment of university graduates, personnel

exchanges, joint research, contract research, consulting, patents and publications, licensing, spin-off companies, industry-funded laboratories and other facilities, and informal contacts such as meetings and conferences (D'Este & Patel 2007; Muscio, 2010; OECD, 1999). Such types of interactions between industry and academia can usually be mutually beneficial by enhancing research productivity of firms (Link et al., 2003), enhancing the research performance and publications of university professors (Gulbrandsen & Smeby, 2005), and shifting the academic curriculum from basic toward applied research (Link & Scott, 2003).

As in prior research, much of the research on university and industry collaboration has been on

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large-sized mature economies such as the United States, the European Union, and Japan (Agrawal & Henderson, 2002; Cohen et al., 2002; Elyse, 2006; Mowery & Sampat, 2005; Swamidass & Vulasa, 2009). Little literature has explored university and industry collaboration in either emerging countries or developing countries, such as Taiwan. NCKU is the most successful Taiwanese university in promoting university-industry collaboration. This study investigates the organizational framework, intellectual property rights (IPRs) operation and management, business incubation, and inspection and testing services in the university-industry collaborative model of NCKU to explain how this university constructs its university-industry collaborative platform. This study further proposes strategies and visions for preventing future bottlenecks in development. In particular, the work addresses how government policy could affect the output of university-industry collaboration.

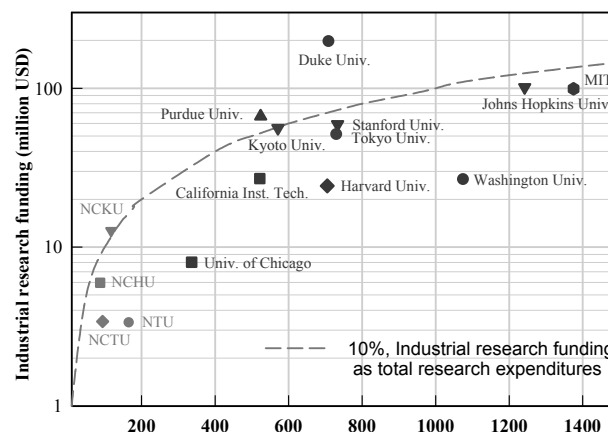
The paper is organized as follows. Section 2 gives a brief description of problems faced by university-industry-government partnerships in Taiwan. Section 3 presents the case study of NCKU. A perspective on university-industry collaboration at NCKU is given in Section 4, and conclusions are drawn in Section 5.

2. University-Industry-Government Partnership in Taiwan

SMEs make up the majority of Taiwanese companies, comprising 97.91 % of total enterprises in Taiwan (SMEAMOE, 2010). Due to insufficient human resources, capital, equipment, and innovative R&D operational models to support their commercial activities, SMEs usually cooperate with academic institutes to satisfy their needs for innovation. Some large enterprises have a certain amount of human resources for R&D, but they also cooperate with academic institutions to search for innovative concepts and shorten R&D time. In 2005, the Science and Technology Advisory Group of the Executive Yuan cooperated with the Ministry of Economic Affairs (MOEA), the National Science Council (NSC), and the Ministry of Education (MOE) to plan an integrated scheme

for promoting university-industry collaboration. They used R&D funds from enterprises, the income from intellectual property, and the efficacy in incubating new enterprises as indicators

Numerous potential problems exist in the university-industry collaboration of Taiwanese HEIs (Higher education institutes). Statistical data from the NSC (2010) stated that the density of HEIs in Taiwan is extremely high (164 universities). Total R&D funding for HEIs has gradually increased in the past decade, including funds from both the public and private sectors. However, these funds have flowed into a limited number of universities. Take the top four Taiwanese universities as examples: National Taiwan University (NTU), NCKU, National Chiao Tung University (NCTU), and National Tsing Hua University (NTHU) (Figure 1) have been granted annual R&D funding of less than US\$ 200 million; of which R&D funds from enterprises totaled less than US\$ 13 million. Both amounts of funding were far less than those granted to universities that were well known globally. A comparison of the proportions of corporate funding of total R&D funding granted to these four Taiwanese universities indicated that the proportion for NCKU was 10.8 % in 2009, which is not less than that of other universities that are well known globally, followed by NTHU (6.8 %), NCTU (3.4 %), and NTU (2.0 %).



Source: ABC(2009), BAC(2009), CAD(2009), EFG(2007), FEG(2008)

Figure 1 Comparison of industrial research funding and total research expenditures of universities

A comparison of IPRs (Table 1) revealed that although the annual number of patents granted to Taiwanese universities before 2007 exceeded 900, the efficacy of licensed patents and licensing income was limited. The primary reasons for this result were the policy of the NSC in increasing the number of granted patents and the insufficient number of personnel for technology transfer. After 2008, both licensed patents and licensing income have significantly grown due to the promotion of integrated university-industry collaboration. With regard to the business incubation of HEIs, funding and human resources are currently the two major challenges. The key performance index (KPI) of business incubation centers granted by the government focuses on increasing the number of incubated SMEs. Although professors provide technology consulting services, many business incubation centers only provide a place for incubation rather than comprehensive assistance.

3. University-Industry Collaboration at NCKU

NCKU was established in 1931. Through 80 years of cultivation, NCKU gradually developed nine colleges, which include Liberal Arts, Science, Engineering, Electrical Engineering and Computer Science, Planning and Design, Management, Medicine, Social Sciences, and Bioscience and Biotechnology. Currently, NCKU is the most important academic research institution in southern Taiwan. In terms of its university-industry collaboration, NCKU has actively integrated its resources over the past 15 years and strengthened the applications of academic research results through interdisciplinary cooperation. According to statistics of the Higher Education Evaluation and Accreditation Council of Taiwan (HEEACT, 2010),

Table 1 HEI licensing income and number of patents granted and licensed

	2006	2007	2008	2009
Licensing income (million USD)	7.2	9.3	15.2	15.8
Number of patents granted	933	975	752	946
Number of patents licensed	-	93	112	171

Source: HEEACT(2010)

NCKU is the most successful Taiwanese university in promoting university-industry collaboration. This indicates that the university-industry collaborative model of NCKU can serve as a worthy reference for other Taiwanese universities.

3.1 Infrastructure of University-Industry Collaboration at NCKU

In the past 20 years, Taiwan has faced the relocation of its traditional industry and the transformation of the capital-intensive technological industry into an emerging small and medium-sized high-tech industry of high risk and short product life cycles. The commercial applications of the research results of HEIs are a crucial factor in improving Taiwanese industrial competitiveness. Based on the needs of “technological industry localization” and “local industry technologization,” NCKU established the Research and Services Headquarters (RSH) in 1996.

The RSH focuses on establishing a platform for interdisciplinary university-industry collaboration and acts as an incubator of research centers. The research centers can be categorized into three major types according to their characteristics, which are public services, humanities and social sciences, and science and technology. The organizational frameworks of the RSH and the research centers are similar to those of the colleges and departments in the academic system. The centers for public services cooperate with other R&D institutes (such as the Metal Industries R&D Centre and the Taiwan Textile Research Institute) and enterprises (such as Delta Electronics, Inc.) and provide IPRs and business incubation services (the Technology Transfer and Business Incubation Center (TTBIC)). NCKU does not offer any funds to the centers for humanities and social sciences or the centers for science and technology. Therefore, apart from receiving commissioned research projects from the government, these research centers must obtain funding through providing services to the public and private sectors.

In addition, research centers must undergo performance evaluations every three years. The

performance evaluations look at two major items: average annual revenue (including projects, inspections and testing, and technology transfer) and whether the research center accomplished its goals. From 2001 to 2010, the number of research centers of the RSH was between 48 and 71, as shown in Figure 2. The number of the research centers increased continuously from 2007 to 2010. However, 15 centers during 2001-2005 and eight centers during 2006-2010 were suspended or merged into other centers because they failed their performance evaluations, indicating that the operations of the RSH have grown gradually and stably in the past five years.

The R&D teams of NCKU also actively facilitate university-industry collaborative activities through the RSH. A great number of R&D teams have applied to establish research centers at the RSH, though the university does not provide any funding. This is considered to be due to the competition for research projects and the general administrative regulations of public HEIs. Generally, according to the technological needs of enterprises, only interdisciplinary collaboration can provide one total solution for enterprises, which is beneficial in competing for relevant research projects. Furthermore, the R&D teams of HEIs are usually comprised of professors and their graduate students, while the turnover rate of assistants (including postdoctoral researchers) is relatively high due to unstable research funding resources. Paper publication is another primary indicator for evaluating

professors, and is a criterion for graduate students, leading to a negative influence on applied research or university-industry collaboration. Therefore, introducing professional personnel (such as research fellows) is necessary.

The RSH must develop relevant regulations on employment, salaries, performance appraisals, promotions, and rewards. Through long-term financial planning and the mutual support of project funding, research centers can retain professional personnel and reduce the costs of recruitment and training, facilitating long-term collaborative relationships between the HEIs and industries. Regarding the regulations for promotion, the RSH eliminated the sole criterion of academic publication and added concrete results in terms of university-industry collaboration as the primary benchmark.

As shown in Figure 2, the number of the research centers in the RSH dramatically increased from 2006 to 2010, and was significantly higher than the increase over the 2001-2005 period. Total income increased year by year from 2001 to 2006. However, it did not positively correlate with the number of the research centers in the RSH over the past 10 years. With regard to the average annual funding for the research centers, Figure 3 shows that average annual funding of the research centers significantly increased during

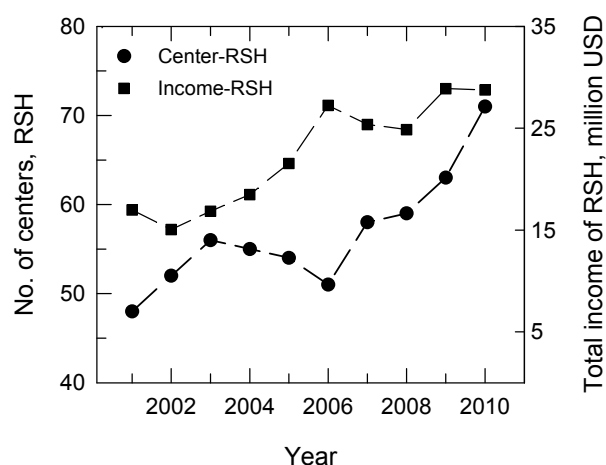


Figure 2 Number of RSH centers plus income, 2001-2010

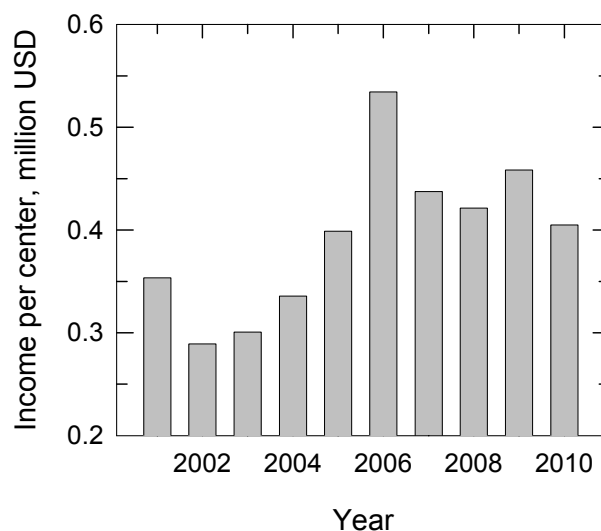


Figure 3 Average annual funding of RSH centers, 2001-2010

2002-2006 and fluctuated slightly during 2007-2010. This indicates that the operations of the research centers in the RSH gradually improved. The data also partially explains why 15 research centers were suspended or merged between 2001 and 2005.

Regarding the management of IPRs and business incubation, with subsidies from the Small and Medium Enterprises Administration (SMEA), the MOEA, and the NSC, NCKU established the Business Incubation Center and the Technology Licensing Center in 1997 and 2000, respectively. The goal of the Business Incubation Center lies in providing an incubator for enterprises to achieve innovation, upgrading, and transformative targets; while the Technology Licensing Center emphasizes patent applications and technology transfer. However, considering the coherence of technology transfer and business incubation and their interactions with enterprises, NCKU merged these two centers into the Technology Transfer and Business Incubation Center (TTBIC) in 2007.

Realizing the importance of university-industry collaboration, the MOE, the NSC and the MOEA supported HEIs in implementing the “Project for Enhancing the Performance of University-Industry

Collaboration” from 2008 to 2010. Therefore, the RSH coordinated nine colleges, the Alumni Association Center, and related units to construct a single service window for university-industry collaboration (Figure 4). The functions of the single service window include joint or contract projects, consulting services for various university-industry collaborative activities, technology transfer and business incubation services (TTBIC, NCKU R&D centers at the Southern Taiwan Science Park, and the SMEA Incubator at the Tainan Science Park), cultivation and matching of industrial personnel (Center for Industrial Elite Training and Convention Management), promotion of international and inter-university collaboration with industry, establishing an R&D database and fostering a campus conducive to university-industry collaboration.

It is believed that the activities of university-industry collaboration through a single window can simplify administrative procedures and improve professional services. When the RSH receives requests from professors or external enterprises, the project managers organize a team, keep track of projects, and report back after the projects are completed. By incorporating “customer first” into their concept of service, the RSH

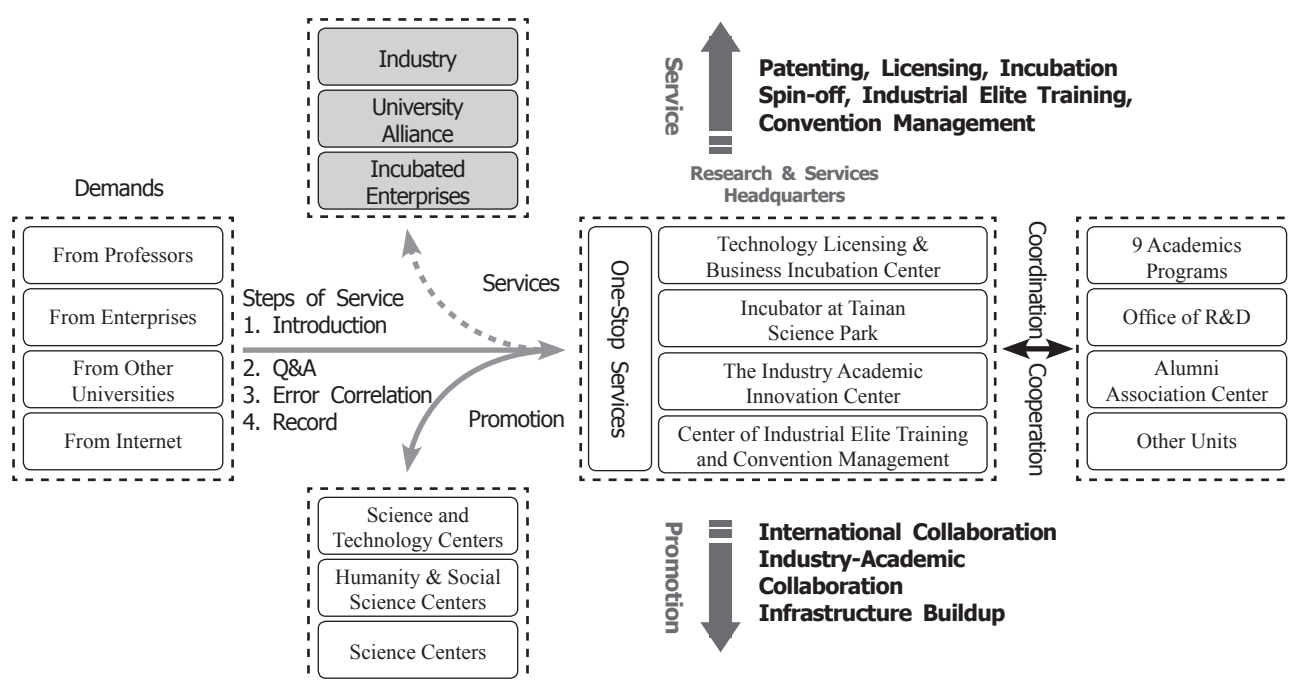


Figure 4 Infrastructure and services of university-industry collaboration at NCKU

enables the customers (professors and enterprises) to better understand the service, which includes patent applications, technology transfer, business incubation, government subsidies, and contract signing, in the shortest amount of time.

The R&D teams of NCKU are the technology sources of university-industry collaboration. The RSH publishes the *University-Industry Collaboration at NCKU* monthly to present their performance in university-industry collaboration so that enterprises can obtain the latest information on university-industry collaborative activities and updated research at NCKU. With regard to incentives for the R&D teams at NCKU, inventors can receive a large payment for technology transfer. If the inventions originate from government-sector grants, the inventors can earn a royalty plus equity of 60 % after deducting related costs (such as the patent cost). If NCKU owns the IPRs, the share for inventors can increase to as high as 85%. Regarding intangible rewards, professors can receive compensation in the form of a reduction in the number of hours they are required to lecture, if the number of joint and contract projects with enterprises reaches a particular level.

3.2 Management of Intellectual Property Rights

The management of IPRs includes patent applications and technology licensing. The TTbIC established a standardized procedure for patent application based on related regulations of NCKU. This was done to assess feasibility, apply for patents or trademarks, and establish follow-up maintenance mechanisms. To avoid overly excessive patent maintenance fees, the TTbIC conducts an annual overall evaluation regarding the granted patents that are under maintenance, followed by a committee review. NCKU will pay maintenance fees for the next

phase if the patents pass the evaluation. As for those patents that fail the evaluation, if inventors suggest that a patent is worth maintaining and are willing to pay 85 % of the follow-up maintenance fees (with the other 15 % being paid by NCKU), the patent can be maintained.

In improving patent quality, patent application should focus on commercial applications. The TTbIC established an interactive platform of IPRs in 2010. Some domestic and foreign companies established in-house IP or consultation firms at NCKU to provide immediate assistance to inventors. Such a mode of operation can assist in commercializing academic research and assist in eliminating unauthorized infringement, thus ensuring the rights of patent holders. This interactive platform is further introduced to HEIs in southern Taiwan. Note that in-university IP firms can also provide IPR internship opportunities for students.

With a grant from the NSC, NCKU founded the Technology Licensing Center in 2000. The primary services include patent application and technology licensing. However, with its limited financial budget, only four employees were hired by the center between 2000 and 2007; so a passive mode of operation has been a challenge to improving the outcome of technology transfer. As shown in Table 2, NCKU only had five technology transfer cases in 2001 (approximately US\$ 10,000), and 26 technology transfer cases in 2005, with an annual licensing income of US\$ 1.02 million. Moreover, the average amount per licensing was relatively low.

In 2008, NCKU obtained a grant for the inter-ministerial project to reconstruct the framework of the university-industry collaborative model, which led to the recruiting of more staff by the TTbIC. From 2007 to 2010, the annual amount of technology transfer increased continuously, topping US\$ 3 million in

Table 2 Number of staff members at TTbIC and licensing income of NCKU

Year*	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Size of staff	4	4	4	4	4	4	7	14	12	12
Licensing income (million USD)	0.01	0.10	0.14	1.01	1.02	0.47	1.15	2.46	3.33	3.40

* NCKU had no licensing income prior to 2000.

2009. This indicates that though NCKU possessed a stream of inventions, the professional personnel of the TTbIC were one of the major factors in improving the performance of technology transfer. This agrees with the previous studies by Markman et al. (2005) and Muscio (2010), in which technologies tend to be commercialized faster and earn higher revenues when inventors collaborate actively with technology transfer offices.

3.3 Business Incubation

University incubators are potential vehicles through which the commercialization of research can be supported (Becker & Gassmann, 2006). They hatch new ideas by providing new ventures with both physical and intangible resources, speed up the establishment of new ventures, and increase their chances of success (Hansen et al., 2000). According to a report from the U.S. National Business Incubation Association in 1997, incubation centers had positive impacts on local development, improved opportunities for employment, and provided a boost to economic development. Although SMEs make up the majority of businesses in Taiwan, they suffer from a relatively small R&D scope, weak capabilities for technological development, production- and manufacturing-oriented technologies, and insufficient technological product development capabilities because of global competition, their relatively small size, and the limited capital and information they possess. Therefore, the MOEA issued the “Guidelines for Encouraging the Formation of SME Incubators in Both Public and Private Sectors.” Currently, there are more than 100 incubation centers in Taiwan, and most of them are incubation centers of HEIs (SMEAMOE, 2010). These school-type incubation centers aim to provide enterprises with an innovative, upgraded, and transformative cradle to enrich their technology development.

Over the past ten years, the TTbIC has assisted enterprises or the corporate teams of NCKU in integrating knowledge in marketing, patents, products, and capital markets. Figure 5 shows the number of tenants incubated by the TTbIC. In this period, the 33

tenants in 2002 represented the highest number, and there were only 21 tenants between 2006 and 2007. This is directly related to the grants from the SMEA and the incubation capacity of the TTbIC. Though the SMEA infuses massive amounts of funding every year to support the business incubation centers of HEIs, numerous business incubation centers have limited manpower (staff of two to four) and insufficient capabilities for cultivating tenants.

Furthermore, the SMEA Incubator at the Tainan Science Park (SIAT) was founded at the Southern Taiwan Science Park in 2003. SIAT intends to provide a place for individuals or SMEs to develop new products, businesses, and technology; to start an enterprise; and to facilitate corporate transformation and upgrading. Major applications include biotechnology and medicine, information and electronics, precision instruments, and green energy and environmental protection. Because NCKU is the most vital academic research institution in southern Taiwan, NCKU was commissioned by the SMEA to manage SIAT. Apart from being a general incubation center, SIAT also provides three precision-instrument rooms and nine clean rooms for tenants. NCKU also provides various instruments, some of which have been placed in SIAT and others which have been placed in the Instrument Center of NCKU, effectively reducing the cost of facilities for tenants in the initial period of R&D.

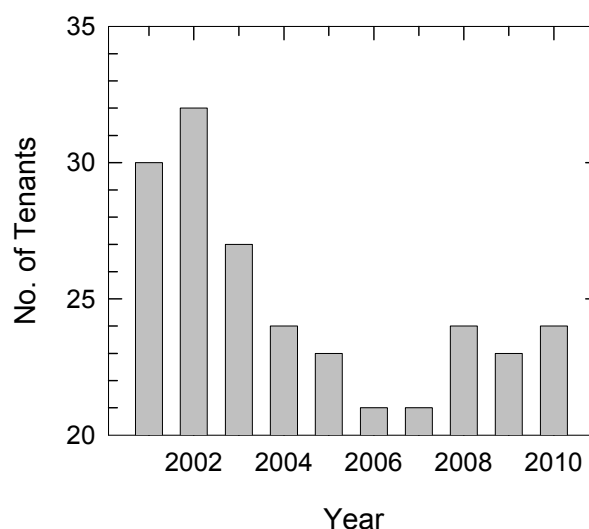


Figure 5 Number of RSH centers plus income, 2001-2010

SIAT also introduced accounting-law offices, human resource companies, and intellectual property offices to provide comprehensive services for tenants.

In the past eight years, the management team of SIAT has focused on assisting SMEs in obtaining governmental resources, assisting enterprises in seeking out collaborative research units (including the departments and research centers of NCKU, other HEIs, and research centers), and assisting enterprises in obtaining financial resources. Until 2010, SIAT had cultivated a total of 79 SMEs (including 30 new enterprises). Through the assistance of SIAT, 15 incubated enterprises were introduced into the science parks, and four incubated enterprises became over-the-counter companies.

However, regarding the sustainable operation of SIAT, a regional incubation alliance is another method for assisting the operation of HEI business incubation centers in southern Taiwan. Connecting tenants with large enterprises is another essential challenge in the sustainable development of SIAT. However, with the limited operating funds provided by the SMEA, the shortage of professional personnel in SIAT is a serious problem. Therefore, recently NCKU has been actively integrating incubation-related units, hoping to provide comprehensive services for tenants through professional services.

3.4 Inspection and Testing Service

Though current economic development in Taiwan is in transition from an efficiency-driven to an innovation-driven economy, many SMEs are original equipment manufacturers or focus on foreign product sales or maintenance. Therefore, product inspection and confirmation are necessary. Taking membrane-type gas gauges as an example, all domestic and imported gauges must conform to the regulations of the Bureau of Standards, Metrology and Inspection, MOEA, for sale in Taiwan. The thermal efficiency of solar collectors must match the national standards. However, most SMEs lack relevant testing equipment. In the past decades, due to academic research grants from the government, HEIs have accumulated various

instruments and equipment that can provide inspection and testing services to enterprises for their products. Therefore, many laboratories in NCKU have recently obtained certification from the Taiwan Accreditation Foundation, providing relevant inspection and testing services to enterprises.

Taking a laboratory for materials testing as an example, the laboratory, in accordance with the domestic and international standards, aims to assist manufacturers in obtaining certificates for certain materials. The revenue of the laboratory increased sharply from US\$ 0.45 million (2001) to US\$ 1.93 million (2010), indicating that the demand for testing is gradually increasing, and the interactions between HEIs and enterprises should develop diversely.

4. Perspective on University-Industry Collaboration at NCKU

In the past 15 years, the university-industry collaboration of NCKU has established comprehensive organizational frameworks, interdisciplinary platforms, and standardized IPR operational procedures. Through revising regulations and introducing professional personnel, NCKU has also built an environment that is conducive to university-industry collaboration. However, with government policies that require public HEIs to obtain partial funding on their own, increasing R&D funding from enterprises is a challenge for the sustainable operation of the RSH and its research centers. According to the Science and Technology Basic Law in Taiwan (2000), patent assignment and stock trading in public HEIs are regulated by the National Property Act, which has a substantial influence on the management and application of IPRs. Therefore, in consideration of the high patent-maintenance fees and improvement in technology transfer performance, a regulation was officially enacted by the NSC to surrender or transfer patents in July 2011. This would be greatly beneficial to HEIs' management of IPRs.

Disclosure of research activities and intellectual property are the primary goals of NCKU in order to enhance university-industry collaboration. However,

the current database consists mainly of basic research information, which cannot provide instant assistance to support the technological needs of enterprises. Regarding patents, although enterprises can obtain information from the Intellectual Property Office of the MOEA, the promotion of IPRs still relies on the interactions between professors, manufacturers, and the staff at the TTbIC. Thus, monitoring R&D outcomes and establishing Internet platforms for university-industry collaboration are necessary. In the initial stage, the RSH can collect and compile previous cases of technology transfers or university-industry collaborative projects to serve as raw data modules. Next, a feedback mechanism for enterprises can be introduced, followed by revising the modules to support the needs of enterprises. Then, a comprehensive database of R&D outcomes of NCKU can be established. Moreover, the databases for patent searches, inspection and testing services, and R&D personnel information can be included in the Internet platforms. Then, the demands for university-industry collaboration can be fulfilled via the online services provided by this single window on the Internet. As for technology transfers, electronic marketing (such as the platform service of widget) can break the bottleneck of relying on professional agents for matching. This Internet platform can further be promoted to the HEIs in southern Taiwan to facilitate resource sharing among HEIs. Recently, NCKU emphasized the application of international patents; therefore, international licensing would be a major goal of the TTbIC.

With the policies of the MOE, most HEIs integrate their IPRs with business incubation. For the TTbIC, increasing the number of professional personnel is the main impetus for improving patent quality and the performance of technology transfer. For business incubation, service quality needs further improvement. In the past three years in particular, a total of five tenants have become spin-off companies, and NCKU also holds stock in several companies. In considering the benefits of university-industry collaboration, actively assisting these tenants in improving operations is a vital issue. Furthermore, grants from the Taiwanese government for university-industry collaboration

have been dispersed. The integration of manpower and resources in the relevant university-industry collaborative units of NCKU is another vital task. The TTbIC should establish a combined service model of patenting, technology transfer, and business incubation, which includes interactions among inventors, TTbIC staff, IP firms, and spin-off companies. This will be beneficial to the sustainable development of university-industry collaboration at NCKU.

5. Conclusions

Most SMEs in Taiwan suffer from insufficient R&D personnel, capital, equipment, and innovative operating models to support their commercial activities. Due to governmental policies, particularly the policy that requires public HEIs to obtain partial funding by themselves, HEIs are gradually emphasizing university-industry collaboration and increasing R&D funding from enterprises is an inevitable trend. As the most vital research institution in southern Taiwan, NCKU exhibits the greatest performance in terms of university-industry collaboration in Taiwan. Comprehensive systems have been established for the operation of university-industry collaborative organizations and the management of IPRs and business incubation.

However, regarding sustainable long-term development, with limited manpower and budget, the online platform for university-industry collaboration can provide SMEs with comprehensive services. Through regional alliances, this online platform can also be promoted to other HEIs in southern Taiwan. The combined service of patenting, technology transfer, and business incubation is extremely beneficial to the operation of spin-off companies by HEIs' R&D teams, consequently increasing the overall benefits of university-industry collaboration to HEIs. The development situation, including bottlenecks, of university-industry collaboration in NCKU can provide a reference for university-industry collaborative development in universities of emerging and developing countries. In particular, it is known that government policy will guide the activities of university-industry collaboration. Interdisciplinary

platforms at the major HEIs are required to stimulate long-term relationships.

Acknowledgements

The authors are thankful to the editor and to the reviewers who clearly helped to make this paper better than it was initially. The financial support by the MOE, the NSC and the MOEA are highly appreciated. The third author would also like to express his sincere thanks to all staff at Technology Transfer and Business Incubation Center, NCKU for their great efforts.

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