University and Industry Relations

A case study analysis of two marine science research institutes in the Philippines

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Abstract

University-industry linkages in the Philippines have received more attention in the last few years. Centers of Excellence (CoEs) and Centers of Development (CoDs) have emerged. These are the selection of public and private institutions which have demonstrated the highest degree or level of standards along the areas of instruction, research and extension. The ministry of education in the country had in fact begun to encourage such relations by including in its CoEs criteria the capability of the institution concerned to engage in industry-academe linkages. In this light we have the three actors of the Triple Helix Model coming together – the university and industry, with government policies encouraging the interaction.

The two case studies in this research were selected as one of the CoEs and CoDs respectively. The analysis provided in this study attempts to highlight the role of the university in transferring knowledge to the industry. It also identified some factors that could limit or encourage the level/degree of the interaction. While this study sheds light only on the activities within the two case study institutions and not on the industry activities, the role of the government is still very much visible, and overall seen in its funding role. The study reveals that in the Philippines, bilateral relationships are more common, university-government, and also, university-industry, but only to a very small degree. Institutions in the Philippines such as our two case studies (and, especially the much smaller institute) have yet to make use of the role of the industry may it be as an alternative source of funding, or in terms of applied knowledge returns to the university.

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Catherine Batac

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List of Abbreviations

ADB	Asian Development Bank
CHED	Commission on Higher Education
CoDs	Centers of Development
CoEs	Centers of Excellence
CORE	Centre for Offshore Research and Engineering
DBM	Department of Budget and Management
DOST	Department of Science and Technology
GIFT	Genetic Improvement of Farmed Tilapia
HE	higher education
HEDF	Higher Education Development Fund
HEIs	higher education institutions
ICT	information and communication technologies
IEMS	Institute of Environmental and Marine Sciences
IP	intellectual property
IPR	intellectual property rights
IT	information technology
LGUs	local government units
LTHEDP	Long-Term Higher Education Development Plan
MOA	memorandum of agreement
MPAs	Marine Protected Areas
MSI	Marine Science Institute
NGOs	non-government organizations
NHERA	National Higher Education Research Agenda
PAC	Professional Activities Centre
PAMS	Philippine Association of Marine Science
PCAMRD	Philippine Council for Aquatic and Marine Research and Development
PESFA	Private Education Student Financial Assistance
R&D	research and development
S&T	science and technology
SD	sustainable development
SMEs	small and medium-sized enterprises
SNPL	Study Now Pay Later
STFAP	Socialized Tuition and Financial Assistance Program
SUCs	state universities and colleges
SUML	Silliman University Marine Laboratory
TLOs	technology licensing offices
UNDP	United Nations Development Program
UP	University of the Philippines
USAID	United States Agency for International Development
ZRCs	Zonal Research Centers

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Chapter 1. Introduction

This chapter is the discussion of the main research elements. The research problem and questions are presented, as well as the levels of analysis and variables. The motivation and the scope and delimitation of the study are outlined. Finally, the methodology is dealt with, with the sub-areas on research design, data collection methods, sample, analysis and interpretation, and validity examined.

1.1. Motivation and Rationale

In the Philippines, there are professions that limit professional growth and economic reward, such as the health and natural sciences. However, there are certain areas that are rewarding but few students choose these professions. An example is marine science. Very few have expertise (at the PhD level) in the marine sciences and there are very few practicing oceanographers in the country (Jacinto in Forum, 2005)[1].

Special attention is drawn to marine conservation efforts in the Philippines because it is identified as an epicenter of biodiversity and evolution (Carpenter, et al. 2004: 467). It is an advantage for the few oceanographers who practice, but are they enough to utilize the vast resources? The motivation for developing this study was out of an inspiration and interest to scrutinize the natural resources that the Philippines may make use of amidst the financial troubles that the country is facing. In the beginning it did not seem plausible to relate this interest to higher education (HE), but through the help of my supervisor, a framework was developed to look at university and industry relations in the context of marine science.

While it is shown in current government policies that the state has a growing concern to encourage university-industry relations, very little has been written about this subject in the

[1] In 2005, to discuss brain drain in Philippine education in greater detail, the *Forum* organized a virtual roundtable discussion among several experts and educators. The discussants for this issue were Profs. Ma. Rosario P. Ballescas and Felisa U. Etemadi of the Division of Social Sciences, UP Cebu College; Prof. Agnes C. Rola of the UP Los Baños College of Public Affairs; Dr. Gil S. Jacinto of the Marine Science Institute; Prof. Jorge V. Sibal of the School of Labor and Industrial Relations; and Dr. Vivien M. Talisayon of the College of Education, UP Diliman.

Philippines. This study also aims to initiate the beginning of future, more in-depth studies of this subject matter.

1.2. Scope and Delimitation of the Study

The analysis of this research focuses on how *knowledge is transferred* from the university to the industry and the *factors that determine the level/degree of interaction* between the two. Because of time constraints, the analysis focuses mostly on information gathered directly from academics. As there was not enough time to go to the Philippines and interview the respondents, interviews using semi-structured questionnaires were conducted via electronic mail (e-mail) instead. The analysis in this study is dependent on responses to those questions. Moreover, background information about governmental policies and initiatives is also provided as well as academics' views on the industry, in the context of the partnerships.

1.3. Research Problem and Questions

The main problem that this study addresses is: How is knowledge being transferred between the (two) marine science research institutes (case studies) and industry, in the context of the Philippines?

Below are the research questions to help address the main problem:

1. How do government policies affect/determine the collaborative arrangements between universities and industry on the one hand, and the marine science research institutes and industry on the other?

2. Why is it important for universities and their respective internal units to form collaborations with the industry?

3. What are the key factors facilitating knowledge transfers from academia to industry?

4. How can the relationship between university and industry in the context of marine science research in the Philippines be characterized? (e.g. what is the overall assessment? What are the main constraining barriers?)

1.4. Methodology

1.4.1. Research Design: Case Study

This research is qualitative in nature and focuses on two case studies. Robert Yin (2003) describes a "case study" by giving a technical definition of its scope: A case study is an *empirical inquiry* that (a) investigates a contemporary phenomenon within its real life context, especially when (b) the boundaries between phenomenon and context are not clearly evident (Yin, 2003: 13). According to the author, a case study as a research strategy comprises an all-encompassing method that includes covering the logic of design, data collection techniques, and specific approaches to data analysis (*ibid.* p. 14). This study was built on e-mail questionnaires and content analysis of documents and secondary-source literature that I have found or in consultation with my supervisor.

The five components of a research design that are especially important in case studies are (*ibid*. p. 21-27):

- *A study's questions* – although the substance of the questions will vary, the case study strategy is most likely to be appropriate for "how" and "why" questions.

- *Study propositions* – if we go back to the research problem and questions in our study, these are "how" and "why" questions and do not state propositions. According to Yin, this is acceptable in other research strategies such as in our study wherein, instead of propositions, we may state our *purpose* in going about this research. Alternatively, we may use the theoretical assumptions/elements (which we will call "factors") identified in the literature as determining the level/degree of industry-academia engagement as our propositions. These elements or factors, when used as part of a broader conceptual framework, provide an indication of where to look for relevant empirical evidence. We will explain this further below.

- *Unit and levels of analysis* – In this study, the phenomenon being analyzed, i.e. the knowledge transfer from academia and the processes that are associated with it, is the unit of analysis. Babbie (1989) differentiates four units of analysis that are common in the social sciences and these are: individuals, groups, organizations and social artifacts (Babbie, 1989 in Blanche, et al. 2002: 37). The units of analysis have an impact on the sample, data and the conclusions that can be drawn from the research. There are no clear boundaries among these different units of analysis and it is to the discretion of the researcher on which aspects the research will focus (*ibid.*). This research will focus on organizations and the individuals that make up those organizations.

The level of analysis is indicated in the research problem, "How is knowledge being transferred between the (two) marine science research institutes (case studies) and industry, in the context of the Philippines?" The breakdown of this analysis involves the organizational (meso-level) and individual, i.e. the role of academics and administrators (micro-level). The 'macro-level' aspects were also touched upon in the background of the study, i.e. governmental policy and global/regional dynamics. Information about each institution has been collected and it is in this area where the theoretical assumptions are utilized. In this case, the factors that determine the level/degree of industry-academia engagement identified in the literature review help identify the relevant information about the institutions. To quote Yin, "without such prepositions [key factors] an investigator might be tempted to cover "everything," which is impossible to do" (*ibid.* p. 23). The author further said that the more a study contains specific propositions or factors, the more it will stay within feasible limits.

According to Yin (2003), the last two components of a research design, *linking data to propositions* and *criteria for interpreting the findings,* have been the least well developed in case studies. The current state of the art does not provide detailed guidance on these two, nevertheless they should be included in a case study. We shall try to shed light on them as we go on to the other sections of this chapter.

1.4.2. Data Collection Methods

In this study we used the following data collection methods: semi-structured questionnaires, document reviews and review of relevant literature. As no one data collection method is ideal for every situation, it is preferable that multiple methods be used whenever possible.

When we use multiple methods to assess the same outcomes, there is a richer, more detailed picture, inconsistencies between methods is illuminated and chance of bias caused by a particular method is reduced (HFRP, 2004). Here are the data collection methods in detail:

The semi structured interview (or questionnaire, as used in this study) – has a sequence of themes to be covered, as well as suggested questions. At the same time there is an openness to changes of sequence and forms of questions, in case of a follow-up based on the answers given by the subjects (Kvale, 1996: 124). Similar to case study interviews that are most commonly of an *open-ended nature*, we asked the key respondents about the facts of a matter as well as their *attitudes* and *opinions* about particular events (Flick et al. 1991 in Kvale, 1996: 101; Yin, 2003: 90). In the questionnaires distributed for this study, the respondent also suggested other persons to contact, as well as other sources of evidence. The respondent's openness to assist transforms his or her role into an "informant" rather than a respondent (Yin, 2003: 90). For this research, distance and time constraints were factors that led us to carry out the semi-structured questionnaires via e-mail. This method of data collection makes use of both interview and questionnaires. According to Kvale, when there is little time available for a research, questionnaires will always be faster to administer, analyze, and report than interview studies (Kvale, 1996: 104). Since we were not able to meet with the respondents face-to-face and the exploration of topics was limited, the type of interview that we did could also be classified as "questionnaire," though still a qualitative study. In this case, the interview guide was structured and a space was provided for elaboration of additional aspects from the respondents.

A preliminary e-mail was sent to several contacts from the two institutions inquiring if they would be available to fill in the questionnaires. After two-three days, we received responses and so we sent our questions to the ones who agreed to be our respondents. Only two out of seven respondents had to be contacted by phone after the given deadline (one week); the rest voluntarily complied with the timeframe provided. When required, the respondents were contacted again to provide additional information/clarification. Two respondents suggested two others we could get more information from. These people gave clarifications regarding the licensing office at the University of the Philippines (UP) and regarding patenting experiences, respectively. We shall discuss more about these respondents, our basis for choosing them, etc. in “Sample.”

Document reviews – are ways to analyze existing records and other documents about the subject concerned. Examples of these are budget records, memos, staff records and annual reports (at the research unit level). It is advantageous to get hold of documents as, most of the time, they are tailored to the study being researched on. They also save the researcher time from making his or her own evaluations, at the same time, there is a high degree of accuracy since these documents are usually made available by staff in the organization that is being studied. One disadvantage of document reviews is the uncertain availability of documents. As experienced in this research, most documents were gathered from official websites on the internet. If some documents were not available, we e-mailed the contact persons. We have experienced either being passed on from one contact person to another or that it usually took a long time for them to respond, if not at all. As to the analysis of government documents, we found it a challenge to deal with documents that had missing data. Also, some documents contain information that are either too vague or too general, for example, “the CoEs/CoDs were carefully selected based on strict criteria.” The “criteria” was not elaborated upon. We checked press releases to find out if they had disclosed the “criteria” and also checked other documents for more data. We surmised that in this case, it is not only the task of finding credible information that is important, but also where to look for that information.

Review of related literature – is the review of similar studies and existing data that were originally collected by other researchers and writers. The body of our literature review (Chapter 4) covers related studies previously undertaken by other researchers in the Asian region, as well as across the world. This chapter also sheds lights on matters we did not have time to access directly from the respondents, such as macro-level aspects (e.g. government policies/world dimensions).

1.4.3. Sample

The Marine Science Institute of the University of the Philippines (UP MSI) was chosen as one of the case studies because it is arguably the leading marine science institute in the country. UP MSI in this study represents the Luzon area, the biggest Philippine island. In comparison, a smaller institute, the Silliman University Marine Laboratory (SUML), was chosen to represent the Visayas region (the second biggest island in the country). The type of sampling that allows us to choose a case is called “purposive sampling.” It is not as simple as picking any case, rather, this type of sampling “demands that we think critically about the parameters of the population we are interested in and choose our sample case carefully on this basis” (Silverman, 2000: 104). We choose groups, settings and individuals where the features or processes being studied are most likely to occur (Denzin, et al. 1994 in *ibid*. p. 104).

Later in the “Case Studies” section 2.9, the two institutes are discussed in detail. The way they complement each other (e.g. in size, location, profile) is also a valuable aspect for this study, as we were able to observe the degree of their involvement with the industry based on these types of contextual differences.

The target sample for the study was three respondents from each institution, i.e. a total of six respondents plus one student. In qualitative studies such as ours, the number tends to be either too small or too large. There are certain limitations in a very small group but the downside when the number is too large is that it is not possible to make in-depth interpretations of the data gathered (Kvale, 1996: 102). The question as to whether our number of respondents is adequate or not may be answered by a quote from Tellis (1997): “Case study research is not sampling research; that is a fact asserted by all the major researchers in the field (including Yin, Stake, Feagin and others).” The above author adds that it is the unit of analysis that is the critical factor in the case study. With case studies focusing on one or two issues that are fundamental to understanding the system being examined, it is typically a system of action rather than an individual or group of individuals (Tellis, 1997). Based on this statement, we assume that in a case study, it is not the size of the sample that matters, but how that sample can give us a better understanding of the system that is being studied.

Let us relate the basis for choosing our sample to Clark’s (1983) discussion on “Authority.”

The author enumerates six levels of authority (not all found in every system). From bottom to top, the first level is the *department*, the second level is the *faculty* and the third is the *university* (Clark, 1983: 108-109). The fourth level is the *multi-campus* academic administration. The state, provincial, or *municipal government* itself is the fifth level. Lastly, the sixth and the highest level is the *national government* (*ibid*. p. 109-110). Not all six levels were dealt with in this study. Three sets of questions were prepared since we needed to reach people from each one of the three institutional levels, namely; a) research unit, b) institute/faculty, and c) university (central administration).

The professional roles contacted were the following: the director of the institute and assistant director of the research unit in each of the respective marine science institutes. In addition to this, we contacted two academics at one of the institutes being surveyed (one young instructor and a Professor Emeritus). In the same manner, two contributing scientists at the remaining institute were also contacted, i.e. individual academics who are associated with and/or administrators of other institutions and organizations. These internal stakeholders provided valuable insights regarding the role of the local government, university or faculty policies, as well as feedback about their roles as professional academics. Additionally, a Master's student was contacted. This seventh respondent, a student involved with research in one of the institutes, was the only student representative available as to share with us his experience on patenting his work. We found this "variation" in the sample helpful since we were able to get contrasting views on the key aspects that each type of academic (e.g. young instructor and/or a Professor Emeritus) values the most. Furthermore, the director and assistant director we contacted are also academics themselves. We assume that different points of view (especially if everyone has the same opinion on a matter) helped lessen the bias in the information that was collected.

In sum, we could not afford to be too selective in our respondents and it all depended on who could give us the information that was needed, and at the same time that person should be available given the limited timeframe of the study.

1.4.4. Analysis and Interpretation

It is especially difficult for (young) researchers to analyze case study evidence, since the strategies for case study analysis have not been well defined (Yin, 2003: 109). However, Yin proposes three general strategies in order to minimize this shortcoming: (a) relying on theoretical propositions, (b) thinking about rival explanations, and (c) developing a case description (*ibid*. p. 111-112).

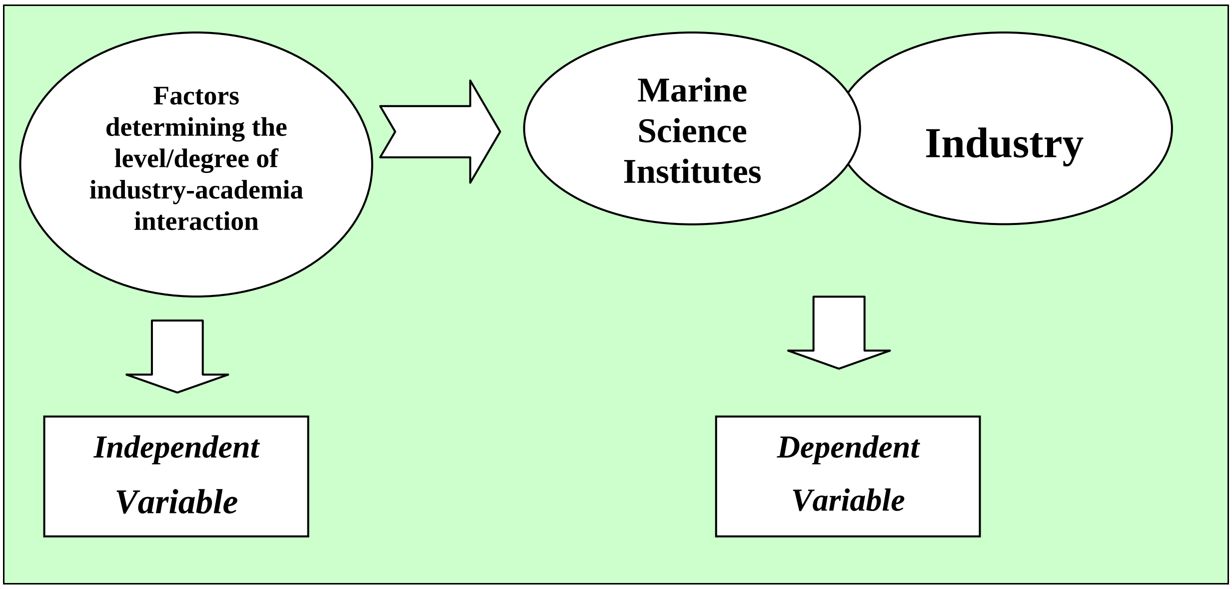
The most preferred strategy, and the one applicable to our research, is to follow the theoretical propositions or factors that led to the case study (*ibid*. p. 111). The original objectives and design of this case study were presumably based on the *Triple Helix Model* (Etzkowitz et al. 2000), which in turn led to the development of a research problem, research questions, reviews of the literature, and, as a result, a set of key variables/factors. The theoretical basis, i.e. the Triple Helix combined with the key factors determining the level/degree of industry-academia interaction gathered from the existing literature, provided the context for making decisions on how the empirical data was to be analyzed (Kvale, 1996: 206). In turn, the factors identified in this study (see Table 1) shaped the data collection plan.

Table 1: Factors determining the level/degree of industry-academia interaction

Levels of Analysis	Key Factors/Variables
University	Available resources Internal processes and routines
Institute/Faculty	Type of industry that the institution collaborates with Institutional profile, organizational structure, and location Internal processes and routines History of the institution and its dominant academic culture Levels of trust (among university stakeholders and between university and industry partners) Available resources (financial and human)
Research Unit	Internal processes and routines Dominant academic culture in the unit Levels of trust (among university stakeholders and between university and industry partners) Available resources (financial and human)

The factors also help focus attention on certain type of data and organize the entire case study. Thus, theoretical variables about causal relations, such as answers to “how” and “why” questions (both of which we have in our research problem and questions) are extremely useful in guiding case study analysis in this manner (Yin, 2003: 112). In light of the Triple Helix, and the research questions posed earlier, we have identified the *key variables* of the study as follows: The factors described above (Table 1) act as the *independent variable*. They determine the degree of involvement between the marine science institutes and industry in the Philippines. The type and level of interactions between the two act as the *dependent variable*. As part of a multi-level framework of analysis, information on state policies (macro-level) regarding university-industry interactions was also gathered.

Fig. 1. The Key Variables of the Study



The causal relationship presented is not a strict one as there may be many indirect relationships amongst the variables resulting to the degree of interaction or knowledge transfers between academia and industry, but the impact of each one of those factors is difficult to determine. (Future studies may attempt to isolate/control some of the factors and shed light on which ones have a stronger impact). In detail: (a) It is difficult to accurately test the degree of influence of the different factors composing the independent variable; (b) it is difficult to determine the effect of the independent variables on the dependent ones since many are in fact, related to each other (e.g. the cases of 'trust', 'resources' and the ‘dominant academic culture’); (c) many of the factors composing the independent variable e.g.

'government policies' act as "environmental factors," together with other aspects at the regional/local level that the study did not take into account; and, (d) the factors are context-specific, thus do not have an equal weight across all institutions, e.g. academic culture is likely to have a stronger impact on large flagships institutions like UP than smaller institutions/units. Public or private ownerships (e.g. SUML) may also be an element.

1.4.5. Validity

Internal Validity

Internal validity is the degree of congruence between the researcher's observations and theoretical ideas (Bryman, 2001). In the case of the two case studies covered here, viewed only from the point of view of the two institutions, we are in danger of bias. It is likely that random errors may have occurred due to the limitations caused by time constraints and use of e-mail questionnaires. There may have been flaws with the subsequent interpretation of the data gathered because not having met the respondents face-to-face and/or not having spoken with them may have decreased the control on how they have interpreted the questions and the manner that they have responded to them. However, when we followed up with two or three respondents to clarify/elaborate on their responses over the phone, there was an opportunity to interact with them. Such is the internal validity that relates to reliability of the data gathered. The subjective nature of qualitative studies makes them prone to errors (more examples in the next paragraphs). On the other hand, use of subjective information is essential to describe the context or natural setting of the variables under consideration, as well as the interactions of the different variables in the setting. The strength of qualitative studies is that they seek a wide understanding of the subject matter.

If there should be a conflict among the three actors (university, government and industry), since we are focusing only on the academics, it is also very likely that the respondents will put the university in the most positive light. Due to time constraints, we were not able to gather empirical data from these two additional actors (industry and government), but we made an effort to shed light on their important roles through the analysis of existing documents and secondary sources. In this research, the core test while interpreting the data gathered is to relate the latter to previous findings using the Triple Helix Model. In the process, the data is also linked to the theoretical assumptions implicit in other earlier studies about the role of the university in society.

Another factor that could be classified as a *limitation* instead of an *error* is the use of the English language in the questionnaire. However, it will be more difficult for the respondents (all Filipinos except for one) to express themselves in (pure) Filipino. Many of them were educated in the United States and they are writing their research works in English. It was clear, though, that the e-mail questionnaire limited them in giving responses, as compared to a face-to-face encounter or even telephone interaction. This issue was evident since the only respondent who is a native English speaker filled in the questionnaire in a more thorough way than the others did. We would also like to make clear that the responses, unless quoted, were edited for clarity, but we made certain that the message remained the same.

Issues on validity are critical in every research project and there are tests common to all social science methods. Since much of the empirical work was derived from semi-structured questionnaires, the main issue in this research when it comes to validation is the "practical issue of verifying (interview) knowledge" (Kvale, 1996: 229). These practical issues have been practiced from the very beginning, such as in the formulation of the questionnaires. As my supervisor and I went through the questions, I learned some important aspects. For example, on how to formulate the questions in a more neutral way, otherwise the respondents *could* have been induced to give the answers I (researcher) was looking for. Once I have obtained the answers, a follow-up in order to clarify pending issues was exercised in some occasions, particularly when there was inconsistency in figures given, the contribution of the proposed research centers, to name but a few.

External Validity

External validity relates to generalizing one's findings to or across a broader population or environment. Are our findings in the case studies from two Philippine islands representative of the knowledge transfer from university to industry in all marine science institutes in the Philippines? Even if the profiles of these two institutes are rather diverse, this might not solve the issue of the generalizability of the data. Furthermore, time constraints prevented us from carefully selecting the respondents. As mentioned earlier, the basis of our selection depended on who could give us the information that was needed, and at the same time that person should be available given the limited timeframe. Data gathered using the methods attached to this type of study, such as the ones used here, are in danger of distortion dependent on the profile of the respondent. Another validity concern is that we did not manage to hear the side of people from the industry sector, so the information about university-industry relations is only one-sided.

But as mentioned earlier, to our knowledge, there has not been any prior research done about university-industry relations in the Philippines. Theoretical and empirical findings are based on the e-mail questionnaires and mostly international literature gathered throughout this study. For a research in its birthing phase, we assume that it is only right to tackle one side of the issue first and foremost. This should serve as a starting point for other researchers to move on to other directions as well as to look in further detail to other spheres of the Triple Helix (e.g. state-industry).

One of the three core aspects of validation that Kvale outlines as investigation, i.e. *checking*, (*ibid*. p. 242) was found as very useful in the context of the study. In *checking*, the researcher in general, plays the devil's advocate toward his or her own findings (*ibid*. p. 242). In this research focusing on the university, there is an opportunity to get the point of views of the academics involved in their respective research units, as well as in aspects associated with the institutional level (university/institute). There is also a chance to shed light on academics' views regarding some common issues across levels, e.g. government funding, patents, etc. In some cases, and due to the variety of perspectives covered, the challenge for us was encountering rival explanations, biases, and the like. In these situations, we adopted a critical outlook of the data (*ibid*. p. 242).

Construct Validity

Construct validity pertains to the measurement of theoretical constructs by different measures; it involves correlations with other measures of the construct and logical analysis of their relationships (Kvale, 1996: 239-240). The main theoretical construct in this study is 'knowledge transfer.' As mentioned earlier, we have identified the factors used to measure/determine this process (see Table 1), as derived from the existing literature.

We could not attest to the validity of these factors other than the fact that they were key patterns seen in earlier documented experiences of higher education institutions (HEIs) from different countries regarding knowledge transfers from academia into industry. What is certain is that the information in the chapter regarding Analysis (Chapter 5) was presented the same way it was conveyed by the respondents. We may have overlooked the subjectivity of some data as subjectivity of respondents is both difficult to prevent and predict. But, to the best of our knowledge, when needed, data provided by the respondents were cross-checked using official documents and other credible sources. For example, facts and figures regarding dates, awards/recognition, etc. were thoroughly checked with CHED for consistency.

Chapter 2. The Context/Background of the Study

2.1. Introduction

This section deals with the macro-level context in which our study occurs, i.e. the Philippines and its geographic surroundings. General information about the following aspects is presented: socio-economic background, higher education landscape and reform efforts. Since the majority of HEIs in the Philippines are private, there is a separate section (below) discussing private HE in the country. Research activities are also reflected upon, particularly as regards marine research, where our two case studies fall under. There is also a brief background on CoEs and CoDs, as our case studies are recognized as such, respectively. Finally, the profiles and characteristics of the two cases (research units) are elaborated upon.

2.2. Socio-economic Background

The May 2000 Population Census put the Philippines' total population at 75.33 million, with an annual growth rate of 2.02 per cent per year from 1995-2000. While this is lower than the rate from 1990-1995, there was no significant improvement in the quality of life of the average Filipino. The economy of the country continues to suffer from the peso devaluation, oil price increase, and political crisis. These statistics have prompted the government to develop measures to reduce the total fertility rate from 3.7 children per woman to 2.1 (replacement level fertility) by 2005 (UNPF, 1999). The year 2005 had come and gone but there was no significant change in the rates as that year recorded 3.16 per cent.[2]

The continued growth of the population is seen as a major deterrent to the improvement of the economy. A survey made by the World Bank in 2000 shows that 47.5% of the population lives below US$2 a day. The poor are left without a choice and will do anything just to earn

[2] This represents the average number of children that would be born per woman if all women lived to the end of their childbearing years and bore children according to a given fertility rate at each age (CIA World Factbook, 2006).

money, often leading to the increase of crime rate in the country.

Brain drain is also a major concern in the Philippines. For instance, the best and brightest graduates have always been offered scholarships abroad. Most of them do not come back because they can achieve their highest potential in their particular fields in the first world setting (Rola in Forum, 2005). But there are measures to facilitate retention of talents – not only by the government, but as well as by the HEIs and the industry. There are HEIs in the Philippines that need individuals with advanced degrees to be part of their faculty and they train these students to enter the field. In the same manner, the industry and non-government organizations (both local and international) continue to recruit and attempt to build in-house capabilities (e.g. in the marine sciences) (Jacinto in Forum, 2005). In our view, it is a challenge for these sectors to give the individuals competitive salaries and a work environment on a par with the international setting. For many years, the state has been unable to supply jobs to its growing population and is sending more and more Filipino workers overseas. This is probably one of the reasons why the unemployment rate has decreased from 2003 to 2006 (CIA World Factbook, 2006), although the data do not account for the "underemployment" rate.[3] With this as a backdrop, it is not surprising that the Filipino people turn to education as a venue to alleviate poverty. On higher education's end, the pursuit of a better quality of life for all Filipinos is a part of its mission. This could be achieved by emphasizing the acquisition of knowledge and formation of skills needed to make the individual a productive member of the society. HEIs aim to develop professionals and leaders, as well as harness the productive capacity of the country's human resource base towards international competitiveness (SEAMEO RIHED, 2004).

Organizations like the World Bank, United Nations Development Program (UNDP) and the Asian Development Bank (ADB) participate in the government programs to alleviate poverty in the country. ADB prioritizes poverty reduction in Asia in their projects and publications. Based in Manila, its aim is to improve the welfare of the people in Asia and the Pacific, particularly the 1.9 billion who live on less than US$2 a day. In 2001, the Philippine

[3] Refers to people employed at a job that does not fully use their skills or abilities.

government forged a partnership with ADB, calling for measures that would promote sustained economic growth, reduce inequalities in income and wealth, improve the delivery of basic social services, and reform the system of governance (RP-ADB Poverty Partnership Agreement, 2001: 2).

Given the close connection between economic growth and poverty alleviation (*ibid*. p. 4), the state ensured that the growth is broad-based, that appropriate attention is given to the development of the rural sector and that there is an increase in the international competitiveness of industries that maximize the use of labor.[4] Investment in human resource development was promoted through a combination of public investments in the provision of basic social services, such as quality basic education, primary health care, nutrition, and safe water and sanitation, and public-private partnerships in HE, vocational and technical training, tertiary health care, and information and communications technologies (ICT) to raise productivity and incomes. Public-private partnerships are more common in secondary schools, for example, the government contracts with private schools to enroll students in areas where there is a shortage of places in public high schools. However, this practice is now ongoing in HE, where contracting schemes seem to have grown (LaRocque, 2006).

2.3. Overview of Philippine Higher Education

A five-year review of the Philippine educational system led to the creation of the Commission on Higher Education (CHED) in 1994. CHED began supervision over all HEIs in the country, whether public or private. An agency attached to the Department of Labor, the Technical Education and Skills Development Authority (TESDA), has since oversaw the post-secondary technical and vocational education including skills orientation, training and development of out-of-school youths and community adults (Biglete, 2003). The table below provides a brief overview of the Philippine HE system:

[4] The text does not imply whether it is “skilled” or “unskilled” labor. But being familiar with the trend in the Philippines today where the state responds to “export labor demands,” we assume that this line refers to maximizing the use of *unskilled* labor.

Table 2: As of Academic Year 2005-2006

	Public	**Private**
Number of Institutions	182	1 465
Enrollment	829 181 (2003-2004)	1 591 675 (2003-2004)
Budget	P17,508,494 (approx. US$370,000)[5]	[6]

Source: CHED (2006) and DBM (2006)

Public institutions are broken down into: (a) state universities and colleges (SUCs), (b) CHED-supervised institutions (CSIs), (c) local colleges and universities (LCUs), and (d) other government schools (OGS).[7] On the other hand, the private HEIs are classified as *sectarian* or *non-sectarian* (please refer to the next section, "Private Higher Education," for more details). The HEIs consist of two-year and four-year colleges, and comprehensive/technical universities. Public institutions are established by law, administered and financially subsidized by the government. Private institutions in general are covered by the policies and standards set by CHED in terms of course offerings, curriculum, administration and faculty academic qualifications, among others. Private institutions are fairly autonomous but they have to acquire permit from CHED to open new courses and to authorize graduation of their students.

The Philippine education system closely resembles the American system of formal education, with English as the medium of instruction.[8] The general pattern of formal education includes six years of primary education and four years of secondary education. College education usually takes four years, and takes longer for some courses, e.g. engineering (five years), medicine and law (eight years).

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[5] April, 2007 exchange rates.

[6] The funds of private institutions are from tuition fees, contributions, capital investments, and other school charges.

[7] Other Government *Schools* are public secondary and post-secondary education institutions, usually technical-vocational education institutions that offer higher education programs.

[8] During the American colonial period, the Americans made English the medium of instruction for the entire education system and an official language for public administration and the professions (Gonzales, 2003: 2).

Government programs, universities, individuals, private organizations and industry provide scholarships to students from low-income families. The University of the Philippines (UP) developed the *Socialized Tuition and Financial Assistance Program* (STFAP). This scheme operates on the principle that rich students should pay higher fees than poorer students, based on the annual family income, assets and other indicators.

Enrolment in private HEIs decreased to a total share of 65% (in 2005-06) from 81% in 1990-1991. The trend is attributed to three main factors: (a) the lower cost of studying and improved quality at public HEIs, (b) the increased number of SUCs which make them more accessible by those in the lower socio-economic strata, and (c) increased scholarships for the poor but deserving students (Ocampo, 2005).

CHED formulated the *Long-Term Higher Education Development Plan* (LTHEDP, 1996-2005), a blueprint that embodies policies, strategies, and programs that are aimed at addressing sector-wide concerns on quality and excellence, access and equity, relevance and responsiveness, and efficiency and effectiveness (Garcia, 1996). However, the plan was revised in view of the rapid technological developments, globalization, and the results of studies conducted by the Asian Development Bank/World Bank (1998 Philippine Education Sector Study in Biglete, 2003) and the Presidential Commission on Educational Reform (PCER Report 2000 in *ibid*.). As a result, the new LTHEDP (period 2001-2010) was formulated to serve as a springboard and guide in the implementation of meaningful reforms in HE. Through a much improved and responsive HE, it is hoped that a better quality of life for the Filipino people can be achieved (*ibid*.).

At the institutional level, HEIs establish and maintain their own internal organization which framework is divided into policy-formulation and implementation. The Governing Board is primarily responsible in the formulation and approval of all policies, rules and standards in the institution, while the President-led administration is in charge of the implementation of policies and the management of institutional operations. Individual charters assured the autonomy of the SUCs. The latter are authorized to open curricula and institutional programs, and award their own degrees. The private HEIs experience some degree of freedom in their internal operations when their programs are Level III accredited.[9] This means that they are fully deregulated in terms of administrative matters and financial aspect such as in setting tuition and other fees. They also have autonomy over their curricula and can initiate reforms in their programs without securing CHED's approval (*ibid.*).

We shall discuss private HEIs in a separate section below, in view of their fairly large share of the Philippine HE system.

2.4. Private Higher Education

The birth and expansion of private HEIs date back to the Spanish occupation, when authorities gave the friars of the Catholic Church the full responsibility for HE (Altbach, 2004: 17). The first private HEIs in the Philippines were church-affiliated and founded by the Catholic religious groups; the HEIs we now refer to as "private sectarian" and are operated by various congregations. During the colonial period, the churches' role extended to HE, partly to help train new members of the clergy (Gonzalez, 1997: 5-6), as in the case of the University of Sto. Tomas (1611) which is the oldest surviving university in the Philippines and in Asia. The earliest private HEIs are also Christian-affiliated, namely; Ateneo De Manila University (1901) and De La Salle University (1911), arguably the best private HEIs in the country today (Gulosino, 2003: 4).

During the American Occupation in the early 1900s, American Protestant missionaries established several educational institutions within the country. That time, a new generation of private HE emerged with the establishment of business or family-dominated institutions

[9] There are four basic levels of accreditation. In Level I, HEIs enjoy partial administrative deregulation. In Level II, they enjoy full administrative and financial deregulation, partial curricular autonomy, priority in getting funding assistance or government subsidy and limited visitation/inspection and/or supervision by CHED. In Level III, they enjoy all the benefits for Level II and full curricular deregulation. In Level IV, they are considered to have distinguished themselves in a broad academic discipline and have the prestige and authority comparable to that of international universities (Biglete, 2003).

referred to as "non-sectarian" (Gulosino, 2003: 5), the HEIs we now refer to as "private non-sectarian" and are owned by private corporations. Private colleges and universities continued to grow in number. These were somehow for-profit driven but, at the same time, were also concerned with providing a better educated work force, a task that public institutions seemed to have been weak at. These private institutions relied on fee-paying students.

Private HE from the post-war period up to the present is characterized by several trends. Examples are institutions that in the beginning focused only on one academic field but had later branched out into other disciplines. As early as then, the government encouraged private funding in education. But even so, in the years that followed, the private HEIs suffered from severe budget constraints and relied mostly on student fees to stay afloat. The 1970s was not a good time for private institutions, when the Philippines underwent a political and economic crisis and the government took charge of the regulation of tuition fee increases.

CHED offers students who enter private HEIs a program similar to *Socialized Tuition and Financial Assistance Program* (STFAP) in UP known as the *Private Education Student Financial Assistance* (PESFA). But, unlike STFAP, PESFA does not fully cover tuition fees. The CHED also has a *Study Now Pay Later* (SNPL) program that offers student loans. In contrast to the application of income-contingent loans in some other countries where the basis for students to repay is their earnings after graduation (c.f. Teixeira, et al. 2004), SNPL requires borrowers to repay their loans at an annual interest rate of six percent, 13 months after graduation. This results to students not borrowing if they have little chance of finding a high wage job upon graduation.

The PESFA Program offered by CHED allows students of private HEIs whose family income is lower than P120,000 (US$9,893), around P15,000 (US$1,237) per year. Therefore, a student who has an annual family income of P90,000 (US$7,420) and who receives the maximum PESFA, would still have to pay more than two-thirds of one's family income just in tuition fees (ICHEFAP, 2001).

Data from 1997 show that the annual tuition fees of private universities are nearly half the average income of Filipino families (P123,168 or US$10,154 in 1997). The table below shows the wide gap between the costs of tuition fees among the premiere universities in the Metropolitan Manila area, the country's capital.

Table 3: Tuition Fees of Selected Universities in the Philippines[10]

	Amount/term	Number of terms to complete a degree	Amount/year
University of the Philippines (Public)	P6,500 (US$536)	8	P13,000 (US$1,072)
University of Santo Tomas (Private)	P20,000 (US$1,649)	8	P40,000 (US$3,298)
De La Salle University (Private)	P30,000 (US$2,473)	10	P60,000 (US$4,946)
Ateneo de Manila University (Private)	P40,000 (US$3,298)	8	P80,000 (US$6,595)

Source: Viray, 2001, in ICHEFAP, 2001.

Very little information can be found on the bases of fee increases. The three reasons for a private HEI to raise tuition are: (a) cope with inflation in its input prices especially wage rate, (b) improve the quality of its instructional facilities and personnel, and (c) open new degree programs that entail higher cost than existing ones (Tan, 2002: 15). Some universities undertake consultations with the parents to explain to them the bases for proposed fee increases. In addition, high-quality institutions have also been exempted from obtaining CHED approval for fee increases (*ibid*.).

The *equity* issue in the expansion of private HEIs is less clear. Due to the increase of tuition fees, students are becoming less likely to afford HE. Tuition fees are expected to continuously rise as CHED liberalized policies for private HEIs. For example, in the academic years 2000-2001, about 37 percent of HEIs raised their tuition fees by an average of 13.1 percent.

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[10] GDP per capita/PPP US$1 = P12.13 (2001).

2.5. National Reform Efforts

During the World Summit on *Sustainable Development* (SD)[11] in 2002, education and educators were recognized as essential elements of the progress towards SD (Peralta, 2004:1). This was a major change, as sustainable development has been focused on a political agenda since the Earth Summit in 1992 and education was not well reflected in the strategies towards SD. As a response to this, the Philippine government and key sectors of society such as the business lobby and civil society, agreed to implement an *action agenda* for SD. The state has vowed to bring SD in pursuit of its key objectives of global competitiveness and poverty alleviation (*ibid*. p. 1-2).

For the first five years since the Earth Summit in 1992, the Philippine HE system focused on systemic reform and strengthening in order to enhance its capability to respond to national demands and international challenges. Basically, the first decade of the development program was devoted to planning. Operationalization of structures, policies and programs were put in place to ensure the system's performance as knowledge center in selected disciplines. At present, Education for Sustainable Development-related activities in formal (e.g. agricultural and fisheries education, engineering, architecture, to name a few), non-formal, and informal education are in place (*ibid*. p. 3).

From a global point of view, the main challenges in Philippine HE are brought about by the changing global economic and social conditions. The last years of the twentieth century were characterized by an oversupply of knowledge, scientific breakthrough, and technological advancement, particularly in ICT, as well as rapid technological diffusion (*ibid*. p. 5). *Globalization* is another challenge, wherein there is a need to prepare the country's human resources, society and culture at large, for the future liberalization of trade and commerce. The current GATS negotiations might present severe threats to the authority of nations over

[11] World Commission on Environment and Development defined 'sustainable development' as: "meeting the needs of the present generation without compromising the ability of the future generations to meet their own needs" (Peralta, 2004: 1).

their HE systems (c.f. Beerkens, 2004: 20), and this might also be true for the Philippines. Another aspect relates to the fact that our study focuses on marine science[12] research, where it is a big challenge for the institutes involved to be effective, but, for that to happen, there should be world-wide distribution (of knowledge) and global connectivity (Marginson & van der Wende, 2006: 4, 27). Lastly, rapid developments in infrastructural technologies such as ICT, biotechnology, and advanced materials technology, among others, are propelling nations towards a knowledge-based economy[13] (Peralta, 2004: 6).

2.6. Research Activities in the Philippines

Research is a major function of HEIs. However, based on the Congressional Commission on Education's (EDCOM) study conducted in 1991, the quality of research outputs of Philippine HEIs was below world standards (Biglete 2003). The research outputs were described as repetitive and heavily biased towards the field of education and allied areas, and very few dealt with the sciences. The lack of appreciation for the importance of research, insufficient funding, inadequate or lack of research facilities and library resources are only few of the many barriers to which the poor state of HE-research could be attributed to (*ibid.*).

CHED is constrained by large financial requirements but recent reforms have been instituted to address this problem. One major reform that was created in 1994 is the *Higher Education Development Fund* (HEDF). In line with the thrust of education for sustainable development (Peralta, 2004: 7), HEDF aimed at improving and strengthening HE in the country by providing support to the identified CoEs in the various disciplines; such as teacher education, business and entrepreneurship, medical and health professions education, engineering, mathematics and the sciences, agriculture and the humanities and arts (Alcala, 1998: 3). In 1996, the same reform paved the way for CHED to begin a series of policies for available funds. The policies have also focused on the priority research areas and the commission's criteria and procedures for evaluating proposals for funding.

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[12] *Marine Science* is a discipline that incorporates fields of marine biology, marine ecology, marine geology, oceanography, ocean and coastal management, among others.

[13] In the knowledge-based economy, the ability to produce wealth depends largely on the organizational capability to create, acquire, accumulate, disseminate, and exploit information and knowledge (Peralta, 2004:

Through HEDF there is an implementation of more focused and effective strategies to respond to the major concerns in HE. CHED (via HEDF) provides financial assistance to the identified CoEs and CoDs amounting to P1 million to P3 million[14] each, annually. The assistance is in the form of student scholarships, faculty and staff development, research grants, instructional materials development, library and laboratory facilities upgrading, as well as funding to conduct networking activities (Biglete, 2003). We will discuss more about CoEs and CoDs in another section, in relation to the two case studies.

In 1998, the *National Higher Education Research Agenda* (NHERA) was launched. NHERA provides the policies, priorities and procedures as well as guidelines on the research environment required to promote, encourage and support research undertaken at Philippine HEIs. The research priority areas in NHERA focus on raising the quality of science and education in the country. Another key area is the development of collaborative linkages with governments and institutions of higher learning abroad aimed at the global/mutual recognition of degrees (Peralta, 2004: 10).

In order to deregulate the research management functions of CHED, 12 HEIs were identified as the *Zonal Research Centers* (ZRCs) of the Commission. The (12) ZRCs are given a budget allocation of P1 million (approx. US$21,000) each, per year. As such, they are expected to conduct seminars on research capability, identify technical experts to review proposals for CHED funding, and select researchable topics for commissioned research endeavors based on CHED's priorities.

In 1998, a research agenda-setting activity was initiated, focusing on the contribution to the country's goals in a variety of core areas; the health area, the science and technology sectors, as well as other governmental initiatives like sustainable development. This process is the result of a bottom-up approach pursued by the *Philippine Council for Health Research and*

6).

[14] Approx. US$21,000 – US$63,000. Exchange rates on this page are from April, 2007.

Development (PCHRD) while drawing up the country’s health research-agenda for the political administration headed by President Joseph Estrada who was incoming that time, i.e. in 1998[15] (Feranil, 2004: 1). This approach differed from the previous research priority-setting exercises, where the national research agenda was decided upon by a group of experts based in the nation’s capital – Manila (PCHRD, 1982, 1985, 1988; DOST, 1990, 1993 in Feranil, 2004: 2). As for regional priorities, these were traditionally the sole responsibility of those living in the regions (Feranil, 1999 in Feranil, 2004: 2). While the former approach posed some challenges and limitations, it, nonetheless, proved enriching since regional consultations were elevated to the national level. Thus, the formulation of a national research agenda became a multi-sectoral and fully participatory exercise in recent years (*ibid*. p. 2).

2.7. Marine Science Research in the Philippines

The first marine research in the Philippines dates back more than 200 years. While the Filipinos’ close relationship to the seas surrounding them goes further back, as seen in traditional Filipino beliefs, it was only during Spanish colonial times (1565-1898) that this anecdotal relationship started to be documented. Although during that time the first efforts aimed at conducting research on marine science areas (e.g. in the area of resources) became evident, there was not (yet) much science involved. In other words, the first research efforts were merely taxonomic[16].

From 1947 to 1954, fisheries research was characterized by a modern approach to problems exercised through systematic scientific studies. However, little attention was paid to real marine fishery biological research. For one, there was a lack of knowledge of the biology and life history of the important marine food fishes, of their behavior, migration, etc.

[15] The priority setting activity was to determine what priorities and strategies regarding the health sector had to be conducted in the next five years (1999-2004) to contribute to the country’s vision of the 2020 scenario. Formed during the previous administration, the said scenario was set in the National Health Plan (1995-2020) envisioning longer life expectancy, lower infant and mortality rates, less disability, a well-nourished population, safe drinking water for all, to name a few (Feranil, 2004).

[16] Relating to “taxonomy.” In biology, the science dealing with the description, identification, naming, and classification of organisms.

Furthermore, there was also lack of a well-balanced fisheries program which minimized the usefulness of the oceanographic surveys in coastal areas that could have helped explain fishery phenomena (Tiews, 1958 in Pauly, 1986: 10).

Starting in the 1970s, increasing attention was given to marine research as a consequence of the growing signs of the destruction of the country's marine resources. This process led to an increased awareness of the importance of quantitative studies as well as resource management policies across the country (*ibid*. p. 3, 4, 9).

The partnerships of marine science research institutions with the industry were usually out of the need to strengthen resources. But, it could not be denied that, to strengthen knowledge about marine life and expand the domestic capabilities of marine science research also required the cooperation of various organizations. At the First National Symposium in Marine Science (in 1989) convened at UP MSI, the *Philippine Association of Marine Science* (PAMS) was established. This was in response to the need for a national organization that would link together various academic, government and private institutions, non-government organizations (NGOs) and industry involved in marine science research and development (R&D) in the country. PAMS has grown from an association of 76 charter members with delegates from Luzon, Visayas and Mindanao, to more than 200 members by 2005. Its goal is to promote growth of marine science in the country and to recognize the important role of Philippine scientists in furthering knowledge on tropical marine ecosystems (PAMS, 2003).

2.8. Centers of Excellence (CoEs) and Centers of Development (CoDs)

CoEs and CoDs, akin to ranking, are a system to recognize public and private HEIs in the Philippines which have demonstrated the highest degree or level of standards along the areas of instruction, research and extension. CoEs and CoDs provide institutional leadership in all aspects of development in specific areas of discipline by providing networking arrangements to help ensure the development of HEIs. CoEs/CoDs in the different disciplines were carefully selected based on instructional quality, research and publication, extension and linkages, and institutional qualifications. In the breakdown of these criteria on the selection form, extension and linkages pertained to industry-academe linkage, other academic linkages, and outreach programs (CHED, 2004).

Data from CHED's Statistical Bulletin (in 2004) show that the marine science discipline in UP Diliman was selected as a CoE while the same discipline in Silliman University was selected as a CoD (CHED, 2004). As discussed earlier, the identified CoEs and CoDs receive financial assistance amounting to P1 million up to P3 million each annually. The designation of CoEs and CoDs shall be subject to regular monitoring by CHED for three years and the designation shall be revoked if the CoE/CoD in question is incapable of fulfilling its functions (CHED, 2006).

2.9. The Case Studies

The two case studies covered in this study are: (a) the *Institute of Environmental and Marine Sciences* (IEMS), a unit of the Silliman University Marine Laboratory (SUML), Silliman University, in the region of Visayas; and, (b) The *Marine Science Institute* of the University of the Philippines (UP MSI) at the UP Diliman Campus, in the region of Luzon. The two cases are complementary. Whereas the latter is a part of the flagship institution, the former, although founded in the same year (1974), is a much smaller unit that is part of a private HEI which was granted autonomy by CHED. Silliman University and UP were founded during the American occupation of the Philippines in the early 1900s and are located in two of the three biggest islands in the Philippines, a country that has 7107 islands. The American era had begun in 1902, a period characterized by the expansion of public education, advances in health care and the introduction of democratic government. The outbreak of war in the Pacific in 1941 disrupted the American rule in the country.

The Institute of Environmental and Marine Sciences (IEMS-SUML) at Silliman University

The Silliman University Marine Laboratory (SUML) was established as a research facility of the university in 1974. The university is an hour by plane from the capital, Manila, and the whole campus is located by the sea. The IEMS faculty conducts research on taxonomy, biology, conservation, management, and mariculture. SUML also offers training courses and outreach services, activities that are supported by grant money and private donations. The institute has working relations with other units of the university as well as other national and international institutions. For example, their two-story facility was constructed with support from the United States Agency for International Development (USAID).[17]

The main concerns of the Laboratory include:

- Research within the marine sciences field with a strong focus on basic research in the areas of biology conservation, management, and (feasible) aquaculture technology.
- The development of management/conservation models focusing on the shallow coastal ecosystems (e.g. coral reefs, sea grasses, etc.)
- Provide laboratory facilities for biological courses held at the university.
- Promote local and international exchanges of scientists and students within the marine sciences field.
- Provide assistance to public and private agencies in marine development activities such as coastal management training, resource and ecological assessment, marine parks, aquaculture, and pollution studies.
- Facilitate knowledge and collaborative linkages between the academic fields of the marine sciences and the humanities.
- Serve as the environmental steward in the Negros Island and across the region of Central Visayas.

The province of Negros Oriental is composed of 20 municipalities and five cities, the center of which is Dumaguete City, a thriving community that is rich in history and culture, as well as natural resources. Silliman University is located in Dumaguete City. Dubbed as “the pride of Dumaguete,” the university is a vast 60 hectare land located at the very heart of the city. From a one-building unit to a small complex of four buildings in 1974, today SUML

[17] USAID is the United States of America’s way of extending help to people overseas struggling to make a better life, recovering from a disaster or striving to live in a free and democratic country.

has a two-story facility which accommodates six internal staff plus graduate students who work with them on a project (contractual) basis. They currently have seven part-time researchers/PhD students. The new marine laboratory built in 1997 houses four smaller laboratories. SUML’s infrastructure also consists of a library, herbarium and zoological museum, conference room, visiting scientist rooms, photo-lab and administrative offices. Furthermore, the marine laboratory provides students and research staff access to a dive shop, experimental fishponds and tanks, and culture facilities in addition to its own mangrove garden.

The Marine Science Institute at the University of the Philippines, Diliman

The Marine Science Institute (MSI) at UP Diliman started as (an almost empty) one-room marine science center in 1974. Diliman is located in Quezon City, the largest of Metro Manila's cities in population and land area. Dr. Edgardo Gomez, now world-renowned marine biologist, was its founding director and has led the institute for a quarter of a century. In 2006, Gomez graced the Commencement Ceremonies at UP Diliman as guest of honor. In his speech to the graduates, he shared the history of UP MSI.

Thirty-years ago, Gomez described himself “as a naïve PhD fresh from the Scripps Institution of Oceanography in California, who came looking for a job” (Gomez’s speech, 2006). During its beginning stages the institute did not have a laboratory space. As such, Gomez had to lend his own laboratory room to the first staff members, i.e. two young female researchers working on seaweed chemistry. After a few years, the two researchers obtained a public grant from the Ministry of Natural Resources. The grant included the construction of what is now the ‘Seaweed Chemistry Building.’ In the following years more researchers were recruited via small research grants, however, they still had to use their own laboratories. Gomez continued to seek for more laboratory space and he was given an abandoned greenhouse. Many years later, the international scientific community in the field had, in fact, noticed the earnest research that had started in that greenhouse. Today, this space which is equipped with modern facilities is one of the main international centers for coral-reef research. Over the years, the research institute became known both at home and overseas, particularly due to its efforts in hosting a series of international symposiums, thus leaving a good impression to foreign guests of a marine science institute based in a developing country like the Philippines.

Financially, MSI's history has also been marked with set-backs. The unit has had to rely heavily on its small research budget after having been unable to get a share of the US$20 million (worth US$48 million or P2.5 billion in 2006) loan from the World Bank which was allocated entirely to the creation of a new campus, i.e. the College of Fisheries at the University of Philippines (UP) located in the island of Visayas. Due to their unwillingness to leave their work place at UP Diliman, Gomez and his associates were increasingly neglected and isolated by the university's administration.

However, in the early 1980s, a new university administration supported the construction of a marine laboratory at Bolinao in the province of Pangasinan (Northern Luzon). Nonetheless, the political troubles experienced by the country at that time halted the completion of the new lab, but in the mid-1980s, the institute qualified for a UNDP institutional development grant worth US$1.3 million. Thus, the unfinished laboratory was completed and additional physical infrastructure was added, including the headquarters of the institute in Diliman. In the mid 1990s, the institute faced a new trial, as a cement factory was proposed to be constructed near the marine laboratory, a move that would threaten the scientific activities held at the institute. Behind this development was none other than a member of the UP Board of Regents.[18] Since the Regent and the University President were not inclined to assist MSI regarding this matter, the latter brought in other people to help. Thus, all the constituent units of the university and many national and international scientific bodies lent their assistance to MSI, making public pronouncements condemning the proposed development. Three major international funding institutions committed to environmentally sustainable development also supported MSI. As for the people of Bolinao, more than the recognition of a research institute in their region, they opposed a project that was perceived

[18] This incident reflects studies made in other developing countries about structural barriers in the development of Science and Technology (e.g., crony politics - c.f. Casas in Cimoli, 2000). However, this might be a complex, isolated case for every country, as David Kang's 2002 work on crony capitalism differentiated South Korea and The Philippines. South Korea's military dictatorship of 1961-1987 created an economic system which thrived on elite corruption and delivered strong economic growth for over 30 years. The latter, the Marcos dictatorship in the Philippines (1972-1986), despite early developmental promise, delivered only mediocre growth while plundering the state funds (Kang, 2002 in Munro, 2002).

as detrimental to their health and well-being. After more than a two-year controversy, the Department of Environment and Natural Resources (DENR) denied the request of the cement factory.

The charter of MSI was approved by the Board of Regents on March 28th, 1974. The Board of Regents is the highest governing body in the UP System, with members coming from various sectors in the university, industry, and government. The whole UP system, of which MSI is a part of, has a president and other officials. MSI as an institute gets its financial support from the university. In the last 26 years, the institute has grown from less than 10 to about 150 personnel, the majority of whom are professional staff. Headed by a director, they currently have 16 faculty and researchers and two Professor Emeritus (see breakdown in Table 4).

In 1998, CHED recognized MSI as the first and only CoE in Marine Science Research. This was the result of the unit's high level of performance and acquired research expertise over the years (i.e. producing about 20 ISI-indexed publications per year, an average of 1.2 per senior staff and considered to be world-class). They publish their research works in English, and some of these are in collaboration with researchers from the international scientific community. In 1995, MSI had one international refereed publication per PhD per year, the highest among academic institutions in the country.

Table 4: Summary of the Basic Data of the Two Institutes

	MSI	SUML
Number of Employees	150	10
Number of Full-time Researchers	16 (all PhD) Breakdown: Regular Faculty (full-time) – 12 (all PhD) Regular Faculty (part-time) – 1 (PhD) Research Faculty (full-time) – 3 (all PhD) Professor Emeritus - 2	8 (6 are contributing scientists)

Number of PhD Students/Part-time Researchers	17 PhD 1 part-time researcher	7
Annual Budget	P6 million for Personnel Services and P1.5 million for Maintenance and Other Operating Expenses, a total of P7.5 million (approx. $158,000 – April 2007 exchange rates) – budget comes from the university	P10 million for operations and research programs (approx. $208,000 – April 2007 exchange rates) – budget comes from external grants
Year Founded	1974	1974

Chapter 3. Theoretical Framework

It is widely asserted that in HEIs, the production of practical knowledge (‘Mode 2’) had become more prevalent than the production of theoretical knowledge (‘Mode 1’) (Gibbons, et al. 1994, in Fisher et al. 2003: 45) in recent years. This trend is partly a result of external social pressures for relevancy in the knowledge being produced. Mode 2 is transdisciplinary, organizationally non-hierarchical, socially accountable, and reflexive and the research is carried out in “the context of application.” By contrast, the traditional mode of knowledge production, Mode 1, designates reliable academic knowledge produced within autonomous disciplinary contexts, providing a little direct linkage between research and social application (Gibbons, et al. 1994 in Tuunainen, 2002: 37).

Aspects of Mode 2 are seen in the Triple Helix Model, the main theoretical framework used in this study. But the uniqueness of the Triple Helix is that it enables the combination between Mode 2 and systems of innovations, complex systems that are based on maintaining interfaces in a variety of dimensions (Leydesdorff, 2005: 190). Porter (1990), for example, proposed to analyze national economies in terms of clusters of innovation (Porter, 1990 in Leydesdorff 2005). Clusters are geographic concentrations of interconnected companies and institutions in a particular field; they encompass an array of linked industries and other entities important for competition (Porter, 1998: 78).

Triple Helix combines Mode 2 and systems of innovations as different subdynamics of the systems under study; and, at the same time, adds the dynamics of the ‘market’ as its third perspective (Leydesdorff, 2005: 194).[19] In other words, the Triple Helix sheds light on the study of the main institutions carrying out the knowledge-based system, i.e. the university, industry, and government. Each is analyzed in depth and each role is distinguished from the other. On the surface, this model looks at the relationships among the three actors but, at the

[19] According to Ben Jongbloed, there is not a single higher education *market*. It is in markets that buyers and sellers of goods and services, capital, labor, etc. come together, and in the case of HE, these are markets for students, research staff, lecturers, research grants and scholarships, donations, graduates, company training and so on (Jongbloed, 2003: 111).

same time, it also takes into account the internal transformation within each one of these three spheres. Furthermore, whereas in other perspectives where the *industry* plays the leading role in innovation (e.g. the national system of innovation approach as presented by Lundvall, 1988, 1992; and Nelson, 1993) and/or the *state* is seen as the privileged actor (e.g. "Triangle" model of Sabato, 1975), in the Triple Helix, the *university* is considered an important stakeholder able to play an enhanced role in the process of innovation in the context of an increasingly knowledge-based society (Etzkowitz et al. 2000: 109, 118).

Rather than focusing on systems of innovation or industry, this study focuses on the *university* since it is here that knowledge (mostly of the 'basic type,' or mode 1) is being produced. Within the Triple Helix, a special role is given to the development of the human capital.[20] The latter is continuously being enhanced along learning curves, avoiding the risk of, amongst other things, technological unemployment (Pasinetti, 1991 in Etzkowitz, et al. 2000: 119). The interactions among the institutional spheres of university, government and industry can have an effect on the knowledge base of a given country. Thus, the information we can get from the three dimensions composing the Triple Helix serves as an indicator for measuring the knowledge base within a specific context, in this case marine science knowledge production/transmission in the Philippines.

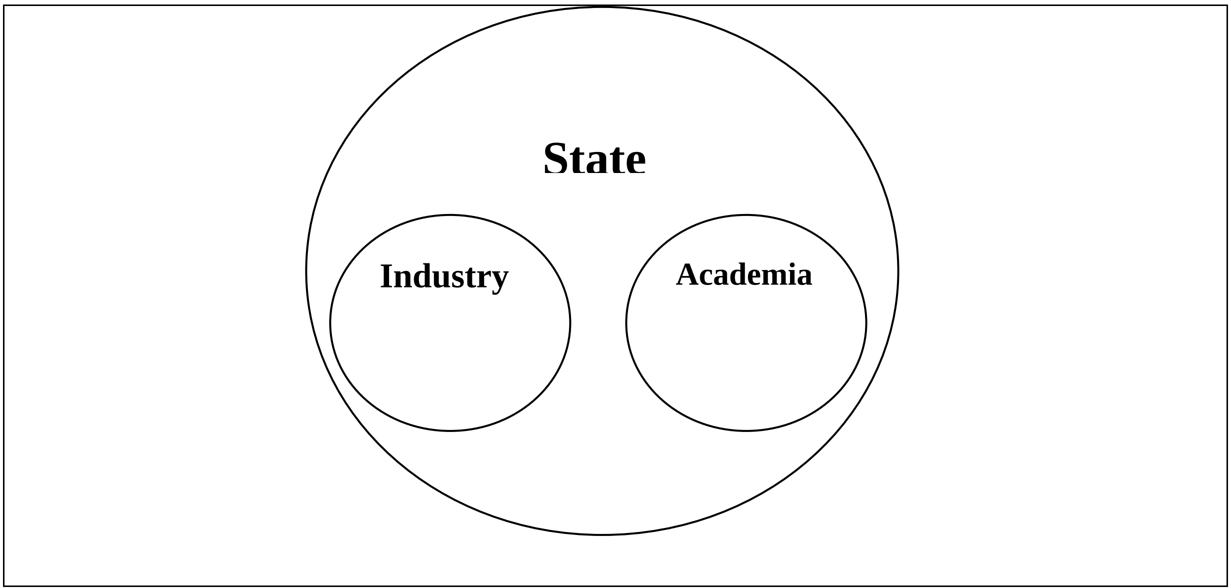
Etzkowitz and Leydesdorff consider the Triple Helix overlay as one that provides a model at the level of social structure for the explanation of Mode 2 as a historically emerging structure for the production of scientific knowledge, as well as its relation to Mode 1. This basically means that the model is thought of in such a way that when one opens the 'black-box' one finds Mode 1 within Mode 2, and Mode 2 within Mode 1. The system is neither integrated nor completely differentiated. But it performs on the edges of fractional differentiations and local integrations (Etzkowitz et al. 2000: 118-119). With the university, industry and government having their specific functions, the Triple Helix is advantageous to

[20] The concept of *human capital*, as defined by Garcia-Aracil, et al. "is the idea that people spend on themselves in diverse ways for the sake of future monetary and non-monetary returns (Garcia-Aracil, et al. 2004: 288). Education represents more than an investment in human capital (Becker, 1993 in Garcia-Aracil, et al. 2004.) as it allows individuals to learn and acquire skills that will essentially mold their behavior, beliefs and role in society (Haverman & Wolfe, 1984 in Garcia-Aracil, et al. 2004).

our study as it performs where these ends meet. Instead of being isolated, through the Triple Helix, these edges merge. Thus we begin to understand the differences of each actor and work around those differences.

The helices can reflexively take the role of one another, to a certain extent.[21] The boundaries of communities can be reconstituted as the technological culture provides options for recombination. However, the price being paid may be felt as a loss of traditional identities or alienation (Etzkowitz et al. 2000: 119). There are three existing variants of the Triple Helix. The most popular variant is known as the 'Triple Helix III.' The first version, Triple Helix I (Fig. 2) is largely viewed as a failed developmental model, since innovation was discouraged rather than encouraged with too little room for "bottom-up" initiatives. On the other hand, the second version, Triple Helix II (Fig. 3), entails a *laissez-faire* policy, nowadays also advocated as 'shock therapy,' in order to reduce the role of the state in Triple Helix I.

Fig. 2. Triple Helix I: Model of University – Industry Relations.



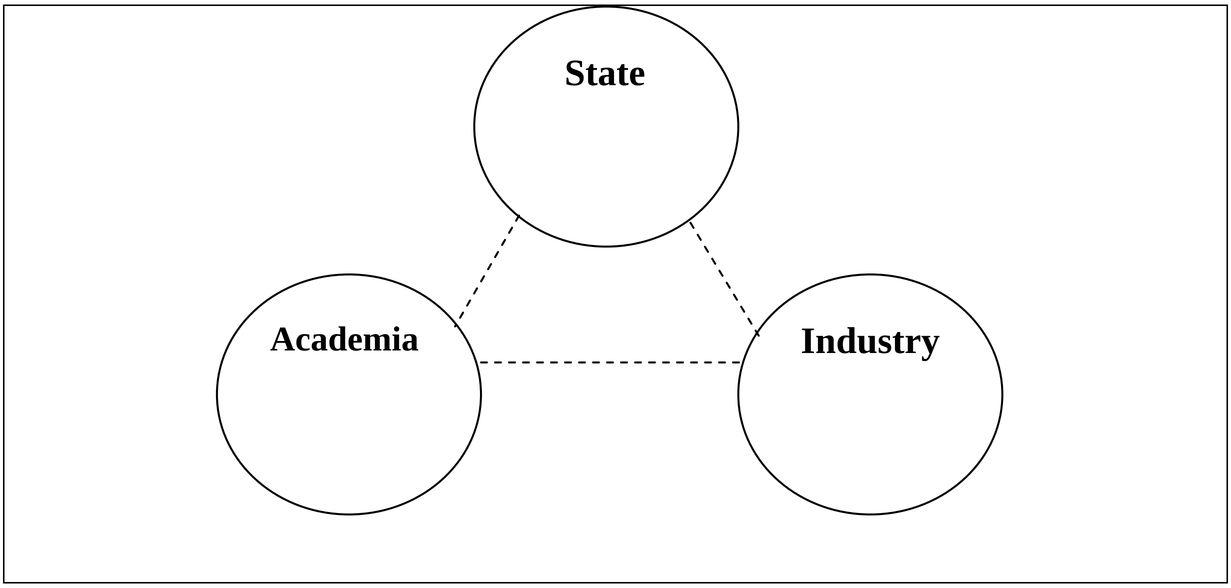
Source: Etzkowitz, et al. (2000: 111)

The common objective of Triple Helix III (Fig. 4) is to realize an innovative environment consisting of university spin-off firms, tri-lateral initiatives for knowledge-based economic

[21] *Helices* are what is referred to as the three "linkages" in the concept of the triple helix – university – industry, university – state, and state – industry.

development, and strategic alliances among industry, government laboratories, and academic research groups. These arrangements are often encouraged, but not controlled, by government.

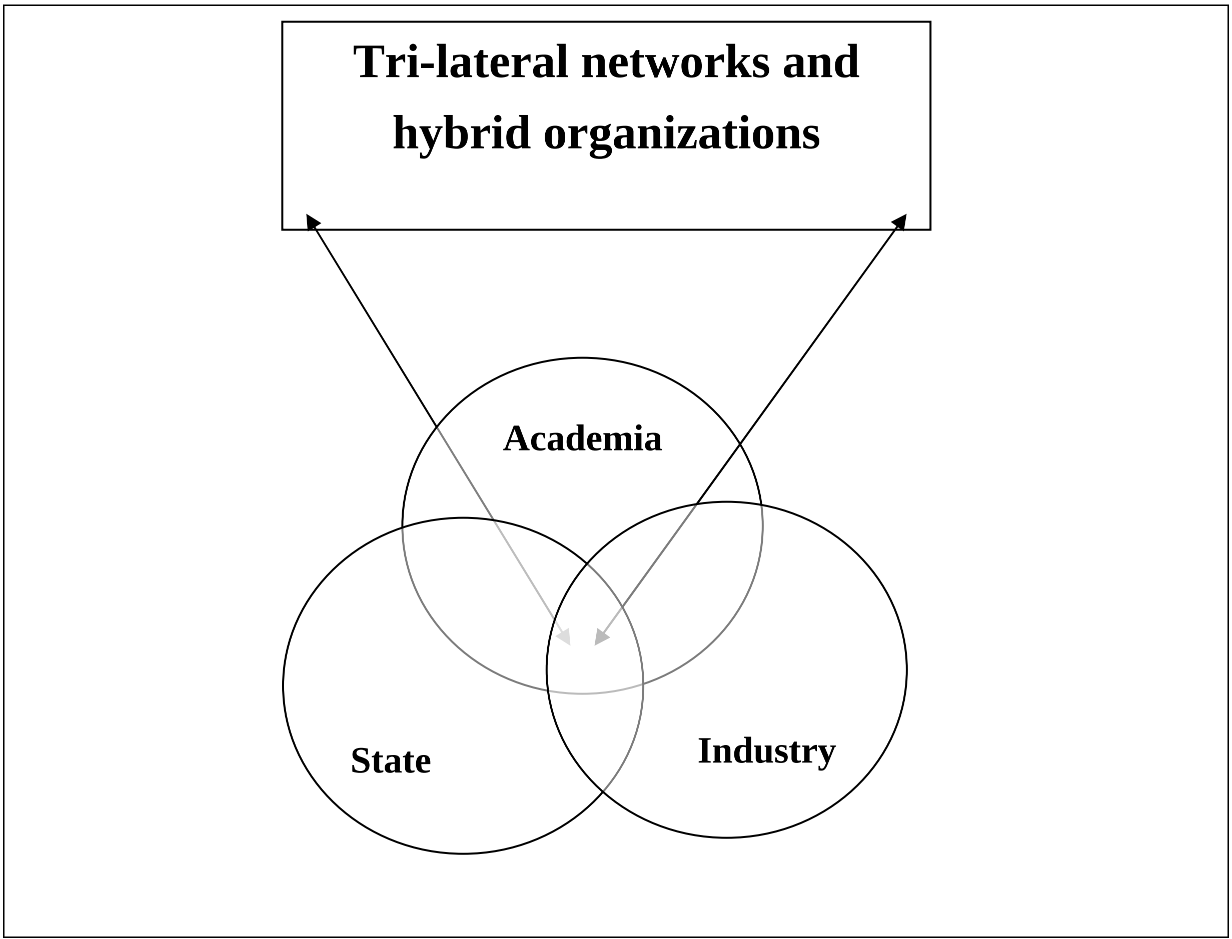
Fig. 3. Triple Helix II: A "laissez-faire" model of University – Industry – Government relations.



Source: Etzkowitz, et al. (2000: 111)

The linear model of innovation either expressed in terms of 'market pull' or 'technology push' was insufficient to bring about transfer of knowledge and technology. In essence, such linear models have been branded as over-simplified views of innovation processes in terms of transfers of specific technologies. In the academic context, *publication* and *patenting* assume different systems of reference from each other, as well as with reference to the transformation of knowledge and technology into marketable products. Due to these factors, the rules and regulations had to be reorganized, and an interface strategy had to be enhanced in order to integrate 'market pull' and 'technology push' via new organizational mechanisms. In contrast to traditional linear models of innovation, non-linear models like the Triple Helix go further by taking interactive and recursive terms into account. Such non-linear terms can be expected to change the causal relations between inputs and outputs (Etzkowitz and Leydesdorff, 2000: 110, 114).

Fig. 4. Triple Helix III: Model of University – Industry – Government Relations.



Source: Etzkowitz, et al. (2000: 111)

In the context of this study, the choice for a non-linear approach was based on the grounds that it fits the study of the interactive relationships among university, industry, and government in the context of marine science knowledge production/transfer in the Philippines. Additionally, the model chosen can also be used as a *unit of measurement* insofar the degree and importance of interaction amongst the three actors. In other words, which interactions are more meaningful? (a) university and industry, (b) university and government, (c) government and industry; and/or, (d) university – industry – government.

In its basic essence, the Triple Helix focuses on the enhanced role of knowledge in a given economy and society. Therefore we should go back to where most basic knowledge is usually produced, i.e. at the universities.[22] As such, the Triple Helix provides a framework to study the role of how universities in the Philippines, via knowledge transfers, are geared towards the goal of economic development by means of interacting with the industry. Basically, in this model, aside from research and teaching, the university is given the *third mission* of contributing to innovation and/or economic development within a given context (e.g. at the national/regional level). All over the worlds, HEIs that combine teaching and research activities are going through change processes (c.f. Clark, 1997; James, 1998; Robertson, et al. 2005). There is often a conflict between the research and teaching functions, with some debates urging the withdrawal of the university from this third mission (c.f. Gumport, 2000; Slaughter & Leslie, 1997). But, if we take it from Martin Trow's point of view, it is far from withdrawal. He viewed the impact of the new information technologies (IT) on traditional forms of HE as one among the major problems facing HE at the turn of the millennium. He stressed that one effect of developments in IT technology is to put the survival of research universities at risk (Trow, 2000: 1).

Having outlined the major conceptual aspects inherent to the Triple Helix Model, it is now time to shed light on the way the latter has been applied in a variety of empirical contexts. Recent findings within the biotechnology industry across the Delhi Region of India (2006) reveal that bilateral linkages and partnerships, mostly between government and public sector research institutions including universities, seem to be highly relevant and meaningful (Sardana, et al. 2006: 351). As such, this study indicates that academic scientists are rather positively oriented towards the commercialization of knowledge and that they accord high importance to it. The study also shows that scientists continue to assign equal importance to publications as compared to patents (*ibid.*).

Studies from China in the context of ICT in R&D activities reveal that Triple Helix type of arrangements among industry, state, and universities proved to be more successful than traditional bilateral relationships among the three actors (Miao et al. 2002). As such, the

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[22] This does not exclude the fact that knowledge is also produced elsewhere, a situation that holds true in the Philippines where, for example, many government units exist to coordinate or even perform science and technology activities in the country.

study indicates, such collaborations resulted in the formation and membership structure of China's third generation 'Mobile Communications System Task Force'; a case of how the most important institutions and interest groups emerged and became integrated into the strategic technology alliance (Miao, et al. 2002: 353).

In the US context, studies focusing on the university, government, and industry relationships within the life sciences sector highlight the intertwined roles and interests of the three core actors/stakeholders, exercised via a complex combination of financial, intellectual, personal and legal relationships (Campbell, et al. 2004). As such, and according to the study authors, these relationships fostered collaboration, productivity, innovation and wealth. Nonetheless, as argued by Campbell and colleagues, many observers find the relationships troubling due to the competing commitments and interests which may threaten the integrity and objectivity of the scientific endeavors, particularly in the cases of the biomedical and health-related sciences (Campbell, et al. 2004: 1, 14, 22).

Cassell's (2007) study on the process of drug development within the pharmaceutical industry, analyzed, amongst other things, how *scientific values* were being kept in the course of university and industry interactions. Her nine years of experience in industry and 30 years as an academic entitles her to a "real-world" perspective on public-private relationships in pharmaceutical development. These interwoven relationships have been a powerful force for innovation, but they also have given rise to a host of potential conflicts of interest (Cassell, 2007: 1, 4). In a similar vein, Campbell and associates acknowledge the fact that, given the amount of research in most universities and the highly technical nature of the research endeavors, the responsibility for protecting the integrity of scientific publications and presentations depends primarily on the leading investigators (Campbell, et al. 2004). Furthermore, the authors suggest that scientists involved in such collaborations should fully disclose the nature of the academic-industry relation as well as the sources of the research funding (*ibid*. p. 19-20).

While studying the introduction of the incubation system in Algeria, Saad (2004, in Sardana, et al. 2006: 357) reflected upon the difficulties in implementing innovation strategies based on the Triple Helix Model in developing countries. Amongst other things, the author observed the lack of power and capability of one of the key actors in order to contribute effectively. Juma et al. (2001, in Sardana, et al. 2006: 357) also express similar views, particularly regarding the fact that, in developing countries where private venture capital is not well established/available, governments are the entities that have to take the lead by directly supporting such collaborative initiatives; a traditional top-down approach. In a similar vein, studies from Eastern Europe (Hungary) identified that a common problem across both former centralized (Communist) economies as well as developing countries, relate to the fact that these lack adequate processes for the distribution of accumulated scientific knowledge, with only very simple types of collaborations existing in those countries (Inzelt, 2004: 977). Hence, these studies reveal isolation or arm's-length connections among the core actors involved in the innovation process *cannot* help countries in catching up with world technology (*ibid.*).

Critics have pinpointed some weaknesses of the Triple Helix. For example, Shinn questions its "neo-differentiation" perspective, asking, "How can we know that the Triple Helix is a 'new' differentiation, rather than a readjustment that has modified environments without imperiling the established institutions?" (Shinn, 2002: 606). But, in spite of its shortcomings, we nevertheless find Triple Helix very useful for this study, while accessing the degree of interaction (that induces knowledge transfer) between universities and industry in the context of marine science in the Philippines. Since collaborations can occur at a variety of levels, i.e. individual, group, institutional, sector, national level (Inzelt, 2004: 977), the Triple Helix Model helps in understanding the ways in which knowledge is being *produced*, *exchanged* and *used*, though, in this study, we will mostly focus on the way the processes of knowledge production and transfer from the university to industry is enhanced.

Chapter 4. Literature Review

4.1. Introduction

Universities have been looked at as major contributors to economic development (c.f. Cloete, et al. 2006). Manuel Castells (2001) enumerated four *functions* of the university, one of which is the generation of new knowledge. In this section, we will look at the process of "knowledge transfer," the activities and government or institutional policies affecting it as well as the culture of those people responsible for making this process happen. The discussion will flow according to the following transition. Firstly, attention will be paid to the knowledge and technology transfer processes. Secondly, we will shed light on the policy coordination both 'top-down' and 'bottom-up.' Thirdly, an elaboration on the pursuit of practical goals versus academic ones is provided. Fourthly, the role of intellectual property rights (IPR) in universities will be discussed. Finally, in the last part of the chapter, an overview of the major benefits and barriers having an impact on knowledge transfers from academia will be presented.

4.2. Knowledge Transfer and Technology Transfer Processes

The amount of new knowledge being produced in academia can be readily illustrated. The field of chemistry produced worldwide a million research articles in less than two years during the mid-1990s (Clark, 1998: 130). The biological sciences fragmented, recombined and produced new knowledge at a rate that required curricular revision of teaching materials every two to three years. The academic field of psychology has, today, more than twenty specialties. Business schools at universities are partly responsible for the vast outpouring of more than five publications a day on business management, which reached over 2000 publications (books) a year in the mid-1990s (*ibid.*). While these are examples of how much knowledge universities can produce, these few examples also clearly illustrate how *knowledge outruns resources*. The reality is, no university, and no national system of universities, can control knowledge growth (Clark, 1998: 130).

According to some perspectives, this outpouring of knowledge can be better managed if universities convert the production of basic knowledge into other valuable resources. There are a number of universities that went beyond the traditional academic departments to become entrepreneurial and link up with industry. What are referred to as "urban universities"[23] take the lead in curricular revision, research emphasizing the application of knowledge, arrangements with private economic enterprises, and public service to improve science and mathematics training in the schools (Adamany, 1983: 427). From the point of view of the industry, faced with turbulent environments and global businesses, collaboration has become a common way to organize economic activities (Sardana et al. 2006: 358). Technology is critical for the competitiveness of universities as this helps, for example, enhance their internal R&D activities and improve their ability to create new knowledge, i.e. innovate; thus, helping attract research funding and new student/staff. As with universities, new *technology* is critical to industry's levels of competitiveness. As such, industry can develop their technical capabilities and products either based on internal or external R&D. The process of developing technologies externally can be conducted in a variety of ways, for example, via university-industry cooperation (Wu, 2000: 2).

As seen in the experiences of some countries like Japan, collaborations of universities with small and medium-sized enterprises (SMEs) that are R&D-focused (e.g. new technology based firms) proved important for the country's innovation system (Kazuyuki, 2004). Survey data from the Research Institute of Economy, Trade, and Industry (RIETI) on Japan's domestic innovation system, show that, on average, SMEs that proactively conduct collaborative R&D together with universities are involved in more problem-solving, hands-on research activities geared towards the introduction of new products when compared with larger enterprises (RIETI, 2001 in Kazuyuki, 2004).

To add more on the collaboration from the point of view of universities, Becher (1994) has also found that some scientists like chemists are reluctant to collaborate with external

[23] Urban universities, as in the case of Detroit in the early 1980s, are not defined by location, since many traditional locations are in cities. These universities serve a nontraditional student population that had generally attempted to build traditional programs of research, scholarship and creative activity. By "nontraditional" we mean that these students are older, are employed and often they are married or raising families (Adamany, 1983: 428**)**.

partners, although they have had traditionally rather strong links with industry. As for physicists, these are also reluctant to collaborate with external partners, although biological scientists are less skeptical than their colleagues from other sub-disciplinary fields. Finally, many professional schools (besides engineering) contribute either directly or indirectly in the training of relevant practitioner groups (Becher, 1994: 156).

Burton Clark in his study on ‘Entrepreneurial Universities’ identifies *five* elements in which universities transform themselves by means of entrepreneurial action: a strengthened steering core; an expanded developmental periphery; a diversified funding base; a stimulated academic heartland; and, an integrated entrepreneurial culture (Clark, 1998: 5). We will encounter some of these elements as we go on with this chapter. Clark defines entrepreneurial or enterprising universities (in traditional European settings) as places that actively seek to move away from close governmental regulation and sector standardization. His case study analysis reveals that these types of universities embrace special industry-like identities and take chances in “the market” (Clark, 1998: xiv). For example, for a university to be “entrepreneurial” it requires taking risks while initiating new practices where the outcomes are difficult to predict.

As such, entrepreneurial institutions enhance the opportunity to make significant strategic moves without waiting for system-wide enactments that often come slowly and have standardized rules attached (Clark, 1998: 4, 6). An entrepreneurial orientation might also require a change at the institutional level while looking for non-traditional sources of funding. For Clark, there is no doubt that since so much is now demanded of universities, traditional ways of undertaking their activities prove inadequate. This imbalance creates a problem of institutional insufficiency. Moreover, Clark’s European success stories show that these enterprising universities are actively involved in contacts with industry, and engage in such tasks as intellectual property (IP) development, continuing education, fundraising, and alumni affairs (Clark, 1998: xvi, 6). What must be added to this list are activities of *knowledge transfer* from academia to industry, the kinds of relationships that this study focuses on.

At this stage, some basic clarifications regarding *knowledge* and the *technology transfer* *process* are required. The process of technology transfer is rather complex to access or study. The matter of defining ‘‘the technology’’ alone is not an easy task. Isolating the technology transfer process is virtually impossible since there are so many concurrent processes. Also, the impacts are usually numerous and they are almost always difficult to separate from other parts of organizational life (Bozeman, 2000: 627). Bozeman’s study takes Sahal’s approach (1981, 1982) as the latter is one of the few theorists who has written about alternative concepts of technology and the confusion owing to poorly specified concepts. Sahal’s concept resolves the problem: the difference between *technology* and *knowledge transfer*. According to this perspective, while there is a major analytical problem of the two having perceived differences, in fact, technology and knowledge transfer are not separable entities. Simply focusing on the (end) product is not enough to study the transfer and diffusion of technology. As such, the product is not the only thing that is transferred but also knowledge of its use and application (Sahal, 1981; 1982 in Bozeman, 2000: 629).[24]

Knowledge transfer activities are a vital way for major universities to bring income to their midst in most cases of budget cuts from the government. The term is basically to bring knowledge "to the market, through company formation, licensing, and the general exploitation of the university's IP" (Clark, 1998: 74). An important aspect from Clark’s study is that all institutions made a voluntary effort to *strengthen their steering core.*[25] For example, in the case of the University of Strathclyde in Scotland, the ideas of *useful learning*, *strategic research*, and *knowledge transfer* came together as a kind of collective ‘belief system’ that has become institutionalized into a unique internal culture across the whole of the university; expressed in outreach willingness and entrepreneurial initiative on the part of faculty and central administration alike (Clark, 1998:80, 81).

In the case of Continental Europe, traditionally, universities have had a rather weak

[24] In this study, we will not go through the complicated process of such transfers. However, one thing that we would like to make clear is that, throughout the study, knowledge transfers and technology transfers will be used as two processes intrinsically related to each other, as indicated by Sahal (1981, 1982).

[25] The five universities in Clark’s book are the University of Warwick in England, the University of Twente in the Netherlands, the University of Strathclyde in Scotland, the Chalmers University of Technology in Sweden and the University of Joensuu in Finland.

capacity to steer themselves, as they were often tightly steered by the state (Clark 1983). However, universities serving as flagship of their own national HE systems tend to survive and prosper, even if some of them may have lacked internal steering capacity. As such, many of these institutions can continue to depend upon their prominence and political influence while competing for resources and status. In the case of UP in the Philippines, it benefits from being a flagship institution but, in our opinion, the benefit is mutual since the latter also gives back to the country in the form of research, graduates, and future leaders. In most cases, it is the smaller universities that are prepared to be entrepreneurial as was the case of Joensuu from rural Finland, which had more room to maneuver as compared with, for example, the University of Helsinki (Clark, 1998: 5, 123).

Turning back to the Asian context, Malaysia, a country neighbor of the Philippines, has begun to develop strategies in order to gain competitive advantages through innovation. During the past few years, the country has embarked on an aggressive reform program aimed at enhancing R&D through the establishment of new universities and research institutions. Despite these efforts, commercialization activities have failed mainly due to the lack of *connectivity* between industry and academia. On the part of universities, commercialization of R&D has not been traditionally a high priority. As to the funding, the Malaysian Ministry of Science, Technology and Innovation has made an assessment indicating that most R&D activities in the country's universities are funded by the ministry and other governmental agencies; with only 0.7% funding coming from industry (Rasli, 2005: 2). Universities in other neighboring countries such as Singapore, e.g. The Professional Activities Centre (PAC) of the Faculty of Engineering at the National University of Singapore, are increasing their efforts to promote continuing education and reach out to industry, by setting up research centers (Cheah, et al. 2006: 1). PAC collaborated with the Centre for Offshore Research and Engineering (CORE). Both are benefiting from the additional income and surpluses channeled back to CORE and PAC respectively to meet their financial needs. While PAC attracts research grants and also gets aid from the government, the founding member companies of CORE are supportive of the R&D activities of the center (*ibid*. p. 6).

4.3. Policy Orientation: Coordinating bottom-up and top-down policies

In this section, we will look at the bottom-up and top-down policies regarding technology transfer. Table 5 (below) summarizes some of the key aspects inherent to these two policy types.

Table 5: Policy Orientations

	Bottom-Up	**Top-Down**
Core Mechanisms	Encouraged to evolve from below	Designed from above
Intellectual Property Rights	Awarded to the universities	Awarded to the inventor
Decision Making Processes	Universities decide freely	The government decides

Source: Based on Goldfarb's et al. (2003).

The top-down initiative

In the European context, the important roles played by both the Swedish government at the national level and the central (university) leadership at the institutional level at the Chalmers University of Technology, provide us with a good example of successful top-down initiatives. The efforts of the university to link up with industry were backed up by a *strengthened steering core*, that is, the leadership of a Rector and an administrative director, who were both very familiar with the style of command common in industry (Clark, 1998: 89). These two individuals pushed hard at the traditional academic divisions and departments as to become more self-assertive.

Giesecke (2000) reports that (in Germany) the government support for biotechnology development began in the late 1960s, when an Organization for Economic Co-operation and Development's (OECD) report identified this technology — among others — as one that was expected to play a key role in the future economic development of the country (OECD, 1966; Buchholz, 1979 in Giesecke, 2000: 206). As a result, the biotechnology sector became one of the technologies to be supported by public funds since and has risen enormously over the last 30 years (*ibid.*).

An advice from Turpin et al. (2002 in Sardana et al. 2006: 371) and Pavitt (2001 in Sardana et al. 2006: 371) is that governments, especially in developing countries, have to play a dominant role in the development of sectors that are of vital importance to the society.

The bottom-up policy

Sardana and colleagues point out, in their discussion regarding the role of governmental (public) funding in different countries, that there are suggested measures indicating that the *bottom-up* approach of the Triple Helix of university-industry-state relationships is better suited to bring about valuable *networking* for the innovation involving industry and academia (Sardana, 2006: 372). In traditional bottom-up approaches, as seen in the US, universities are provided with adequate incentives to respond to a commercial opportunity, but the state does not dictate or even suggest what the best response to this opportunity might be (Goldfarb et al. 2003: 645).

As Table 5 shows (above), if it is the government that is at work, academics might lose involvement/interest with regards to academia-industry relations, as was the case in Sweden. As such, the traditional incentive structure of academics does not encourage commercialization activities and, if anything, such activities are generally discouraged as it diverts effort from more fundamental research endeavors (Goldfarb et al. 2003: 642). Individual incentives per se, may come in the form of research grants or by being directly involved in a company, e.g. as a consultant. Researchers' efforts are arguably less constrained in a grant arrangement than when they are directly involved in a company either as consultants, board members and/or founders. Although this kind of research support provides weak incentives, it is likely to be less expensive for companies (Goldfarb, et al. 2003: 642-643), as, for example, compared with costs associated with consultancy services.

A study made by Fisher et al. (2003) explored ways in which universities can learn from best practice in the commercial sector when seeking to commercialize their research. The authors consider consulting organizations as a model for university technology-transfer processes. As such, most consultancies do not produce patents but use instead available metrics. It was found that some consultancies produce substantially more patents per researcher than universities. A reason for this, the authors argue, may be that consultancies are working in fields that are closer to market needs. Nonetheless, it may be that some of the processes (e.g. technology transfer processes) developed by consultancy firms would be appropriate within a university context. (Fisher, et al. 2003: 45, 48, 49)

Among Clark's five elements, described earlier, we find that the existence of a *developmental periphery* relates best to our study of university-industry relations. This element refers to how enterprising universities exhibit a growth of units that, as compared with traditional academic departments, are more readily available (i.e. willing) to reach across old university boundaries with the aim of linking up with industry and other groups. Academic departments based on disciplinary fields of knowledge will go on being important, as this is a cornerstone of HE systems worldwide (Clark 1983). However, traditional departments alone, as shown by Clark (1998), are unable to achieve all the missions that universities are increasingly expected to fulfill. Outward-reaching research centers bring into the university the project orientation of outsiders who are attempting to tackle serious developmental problems of either an economic or social nature. In his study of European universities, Clark suggests that system-organizers can help to clear the way by reducing state mandates and manipulating broad incentives, but only universities themselves can take the essential actions (Clark, 1998: 136).

In the case of the US, the Bayh-Dole Act allowed universities to appropriate the property rights to inventions resulting from university research that were financed by federal grants.[26] Following this act, public–private partnerships, often initiated or promoted by the American central or local government, evolved over time as to include core competencies and facilitate technology transfers between universities and industry (Sardana et al. 2006: 359).

As far as funding is concerned, the universities we encountered in this literature review (both

[26] The *Patent and Trademark Law Amendment Act* of l980, more commonly known as the Bayh-Dole Act, is the legal framework for transfer of university generated, federally funded inventions to the commercial market place (Bayh-Dole Act, 1999).

in Europe and Asia) are in charge of their own knowledge production activities but rely heavily on their national/local government for funds aimed at the development of new infrastructures that facilitate knowledge flows from academia to the outside world, hence help foster commercialization processes. The financial base is mostly concentrated on the government but as this wanes, it is essential for the university to turn to other sources, e.g. market-type mechanisms (Jongbloed, 2003). Most enterprising universities turn such unreliability (i.e. dependency) from the government to their advantage (Clark, 1998: 6). In practice, these institutions raise money by turning to research councils and fiercely competing for public/private grants and contracts. Furthermore, they stretch third-stream income sources across industry, local governments, philanthropic foundations, royalty income from IP, earned income from campus services, student fees, and alumni fundraising (*ibid.*). At a later stage, we will look at the ways in which the two case institutions/research units covered here are actively involved in diversifying their funding base and looking beyond government as a means to increase their sources of income.

In relation to a diversified funding base, but not exclusively, a perspective known as "academic capitalism," wherein colleges and universities engage in market and market-like behaviors, has gained some attention (and criticism), in recent years (c.f. Slaughter and Leslie, 1997; Slaughter and Rhodes, 2004). This is more than just selling of university merchandise or professors writing textbooks. In the US, for example, public colleges and universities have, in recent years, faced a major loss in state financial support (c.f. Geiger, 2005)**.** HEIs in the US attempt to stay close to their "social" mission but, nowadays, many of them are involved in the development and marketing of a wide range of commercial products/services to the industry, as a basic source of income. More than non-academic consumption items (such as logos, tee-shirts, etc.), these sorts of endeavors go far beyond in such a way that HEIs are seeking to generate substantial revenues from their core educational (e.g. tuition and fees), research (e.g. bids, contracts) and service functions (e.g. outsourcing). These commercialized assets range from the production of knowledge such as in research leading to new patents created by the faculty to the faculty's curriculum and instructional activities resulting in new teaching materials which can be copyrighted and marketed (Rhoades, et al. 2004: 37).

A synergy between top-down and bottom-up

Burton Clark (1998) expresses a view of the synergy of top-down and bottom-up policies by stating that institutional transformation occurs through a *collective* entrepreneurial action at the level of individuals, where the latter come together in university basic units and across the institution over a relative long period of time in order to enhance change. They often accomplish this process by means of organized initiative, i.e. an adequate institutional structure and proper strategic orientation. From a top-down perspective, national and state systems of HE are ineffective instruments for leveraging change at the institutional level, partly as a result of the decoupled structure characterizing many HEIs (Clark 1983). On the other hand, bottom-up type of processes enhanced by individual faculty members or administrators are constrained by the institutional capacity to deal with emerging tasks.

However, as indicated by Clark (1998: 4), despite the fact that universities as a whole often resist adaptive *change*, internal stakeholders like faculty coalitions, influential administrators, and sometimes students, acting collectively, can fashion new internal structures, processes, and orientations (Clark, 1998: 4); once again pointing out the critical role played by internal stakeholders in the processes of institutional adaptation to new external demands. Let us go back to Clark's (1983: 182) views on "Change" within HE systems. To quote the author: "How can it be that the university, and indeed the higher education system at large, is sluggish, even heavily resistant to change, but somehow also produces virtually revolutionary change?" (*ibid.*). Examples of the patterns of the basic directions of change, as discussed by Clark, relate to: (a) the proliferating of academic disciplines; (b) the adding of levels of student passage; and, (c) the strengthening of state authority (Clark, 1983: 182). Thus, the educational system accumulates characteristics of the larger community that it is a part of, but, as it grows, it builds its own sources of *continuity* and *change* (*ibid*. p. 183).

Furthermore, Clark mentions that, in less-developed systems under authoritarian rule, a simpler and less bottom-heavy structure can be more readily managed from the top. But still, even in the most top-influenced systems, with the former Soviet Union as an example, observers report that *adaptation* takes place by, "small steps instead of far-reaching reform" (Glowka, 1971 in Clark, 1983: 236). Clark supported this synergy by saying that more than elsewhere changes initiated at the top often need the support of key interests from those individuals at lower levels, i.e. the academic staff in the case of universities. For Clark, instead of commanding, those at the top of the hierarchical structure (rector, deans, etc.) have to build groups (i.e. coalitions) as to support and implement their own, and the state's, desires. This aspect sheds light, once again, on the bottom-heavy orientation characterizing most university systems across the world, at the same time, this means that groups at the lower level of the organization are key participants in implementing the desired reforms or change processes (*ibid*.).

There is plenty of empirical evidence on the fact that old organizations, universities or other organizations for that matter, are not, as such, quick in embracing change. However, it is also possible that the more mature and established institutional players know something about the critical processes of *adaptation* and *evolution* that new enterprises and younger systems must learn. It is a basic principle in academic change that institutionalized structures possess response behaviors that are likely to shape the way HEIs react to emerging demands, either internal and/or external (Clark, 1983: 184). In other words, institutional settings act as mediating variables among the linkages and relationships among external pressures (e.g. state policies, acting as independent variables) and academic behavior, i.e. the dependent variable (Dill 2004: 5). Clark's view is that the academic system, acting as modern society's main institution of knowledge-creation and production, is inherently *multi-sided*, *diffuse,* and *bottom-heavy*. Clark said that the belief of many observers is that academic systems change only when affected by external forces. The reality however is more complex, and evidence seems to exist for the fact that such systems increasingly change and adapt at the level of their internal bottom units (Clark, 1983: 234) and in light with internal interests (e.g. access to resources) and institutionalized processes or path-dependencies (c.f. Gornitzska 1999). An important aspect mentioned by Clark is the *false expectation* regarding the final outcome derived from top-down influences across HE systems, namely that the former can lead to major academic reforms. In reality, and in the great majority of the cases, state-led reforms usually bring about limited changes as a result of multiple efforts at the top, in the middle, or at the bottom of the institutions; thus, entailing wrong experiments and false starts (Clark 1983: 235).

A wide variety of empirical evidence shedding light on the synergy between top-down and bottom-up policies, as far as HE dynamics is concerned, has surfaced in recent years. For example, a study undertaken by Zadnik and colleagues, aimed at improving the quality of teaching and learning within an internal unit at Curtin University of Technology in Perth (Australia), confirms the importance of the interplay between the two strategic orientations (Zadnik, et al. 2004: 1-9). According to the authors, the overall goal was to develop a holistic approach. In order to achieve this, top-down strategies to create awareness and discussion and bottom-up strategies to encourage and support staff involvement, were successfully combined (*ibid*. p. 2-3).

Nonetheless, variations occur across specific socio-economic and national contexts. For example, in the case of the biotechnology sector in India, the importance of extensive governmental funding was seen as a critical factor, particularly so during the initial stages of R&D (Sardana et al. 2006: 370). In the same manner, an earlier study from the US, by Mansfield (1995), revealed that governmental funding seemed to have played a prominent role in financing academic research across various (seven) industries (Mansfield, 1995: 55, 61, 64). Many argue that neither top-down nor bottom-up strategies for educational reform work and that a blending of the two strategies is essential (Scott, 2004: 8). Point being is, the government serves as a good foundation for projects of universities to be carried out, until the latter stages when the universities are ready to find other resources. There are certain contexts in which one could see the unique advantages of each one of the two policy orientations. While there are national policies that are probably the most efficient in promoting the commercialization of university-generated knowledge (e.g. in those cases where institutions are rather weak and incentives are inexistent), we argue that the way it might work best in majority of the cases is via the simultaneous coordination of both bottom-up and top-down policies.

4.4. The Pursuit of Academic Research Activities vs. the Commercialization of Scientific Results

In this section, we will discuss two (often contrasting) views, those of academic and those of practical (commercial) goals. We believe that in order to understand university systems it is essential to analyze the setting in which they take place – the institutional level, and in particular what makes up the institution – the disciplinary level and the individual academics.

Institutions

National systems vary in how much they believe research can and should be integrated with teaching. The German, British and American ideals have emphasized such integration with a heavy assignment of research to universities and the combination of research and teaching in the professorial role. In contrast, other national HE systems like the French one have long incorporated the belief that the university, first and foremost, tests and teaches students and, while it is accepted and necessary for academics to undertake research efforts, a national research structure has been seen as necessary (Clark, 1983: 98).[27]

Within institutional management there is a tendency for university administrators to lay down uniform specifications to be observed across the whole range of internal units (departments, research centers, etc.) even if those arrangements are clearly seen as inappropriate (Becher, 1994: 157). For example, areas for institutional growth and expansion may be recognized by reference to high research earnings, even though the opportunities for these are not evenly distributed across fields. Such a criterion would be in favor of expensive areas such as physics and against low cost areas like philosophy (*ibid.*). Just the same, staff promotions which criteria is based on the number of publications would have a clear bias in favor of, for example, chemistry, where it is common to publish several short papers a year, vis á vis, e.g. history, where the norm is to produce fewer and more time-consuming book publications. In the case of the professions, the academic staff is expected to maintain their professional credibility through direct involvement in consultancies, or more directly in practice, at the expense of publishable research (*ibid.*).

Looking at differences across particular disciplinary fields, academic enquiries in hard-pure fields (such as biology where marine science research is classified) is liable to be expensive,

[27] France is not alone with regards to public research institutes outside universities, as seen in other European countries such as Norway, Portugal, Denmark (until 2007), etc.

giving rise to an effective lobby for fund raising (Becher, 1994: 155).[28] For example, marine science research tends to involve teams comprising tenured and post-doctoral staff, doctoral students as well as other technicians. Individuals are also heavily dependent on sophisticated laboratory apparatus and in-house accommodation/large spaces. On the other hand, research in the field of mathematics typically involves a solitary researcher armed with no more than a desk, paper and pencil, and perhaps blackboard and chalk (Becher 1994: 158; Clark, 1983: 77).

As emphasized by Etzkowitz et al. (2000, in Goldfarb et al. 2003: 647), it has often been in the interest of (Swedish) universities to *discourage* contacts between faculty members and industry, due to the fact that rigid civil servant pay schedules and other constraints have made it very difficult for institutions to retain highly qualified scientists who have established personal ties with industry. This is not the case in the US, where a less strict system of interaction with industry has long been in place. Also, if faculty members have full ownership of IP, this factor alone gives the university as a whole little incentive to become involved in technology transfer to outside world. Another related dilemma occurs when the IP owner (either the academic or institution) shows little interest in the commercialization of knowledge (Goldfarb et al. 2003: 647).

Disciplinary Cultures and Individual Academics

Within the institutions are the academics having their own disciplinary cultures. The culture of each discipline affects the activities of individual academics. In the case of this study, these contextual factors (i.e. the disciplinary culture) partly determine the level of collaborative interaction between academe and the industry[29].

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[28] Becher's typology is classified into the following: hard pure (natural sciences), soft pure (humanities and social sciences), hard applied (science-based professions) and soft applied (social professions) (Becher, 1994: 152).

[29] As Bailey (1997, in Becher, 1994; 151) notes, even though universities are composed of different tribes, they operate as a "community culture." He contends that each tribe has each own distinct characteristics, nevertheless, the whole set of tribes possess a common culture that allow them to understand and communicate with other tribes/universities.

Across national HE systems as well as disciplinary fields and their respective academic cultures, there are substantial differences in research traditions, the profiles of undergraduate programs and the like. In spite of these differences, an important characteristic of academic cultures is their high degree of universality. Disciplinary cultures, in virtually all fields, go beyond the institutional boundaries within a given national higher education system. For example, within and across HE systems, it has long been observed a high level of mobility of academic staff from one institution to another, as well as the common readers/followers of academic texts (whether books or journals), to name but a few (Becher, 1994: 153).

In spite of this fact, often, these variations of disciplinary cultures are not taken into account neither in the management of HE systems nor during evaluation procedures. But this is not surprising as disciplinary cultures are hard to pin down, since, as Clark (1983: 76-77) contends, these are only vaguely sensed by their own members and difficult to perceive by outsiders. In the past, the outcomes of managerial policies to enhance the efficiency of teaching and learning have often proved disappointing (Becher, 1994: 157-158). For instance, faculty development programs tend to lose credibility with their potential clients because of their discipline-independent approach (*ibid.*)**.** Even when all academics know the basic principles of good lecturing, there is a wide variety of different needs amongst students and across fields of studies, i.e. seminar teaching in the humanities or overseeing field-work exercises in the areas of geography and/or biology (*ibid.*).

On the other hand, the very dependence on external funding makes any disciplinary field susceptible to being influenced by external demands towards social and economic relevancy (Becher, 1994: 155). There is a comparable contrast between different disciplinary groups in relation to contract research, where departments in hard-applied and soft-applied areas, as per Becher's (1994) typology, are able to earn substantial funds by undertaking sponsored research; while, for example, faculty in hard-pure areas tend to perceive such actions as low-status activities. It is clear that those academics involved in collaborative activities with external partners necessarily have wider contacts beyond the academic world, which they are able to exploit in a variety of ways, e.g. by offering graduates a wider range of job opportunities and using additional earnings to improve departmental conditions (*ibid*. p.

156).

On the part of academics, some of them choose not to let industry interests affect their daily research activities, however this maybe a dilemma for others whose outputs are easy to measure (e.g. via publications) since higher public exposure or visibility (via publications, main discoveries, seminar attendance, etc.) permits industry to monitor and potentially exploit (i.e. apply into products) new university-produced, usually mode 1 type, knowledge (Goldfarb et al. 2003: 640). However, there are some cases when the research endeavors are both commercially valuable and important from the academic viewpoint (*ibid*. p. 642). Trouble starts when academic and commercial goals as well as values (as shown earlier) do not match, as it often happens.[30]

The goals of an academic may be affected by restraints on work in the discipline, whether inside or outside academic systems – for example, the freedom of chemists to proceed according to the canons of chemical science whether they work within governmental bureaus, industry, or universities and colleges (Clark, 1983: 92).

Along with this issue of academics involved in the knowledge transfer to the commercial sector is the problem of *patents* and/or *IPR*. In this study, we will not deal with how protected individual academics are, neither how they will personally benefit from the commercialization of knowledge, rather the focus here is on the overall capability of the university to transfer knowledge beyond its internal borders, with a special emphasis on the key role undertaken by internal stakeholders, particularly academics.

Furthermore, there is reputation. The commercialization of knowledge may be equated with financial incentives but these sorts of activities may also enhance academics' professional reputations (Goldfarb et al. 2003: 641), as is the case in professional fields like medicine. In our view, *reputation* as such, is then related to the pursuit of academic goals. For example,

[30] A criticism directed to research geared towards achieving commercial goals is that the overall quality often deteriorates (Goldfarb et al. 2003: 642).

researchers pursue their academic goals, publish papers and wish to have these papers cited because this is a signal that they have established a reputation within the academic community (*ibid*.). The reputation of the university where the researchers belong is another matter. The official image and public reputation of universities, more than their technical structure, are what the society generally knows about an organization (Clark, 1983: 72).

As seen in the discussion in previous paragraphs, the culture of the discipline is a complex issue. On the one hand, we may find academics having unity, i.e. all these men and women in the doctrines of the profession are part of a single "community of scholars" sharing interests that set them apart from others (Clark, 1983: 91). On the other, they may have different work orientation and goals. All these factors contribute to the overall willingness of individual academics to collaborate with the industry.

4.5. Intellectual Property Rights

The interaction and interdependence between the university and industry is also seen via patents or Intellectual Property Rights (IPR).[31] There are different mechanisms on how knowledge can be transferred from academia and commercialized by industry. The most prominent of these is through technology transfers. One important mechanism of knowledge/technology transfers, and one of the common solutions seen to enhance the performance of universities, is the creation of an internal patenting and/or licensing office (c.f. Wu, 2000: 1). However, there are other studies like those of Agrawal and colleagues that are consistent with earlier findings confirming that patenting and licensing constitute a relatively *small* channel for the transfer of knowledge from academia into industry (Agrawal, et al. 2002: 51). According to some scholars, academic *entrepreneurship* is often the most effective means to facilitate technology transfers, but, this is not necessarily the best option under all circumstances (Goldfarb et al. 2003: 646).

[31] A patent is a grant of property rights to an inventor that gives him/her the legal rights to stop anyone else from making, using or selling the invention without his or her permission**.** In general, the term of a new patent is 20 years but under certain circumstances, patent term extensions or adjustments may be available (Patentarea, 2003).

One way to facilitate technology transfers is through technology licensing offices (TLOs). The study by Owen-Smith and associates (2003) indicates that several informants in TLOs at the universities mentioned that the process of marketing a given technology often occurs before a decision to file for patent protection is made. In practical terms, licensing officers search for information about the potential impact of a new invention, but, based on personal experiences by those involved in the process, it seems that industry does not readily reveal valuable insights (Owen-Smith et al. 2003: 1701). Further, the above study contends that access to evaluations provided by commercial contacts is a key factor in successful technology transfer processes (*ibid*. p. 1702).

Owen-Smith and colleagues (2003) undertook a case-study analysis of a private university with an established and successful technology transfer infrastructure, and a public university, which licensing office was much more recent and struggling. Their study focuses on the expanding role of university patenting within the field of life sciences. Amongst other things, the authors point out, the increase in biomedical patenting on campus may be part of a larger phenomenon, i.e. the commercialization of academic life-science research is deeply intertwined with the emergence of a new industry, biotechnology. The modern biotechnology sector had its origins in university labs and is designated as a high-tech industry where companies spend large amount of funds on R&D programs (Owen-Smith et al. 2003: 1697; Sardana et al. 2006: 358). As biotechnology evolved, its ties to the academia deepened, with ‘star’ scientists playing central roles in new biotechnology industry (Zucker et al. 1997 in Owen-Smith et al. 2003: 1697) as well as in the transfer of new knowledge from universities into industry (Zucker et al. 2002 in Owen-Smith et al. 2003: 1697).

Owen-Smith’s study also contends that universities *should* learn the intricacies of patent filing as well as find methods on how to identify and pursue high-impact IP through connections with their commercial partners. This is particularly the case in the field of life sciences where the scientific gap between universities and industry is the narrowest, and the informal ties between academia and industry are an important condition for the success of the latter.[32] Also, these existing ties facilitate the universities' decision-making process regarding IP investments (Owen-Smith et al. 2003: 1701).

While some studies like the one cited above are concerned with getting data regarding the use of patents, the ultimate challenge for academics in some countries is, first and foremost, to develop *trusty relationships* with industry. For example, in Malaysia, efforts are being made as to change the mindset of industry and to some extent the government's, regarding the assumption that research undertaken at the local universities is inferior and irrelevant when compared to market requirements (Rasli, 2005: 4).

When it comes to insights on patents, industry discretion might best be explained by findings from Fisher et al. (2003) study. As pointed out by the authors, one element industry and academia may not agree upon is the fact that a particular commercial partner might choose to exploit a novel idea in-house and keep it secret from others, rather than patenting it, thus disclosing it to the public[33] In the case of universities, it's probably due to the costs involved that make in-house commercial exploitations of new knowledge/technology unlikely to be feasible, thus, in order to exploit an invention commercially, a university first needs to patent it (Fisher, et al. 2003: 46). One reason why patent and licensing data has become particularly important in university innovation is related to the fact that innovations that are patented are expected, by definition, to be commercially useful (Agrawal, et al. 2002: 44).[34] The reality however is more complex, as shown in previous empirical studies all over the world.

It is worth mentioning that, exploiting the potential value of patents is more a function of having access to information that assists in evaluating the potential economic impact of

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[32] The importance of such connections was seen in Owen-Smith's et al. (2002) interviews, as with a senior licensing associate specializing in life science innovations at a private university who found it hard to get information from companies.

[33] However, firms may be more cooperative in other ways, for example, in writing papers (but not patents) together with academics.

[34] The authors of this study add that this, of course, is not to say that these innovations are commercially successful. In fact, only a very small percentage of patented inventions result in financial success.

faculty innovations rather than of having a small number of industry partners advising universities on how to commercialize their novel research findings. As stressed by a technology transfer officer interviewed in Owen-Smith’s et al. (2003) study, universities have very good direct links with the biotechnology sector industry and they get quick responses from their partner companies. However, this process is not the same across the *physical-sciences* (e.g. some courses related to Mathematics), where product life-cycles are so short that smaller (i.e. less resourceful) industry partners cannot afford to spend time on building long-term relationships with universities (Owen-Smith et al. 2003: 1705).

Patenting production per se is an activity wherein academics find that they must engage with a distinct group of individuals like patent agents and industrial liaison officers. In the same manner, academics must collaborate with such stakeholders as spin-off firms, large established corporations, and the respective patent offices. The nature of these relationships is more of a legal and contractual rather than collegial nature (Packer, 1996: 446). As for the urgency of action, Adamany (1983: 4217), while referring to a comment by the president of the University of Michigan (USA), indicates that there is an extraordinary short time-lag between the development of a new idea and its useful application or commercialization. Another concept of “time” regarding patents is also expressed in Agrawal’s et al. (2002: 50) interview with a university professor who stated that: “Many people [from the university and industry] don’t even care about patents. The patent system is too slow for them.”

In a similar vein, the director of a technology transfer office at a large public university involved in Owen-Smith’s study (2003) indicates that the *core* challenge of being a new entrant in the technology transfer process, where limited budgets constrain universities’ ability to patent, is that, unless there are companies interested in a given technology and/or the industry partner agrees to reimburse the university for patenting costs, the latter simply cannot afford to move forward. Network connections with industry may be both, necessary as well as risky for universities, especially in the case of new academic entrants in the commercial arena whose technology-transfer infrastructures are not yet economically self-sufficient. As a result, universities depend heavily on the interest of their industry partners to justify pursuing IP. Somehow, the financial dependency on industry *may* limit a university’s ability to capitalize on the few technologies they succeed in protecting (Owen-Smith et al.

2003: 1705). Packer and Webster (1996) have the same observations, i.e. that the financial costs of patenting are unlikely to be borne by individual scientists or even by their departments. In contrast, the authors found, it is much more likely that these costs will be met by the industry that receives licensing rights from a university (*ibid*. p. 431).[35]

While discussing university patenting, it is worth mentioning that the *effectiveness* of patent protection varies from industry to industry (Cohen et al. 2000 in Goldfarb et al. 2003: 644). Therefore, it is expected that academic entrepreneurship is *more* important across industries where property rights are weak (e.g. semiconductors), and *less* important in industry sectors where patent protection is strongly established (e.g. in pharmaceuticals) (Goldfarb et al. 2003: 644).

When it comes to *publications*, the relationship between the latter and patents has not been fully explained (Owen-Smith et al. 2003: 1700). Within academia, publishing is a much more important activity than patenting, first and foremost, since this is the main reward system that provides status and job mobility to academics involved in research efforts (Clark, 1983: 44-45). Moreover, studies have revealed, the industry collaborates with academics more often as regards scientific papers rather than on patents, and the fraction of the industry that engages both channels is rather small (Agrawal, et al. 2002: 48, 52). For example, in Agrawal's et al. study, 58% of the industry that collaborated with the professors did so by writing papers together, but did not file any joint patents. Amongst the 20 firms with the highest number of paper collaborations with academia, accounting for 83% of the total number of paper collaborations, 14 did not collaborate on any patents (*ibid*. p. 52).

The above elements shed light on the fact that, freedom to publish is essential to the academic lifestyle/culture. The conflict here is that while *academics* have usually treated knowledge as a freely disseminated outcome of research, *industry* on the other hand, views

[35] University research is largely funded on the premise that mechanisms like patents are particularly ill-suited for capturing financial returns. As such, academics transfer knowledge in many other ways, e.g. by mentoring students' research efforts, delivering conference presentations outside academia, and, most importantly, by publishing in refereed scientific publications at a limited cost (Agrawal, et al. 2002: 45).

new knowledge as private property, i.e. the result of an investment in research that should be utilized in the best commercial interests of the firm (Wu, 2000: 5).

Furthermore, different processes and procedures govern citation strategies in either *scientific manuscripts* or *patent applications*. Whereas the former is governed by reputation-driven peer-review processes, the latter follows a set of legal strategies and patent examiner's prior art searchers.[36] Hence, these differences may contribute to a weak direct relationship between citation measures in academia and commercial indicators of innovation (Owen-Smith et al. 2003: 1700). For example, Branstetter's (2000) study focused on citations of academic papers, as opposed to patents, as core indicators of knowledge transfers to industry (Branstetter 2000 in Agrawal, et al. 2002: 45). In a similar vein, for the faculty in the target departments of Agrawal's et al. study (2002), publishing academic papers was seen as a far more important activity than patenting. On average, only about 10–20% of the faculty patent in any given year, and nearly half of the faculty sampled never filed a patent during the 15-year period under investigation. However, when it comes to publication, an average of 60% of the faculty members publish in any given year, with less than 3% of them never publishing over the same period. Respondents estimated that *patents* were responsible for as little as 7% of the total amount of knowledge being transferred from academia into industry (the remaining via other channels) (Agrawal, et al. 2002: 45). These results are consistent with earlier findings by Cohen et al. (1998) revealing that only about 11% of the total amount of information obtained from university research by industry had been transferred via patents (Cohen, et al. in Agrawal, et al. 2002: 46).

IPR in the Philippines. In the Philippines, the state recognizes and is supportive of the IPR in the field of agriculture and the indispensable role of the industry. As far as marine science is concerned and unlike in agriculture where developed R&D programs for university-industry partnerships and private R&D have been growing rapidly in recent years, an example of a

[36] A professional prior art searcher is a technology history researcher with a background in patent law. Good prior art searchers restrict themselves to technology areas which they know and can quickly learn the technical specifics associated with a particular patent. Ideally, a prior art searcher is also experienced both in the patent prosecution process and patent litigation (Patenthawk, 2007).

program that is still in its infancy is the case of fish genetic improvement technology. It is only recently that a few research institutions (public/international) have established collaborations with industry as a means of sustaining the costs of genetic research and disseminating widely the knowledge on improved fish seed. An example of such collaborations is the case of *Genetic Improvement of Farmed Tilapia*[37] (GIFT). The WorldFish Center and its public good research partners undertook this project in the country. The GIFT project ended in 1997 but a non-profit private foundation was created to continue the breeding program and commercially disseminate the new technology (Acosta, et al. 2004: 2).

The Philippine Government has well-defined programs and support policies that encourage the active participation of the fish seed companies involved in the collaboration. For example, the Government has developed a *Republic Act* stressing the role of the state insofar the protection of the exclusive rights of breeders (with respect to their new plant variety and when they are beneficial to people, in particular). The government also encourages the participation of industry and provides incentives such as investments in the development of new plant varieties in the crop sector. But, while the government recognizes the crucial role of industry to further the goals of the country's *tilapia* industry, adequate support policies that will harmonize the initiatives of the university-industry collaborations and accelerate the participation of the industry in genetic improvement and dissemination of improved *tilapia* seed, are still lacking (*ibid*. p, 10).

4.6. Knowledge Transfers from Academia: Core Benefits and Main Barriers

As early as the 1980s, when researchers like Adamany (1983) were still speculating regarding the benefits inherent to the urban adaptations of industry-university relations, a widespread belief existed that much of the research activity at urban universities would take place directly at major business enterprises located within their geographic vicinity. As such, it was argued, these large and resourceful enterprises possess the capacity to invest in

[37] *Tilapia* is a freshwater fish that has gained prominence in fish farming and global food status.

modern laboratories and equipment widely unavailable and unaffordable to universities (Adamany, 1983: 429).

Similarly, Zucker and collaborators (Zucker et al. 1998a, 1998b; in Agrawal et al. 2002: 45) have established the importance of *geographic proximity*, research *collaborations*, and personal *relationships* in the transfer of knowledge from academia into industry. This is related to the claim by Harvard economist Michael Porter (Porter, 1998: 77) regarding the importance of *competitive advantages* in a global economy, as relying increasingly in local factors such as knowledge, relationships, and motivation; that are difficult to imitate by geographically distant industry rivals. This perspective is interesting, since, in an age characterized by faster communications and mobility (of people and ideas) and where almost anything is accessible by the click of a mouse, the role of *location* in competition is diminished. But, Porter argues, today's economic map of the world is dominated by industry or knowledge clusters that are geographically concentrated (*ibid.*), e.g. Silicon Valley in California (USA). An example of this is shown in Owen-Smith's and colleagues' study (2003), while pointing out to *location* in an active biotechnology region as a crucial factor in bringing advantages to universities in terms of the development of IP, particularly so across industries where firms and universities are more closely equivalent in terms of the *types* and *impacts* of the patents being developed (Owen-Smith et al. 2003: 1699).

Studies from Europe (Sweden and Ireland), reveal that universities' *Industrial Liaison Offices* (ILOs) have benefited from increasing collaborations with industry, leading to greater funding for research (Jones-Evans, 1999). In turn, this increase in disposable income available to institutions resulted in better teaching and the improvement of research facilities, two factors likely to influence the internal recruitment of top students as well as renowned scientific staff. All in all, this study shows that increases in external funding across Swedish and Irish universities, as a result of academia-industry collaborations, resulted in: (a) improved high-tech equipment; (b) skilled teaching; and, (c) top-class research training geared towards solving 'real' (industrial) problems (*ibid*. p. 53).

In the case of Asia (e.g. Taiwan), the goal of increasing industry profits is accompanied by enhancements at the level of technological sophistication. In order to encourage the latter, research cooperation between industry and universities was regarded, by the study's author, as paramount (Wu, 2000:1). Peters and Fusfeld (1982 in Wu, 2000: 3) identify a variety of *benefits* coming from the interaction between universities and local industry. Firstly, industry provides a new source of income for universities. Secondly, industrial money involves less "red tape" (bureaucracy) as compared with government money. Thirdly, industrially-sponsored research provides students with exposure to research problems in the 'real' world. Fourthly, research sponsored by industry provides university-based researchers a chance to work on intellectually challenging research programs. And lastly, governmental funds available for applied research are likely to stimulate joint efforts between universities and industry partners.

Turning back to Europe, and the case of Irish and Swedish universities (above), it was shown that the main *barriers* for academic engagement with industry were related to: (a) the lack of academic recognition for commercialization; (b) the existence of a reward structure benefiting academic/scientific publications as opposed to patents; and, (c) inefficiency regarding existing systems of collaboration between the two actors (Jones-Evans et al. 1999). It was also found that, at the university level, there was a need to encourage entrepreneurship among academics, since many individuals fear that ongoing research collaborations with industry clash with the academic ethos of the university as an important social institution (Jones-Evans et al. 1999: 53). As such, the authors indicate, it was rather difficult to promote collaborations with industry if academics themselves were not actively involved in the process, as they played an important part in the latter. Finally, *financial incentives*, as discussed in the previous sections, also played an important role in the Irish and Swedish contexts. As such, initiatives geared towards academic-industry engagements were characterized by having poor incentive structures when compared to the established academic activities of research and teaching (*ibid.* p. 53).

Hence, bearing in mind the elements exposed above, the core challenge for successful university-industry interactions is related to the fact that university and industry exist for the accomplishment of different goals. As such, universities are more concerned with the advancement of knowledge, free inquiry, and the exchange of ideas, regarding themselves as responsible to "the public," since their work contributes, directly and indirectly, to large social, cultural, and civic purposes. Most importantly, within academia, existing reward structures determining individuals' behavior are largely based on scientific publications rather than commercial orientations (Bozeman, 2000: 634).

On the other hand, business corporations exist to offer a service or product to society and, on this basis, their 'raison d'être' is geared towards making a profit. The latter enables internal growth, sustains the employment of its personnel, and provides adequate financial returns to direct investors, i.e. stockholders (Wu, 2000: 5, 12). Viewed from another perspective, the so-called *Corporate Social Performance* model, that has become more prominent in recent years, attempts to integrate the industry's overall economic contributions to society with its social responsibility and responsiveness (Carroll 1979 in Wartick, et al.1985: 758; Wood, 1991: 691).[38]

Whereas universities are important social institutions characterized by a variety of *autonomous* and *popular* functions (c.f. Trow 1973; Castells, 2001), industry, on the other hand, regards its existential role as one of market domination and profit-making. Obviously, these two distinct orientations are supported by a different set of cultural dimensions, and, therefore, are not always (if ever) easy to co-exist with each other.

Table 6: Summary of knowledge transfers from academia: Core Benefits and Main Barriers

Core Benefits	Main Barriers
Greater funding which led to: (a) improved high-tech equipment; (b) skilled teaching; and, (c) top-class research training geared towards solving 'real' (industrial) problems	The fear that ongoing research collaborations with industry clash with the academic ethos of the university as an important social institution
Enhancements at the level of technological sophistication	The existence of a reward structure benefiting scientific publications as opposed

[38]A recent trend is seen in the emergence of different marketing strategies like *corporate environmentalism* ("enviropreneurial"), where a given firm financially benefits from the promotion of its social responsibility (Menon, et al. 1997: 51).

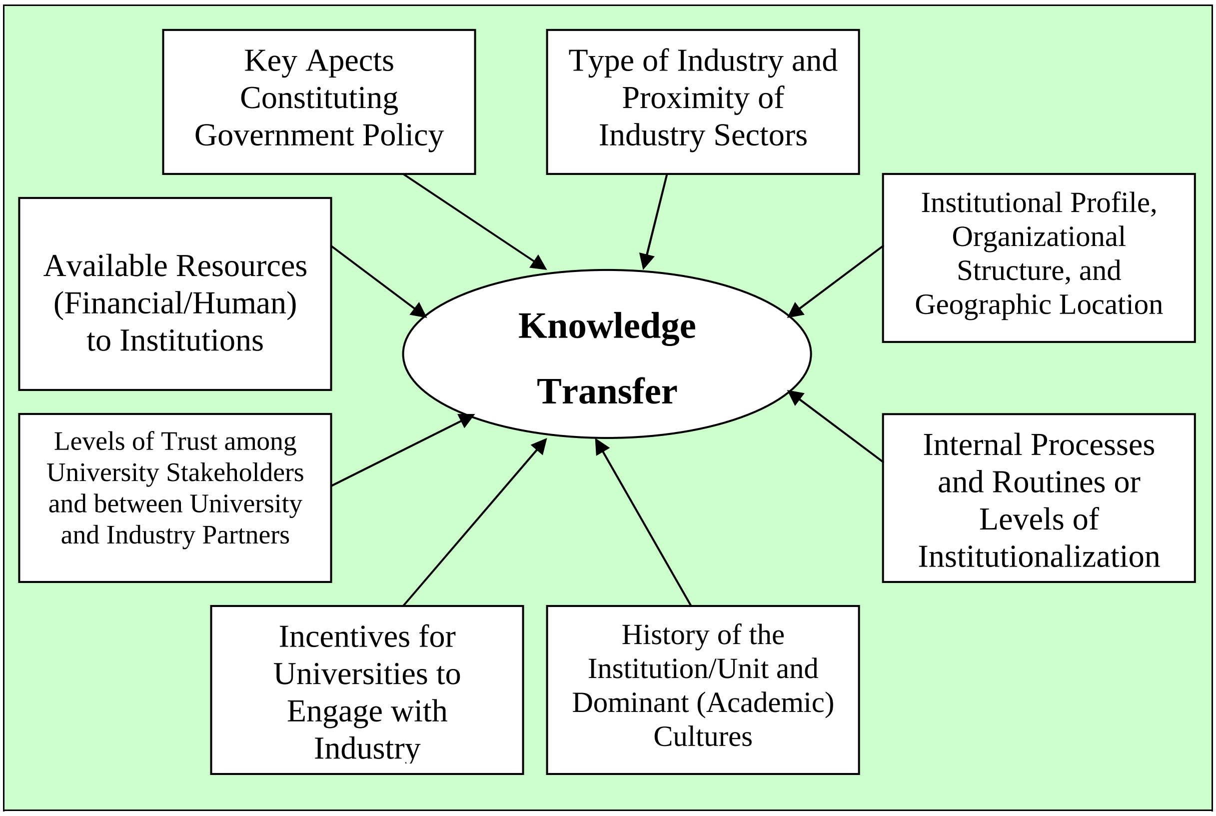
	to patents
Industry provides a new source of income for universities	Inefficiency regarding existing systems of collaboration between the two actors
Industrial money involves less "red tape" (bureaucracy) as compared with government money	The lack of academic recognition for commercialization
Research sponsored by industry provides university-based researchers a chance to work on intellectually challenging research programs	Initiatives geared towards engagements were characterized by having poor incentive structures when compared to the established academic activities of research and teaching

4.7. Conceptual Framework

In attempting to reach the core objective of this study, i.e. to find out *how* and *why* knowledge is being transferred between (two) research institutes (case studies) and industry, we have pinpointed the following factors, as per our literature review. These factors, based on previous empirical studies (Chapter 4), determine the level/degree of industry-academia engagement (see Fig. 5). They are: (1) type of industry that the institutions collaborate with; (2) institutional profile, organizational structure, and location; (3) internal processes and routines; (4) history of the institution and dominant academic culture in the unit/institution; (5) levels of trust (internally amongst university stakeholders and externally between university and industry partners); (6) available resources (human and financial); (7) key aspects constituting government policy, and; (8) incentives for universities to engage with industry. We took after the study of Gunasekara (2006) which conceptual framework explored 'what' universities do and 'why' they do what they do. Part of his framework consisted of a number of factors evident in the literature that appear to explain the roles that universities perform (Gunasekara, 2006: 101-102).

Since the respondents of this study are coming only from the academic sector, these two layers of network are mostly seen from the point of view of the university. But indeed it is our intention to highlight the role of the university as a knowledge-production entity, particularly in light of the critical role of innovation in the context of knowledge-based societies; in contrast to other models where the *industry* (e.g. the national system of innovation approach as presented by Lundvall, 1988, 1992; and Nelson, 1993) and/or the *state* (e.g. “Triangle” model of Sabato, 1975) are seen as undertaking the leading roles in innovation (Etzkowitz et al. 2000: 109, 118).

Fig. 5. Factors affecting knowledge transfer from academia.



Chapter 5. The Empirical Work

The data described and interpreted in this chapter were taken from inquiries with academics from the two cases composing this study, i.e. the *Institute of Environmental and Marine Sciences* (IEMS) at the Silliman University Marine Laboratory (SUML) and the *Marine Science Institute* (MSI) at the University of the Philippines (UP). As mentioned earlier, the latter is a unit of a flagship institution in the Philippines whereas the former is a much smaller unit.

Below we present/explore empirical findings on the basis of the elements composing our conceptual framework (see Fig. 5, above). An attempt is made to connect these findings with earlier empirical data (Chapter 4) as well as major aspects of theoretical importance (Chapter 3).

5.1. Type of Industry that the Institutions Collaborate With

Four of our seven respondents were asked to rank how important it is for their research unit to develop collaborative relationships with industry while developing new commercial products and/or solutions to certain problems. Their choices ranged from “very important,” “somewhat important,” “not important”, and “not important at all.” Whereas the two respondents at MSI were rather positive towards engagement with industry (“very important” and “somewhat important”), the respondents at SUML were a bit more skeptical (“somewhat important” and “not important”). We will elaborate on their responses in the succeeding paragraphs.

For one academic at MSI, he/she finds it important to develop collaborative relationships with the industry, while developing solutions to certain problems. However, it appears that the level of engagement depends heavily on an academic’s level of expertise and research agenda, as well as on individual motivations, e.g. the need to involve outside organizations in the activity**.** It also depends on the kind of project a researcher is doing and on what kind of industry is willing and/or has the need to collaborate with academics. The work of this particular academic involves environmental conservation and he/she finds the need to share new knowledge and insights as freely and widely as possible. Moreover, the above individual feels that he/she would get better scientific results if more people from the industry sector dedicated to environmental conservation would get involved. Therefore, he/she claims that patents and the like are not a concern at all. From the perspective of this respondent, partnering with industry is important from the standpoint of making the latter a positive stakeholder towards the goals of protecting the environment. While he/she thinks that partnerships with the industry are 'somewhat important,' this particular academic/researcher has not yet moved into the stage where he/she needs to be involved in such collaborative partnerships, and, therefore has not really seen a major contribution of such endeavors to the improvement of his/her research projects; although he/she knows he/she will get to that stage of collaborating eventually.

Another researcher at MSI, a Professor Emeritus, considers collaborative relationships with the industry "very important", because the product he/she is currently working on is seen as an important input to the development of the seaweed resource and/or commercialization of these sorts of products/technologies by industry partners. For this academic who is now utilizing his/her time only to research, this collaboration between research and industry enhances his/her professional growth. Like most academics, he/she had previously experienced conflict in balancing teaching and research activities, some of which involved direct collaboration with industry.

A similar view was stated by another scientist at SUML, who remarked that, within an academic setting, it is always easier to focus on the traditional internal academic activities instead of engaging with outside organizations. At the same time, this respondent also believes that, in order to make their work more relevant, scientists need to undertake efforts to reach out to industry. The data seem to indicate in this case that, on a day-to-day basis, most academic work at the university does not require active collaborations with industry. According to this respondent, in the case of special research projects or field extension projects, the university-industry interaction *could* have a positive impact, especially so while linking one's academic work to real life situations. He/she further stated that the industry has the potential of bringing a dimension that pure academic activities lack. Based on our previous literature review (Chapter 4), studies from Europe reveal that increases in funding have resulted to the improvement of research activities geared towards solving ‘real’ (industrial) problems (Jones-Evans, 1999: 53). This is related to another finding regarding the benefits coming from the interaction between universities and industry, namely; that industrially-sponsored research provides students with exposure to research problems in the ‘real’ world (Wu, 2000: 3).

Using the words of an academic based at SUML, who stated that, in his/her opinion it is “somewhat important” to develop collaborative relationships with industry:

> “Applied knowledge or that gained by doing projects, making things happen etc., is valuable knowledge needed in the world. The more practical that academic knowledge becomes, the more useful it is to society. Strictly academic findings, not tested in the world, are often not used later on or need to be tested. Partnerships with industry can add a dimension of what is really needed in business and what is in demand of society.”

The above statement indicates the scientist’s positive views regarding university-industry collaboration. However, the cautious way in which he/she said that, i.e. it is not “very,” but “somewhat important” to collaborate with industry, *may* be explained by the following examples. The above respondent said that the level of importance of academia-industry collaboration depends on the product scientists at the research unit are developing, e.g. if academic scientists are developing a design for a marine protected area (MPA) that is strictly relevant for managing corals inside the MPA, then the involvement of industry will not be necessary. On the other hand, if academic scientists are instead developing a more energy efficient method of fishing that is also better for conservation, they will then need to interact closely with the fishing industry as a whole, to get inputs as well as to promote the eventual acquisition of the product they (academics) have designed.

To continue further with the analysis of the data gathered from the same scientist from SUML (above), he/she agreed that many of the research projects undertaken at the research institute have benefited from collaborative partnerships with the particular industries. These include such projects as working with the tourism industry (private sector) in areas related to marine science research. These sorts of activities contribute to conservation as well as the interests of the tourism sector in general and the specific regions in particular. Furthermore, the same academic at SUML was also able to obtain support from companies that have implemented developmental projects in the areas of fisheries, coastal zone management, etc. "Support" here means different kinds of things; employment, access to modern technology, access to skills within a company that might not be available elsewhere, and monetary grants. An interesting aspect in the context of this study is the fact that, through working with industry, this particular academic scientist recognized that many industry employees as well as institutions possess the same *basic* goals as those of government and universities. When asked to elaborate further on what he/she meant by this, this scientist explained that some private companies mostly employ highly educated people who could equally be employed in the government or academe. He/she said that the only difference as to where people end up working to some degree depends on how they want to influence the world.

The one respondent in our sample who did not find partnerships with the industry as being important at all, was, nonetheless, the one who gave high importance to patenting his/her academic work above everything else. Amongst other things, this individual stated that partnerships with industry come with the "unnecessary exposure while developing your work" and that, as much as possible, academia-industry partnerships should only occur after research outcomes have been determined to be of value to the concerned parties. Nevertheless, and despite this cautious attitude towards industry, this respondent finds collaborating with the industry sector as a necessary condition if one's academic work is to be patented, even though, as shown in the literature review (Chapter 4), some corporations do tend to be discreet when revealing scientific insights (Fisher, et al. 2003; Owen-Smith et al. 2003). In view of these statements that seem to go on in a circle, there are important lessons that *might*[39] be useful for us, in the context of the constraints/dilemmas of university-industry collaborations. These include, but are not limited to: (a) it *may be* that industry partnerships should only occur after research outcomes have been determined; (b) in those cases where the work is to be patented, collaborating with the industry sector *might* be necessary; and, (c) those academics more skeptical towards collaborations with industry *might* be among those who are more willing to use patents as a means to protect their work

[39] The *might* relates to the fact that our initial assumptions or lessons are taken from the insights of a single individual, thus, making any broader generalizations problematic to say the least.

from being explored by outside sources.

The interactions between university and industry are on the premise that both sectors are, in a way, dependent on each other. Products developed in the marine industry are used, for example, for biological and medicinal research at universities. But on the other hand, some marine industries in the Philippines that have emerged in recent years and have prospered were brought about, not only by modern technology, but also as a result of persistent research involving the cooperation with university scientists. The seaweed industry is a good example in this regard. As such, we did not find any indications from our inquiries on whether the size of the industry partner matters, as seen in the experiences of some countries like Japan where collaborations of universities with small and medium-sized enterprises that are R&D-focused proved important for the country’s innovation system. However, we found data from other sources shedding light on the fact that, in 1998 the seaweed industry accounted for a considerable portion (68% or 652,680 metric tons) of the country's total aquaculture output totaling 959,484 metric tons, as well as one fifth (23%) of total fisheries production (2.79 million metric tons) (PCAMRD, 1998). Such a strong orientation is geared towards research in this particular industry in the Philippines that the country is now considered as one of the few in the world which has, on a commercial scale, successfully cultivated seaweeds. The above data indicates that, as shown in our conceptual framework (Section 4.7 Fig. 5), the *type* and *location* of particular industry sectors (or sub-sectors) are factors likely to have an important impact on the level of interactions with academia.

5.2. Institutional Profile, Organizational Structure and Location

The data gathered indicate that the graduates from MSI have a variety of job options. For example, some choose to serve in their home institutions or agencies, others join consulting groups, government agencies and/or non-government organizations (NGOs), and there are those who prefer to move on to further studies abroad or instead decide to undertake post-doctoral work abroad or at MSI**.** Over the years, MSI has attempted to keep the standards of the institution high and to undertake world-class research as a means to establish a reputation of Center of Excellence (CoE) in marine science research in the country. The unit's future vision is to become the center of tropical marine science in the world. This ambitious vision and a well-established reputation have contributed to attracting students from different fields of science. In our view, while it is not difficult to recruit young and established talents to their unit, it does not hide the fact that very few have expertise (at the PhD level) in the marine sciences in the country.[40]

In December 2006, an executive order (EO 583) by the President Macapagal-Arroyo was signed, establishing the *National Science Complex and Technology Incubation Park* at the University of the Philippines, Diliman (UP Newsletter, 2006). The new science complex, which will occupy a 21.9-hectare portion of UP Diliman, will be organized, managed, and operated by the institution's Board of Regents. The complex will be composed of all the units in the College of Science of the university, including its Marine Science Institute (MSI). As per the executive order, MSI will have the responsibility over the marine biotechnology business incubation laboratories to look at such aspects as: marine and herbal drugs, peptide production, and bio-imaging.

This "incubator" approach, whereby universities train and develop young industries and young people and then send them out into the commercial world, is growing in popularity, e.g. in China (Miao, et al. 2002: 353). A form of university-industry interaction, most research parks and incubators are located on or near the campus and are intended to draw technology-intensive industries into the university environment. Research parks can be beneficial to both university and industry alike by facilitating interaction and encouraging them to take advantage of each other's resources (Wu, 2000: 4-5). For this sort of incubation-related activities, the President of the Philippines directed the Department of Budget and Management (DBM) to release P500 million[41] for the project. The complex will "serve as the national hub for the generation and application of new scientific knowledge in the natural and applied sciences and mathematics," President Arroyo said (UP Newsletter, 2006). Among other things, she pointed out that UP has the capability to supply competent

[40] This is a statement that came from one MSI academic in a Forum conducted in 2005, as we stated in the 'Rationale' section of this study, in Chapter 1.

[41] Approximately US$10.5 million (April, 2007 exchange rates).

manpower and technical support to the Science and Technology Park and its component Technology Business Incubators. This is an example of the expansion of UP's developmental periphery, an element described by Clark as one that is common amongst enterprising universities; exhibiting a growth of units that are more ready to reach across 'old' university *boundaries* to link up with outside organizations and groups (Clark, 1998: 136).

As seen in the experiences of the academic scientists we contacted for this study, and with regard to ongoing research activities, it seems that all of them share the common need to rely on governmental funding, particularly so during the initial R&D stages. Moreover, 'top-down' initiatives discussed in the literature review in Chapter 4 (e.g. Clark, 1998; Giesecke, 2000; Sardana et al. 2006) prove themselves useful to support areas of national interest, e.g. environmental conservation (as discussed in the previous sections). Our earlier literature review has also indicated that, at a later stage, academics actively seek grants from outside entities, as was shown in the case of the biotechnology sector in India (Sardana et al. 2006: 370). Thus, the data is rather revealing regarding the positive role of incentives as initiator of important initiatives like the establishment of incubation parks. In this process, the state builds initial capacity and, at a later stage, several possibilities emerge for university initiatives to link up with industry.

From the side of the state and regional authorities, there is confidence in the above incubation project since it is expected to provide employment opportunities for the residents of Quezon City, the location of the UP Diliman campus. In 2006, town mayor Feliciano Belmonte Jr. approved and signed an ordinance adjusting the zoning classification of a portion of UP Diliman devoted to the UP North Science and Technology (S&T) Park. Mayor Belmonte said that the classification of the area as an S&T Park was in line with the thrust of the city government toward becoming the country's ICT capital.[42] He said that the UP North S&T Park project promises to be a magnet for fast-evolving high-technology companies that would prove essential for the creation of a strong business and employment center in Quezon

[42] This initiative provides another good example of a top-down policy at work.

City.

In addition, the Arroyo administration is supportive of S&T activities as a means to generate economic development and employment. Thus, universities are seen as ‘engines’ for social/economic development and domestic growth. To quote the President, “efforts to boost the country’s scientific and technological capabilities and their application to productive systems require complementary initiatives in new scientific knowledge and technology, technology transfer and diffusion, and technology utilization and management” (UP Newsletter, 2006). The initiatives mentioned in this paragraph, in which the state develops strategies for economic development and involves both university and industry as key stakeholders, is a revelation of Triple Helix in practice in the Philippines. Here we find an interaction among the main institutions carrying out the knowledge-based system, the university, government, and industry. As discussed in Chapter 4, Triple Helix combines Mode 2 and systems of innovations as different sub-dynamics of the systems under study and, at the same time, adds the dynamics of the ‘market’ as its third perspective (Leydesdorff, 2005: 194).

At SUML, the data gathered reveal that, as of today, there are no formal processes of knowledge transfer to industry. The research activities at the institute mainly focus on such areas as biodiversity, coastal resource management, conservation, marine protected areas, genetics, etc. Research efforts do not usually entail the development of a technology that would require patent protection and the research results are shared with the involved local government units (LGUs) and the local community. These results are also published and presented at scientific symposia. In those circumstances where a given LGU is interested in requesting training for a particular area, communications with the director of the IEMS (the unit at SUML) are established and training is arranged, with the trainees having to pay a moderate fee. However, these trainings are very irregular. Sometimes they have as many as four in a year, sometimes only one training per year. These trainings can last for a week. Within the institute, weekly seminars aimed at sharing research results amongst internal constituencies as well as sporadic university lecture series for students are often exercised. Despite these ongoing activities, there are still no formal rules and procedures as such, thus, the degree of institutionalization *might* be considered weak to moderate; bearing in mind that these types of endeavors occur on a regular, but still rather informal, basis.

One of the scientists at SUML indicated that he/she finds it a major challenge for the institute to train (i.e. socialize) world class researchers in the field on the grounds of increasing their levels of *social conscience* (i.e. researchers who put into practical use the research findings) and with a view of strengthening the existing research infrastructure. When asked to elaborate on this, he/she explained:

> "Not only are there few researchers in marine sciences but also there are few among them who attempt to make practical use of their research findings. This situation must change. In general, research infrastructure in academic institutions is in need of development. There are few laboratories, inadequate libraries, lack of basic equipment. All these discourage researchers from developing research programs. In addition, administrators do not encourage research and do not provide adequate budgetary support. Finally, administrators themselves are ill-prepared to recognize and distinguish good research from bad research."

Without these two key aspects (increased social conscience and strengthened research infrastructure), the respondent stressed, academe-industry linkages cannot be built. He added that in the marine sciences, trends toward oceanography and the use of new tools in research such as genetic markers would look promising in terms of industry collaborations.

5.3. Internal Processes and Routines

At MSI, the integration of normal research activities at the institute with industry, non-governmental, and governmental institutions (both local and foreign) is exercised across *three* major areas; (a) training, (b) research and development (of appropriate and environmentally marine-based technologies for industries), and (c) economic development. The integration process is facilitated simply through a letter request or via formal venues like a Memorandum of Agreement (MOA) between MSI and the corresponding external partner.

In line with the importance of learning the intricacies of patent filing and intellectual property rights (IPR), (c.f. Owen-Smith et al. 2003: 1701) as discussed in the literature review section (Chapter 4), data from the UP website show that UP has long recognized the need to protect the IP of its scientists and scholars, when, around 20 years ago, the "Policies, Rules and Regulations Governing Patentable and Copyrightable Works Produced by the University of the Philippines Personnel" was approved. More recently, UP has developed IPR guidelines, and for MSI, it is primarily as a means to avoid problems related to authorship, the ownership of data/images, as well as regarding the transfer of knowledge and data into the public domain. At the central level, UP is now undertaking efforts concerning IPR issues and regulations, which means that the institutionalization of internal processes is underway. Overall, the entire UP System has set up a *Technology Licensing Office* (TLO) under the office of the Vice President for development. The TLO at UP is responsible for overseeing the technology licensing activities of the entire university.

Insofar IPR, technology transfers and a general contribution toward the public good are two key aspects of the university's policies across the entire UP system. As for *copyright*, if the work is the result of collaborative efforts among the university, an outside entity, and the knowledge creator(s) (i.e. academic researchers), there is a 'joint ownership agreement' among the three actors involved. However, the university may waive its copyrights in favor of the individual researcher(s), if this is likely to enhance the transfer of technology and lead to improving access of the work by the general public.[43]

On the other hand, if the scientific discovery resulted from the collaborative efforts among UP, an outside entity, and the individual researchers involving the substantial use of university resources, the patent *may* then be jointly owned by the three stakeholders, as long as a prior written consent of the university is in place. In those cases where the funding of research activities is wholly or partially covered by outside entities, the university negotiates directly with the funding/sponsoring entity, with regards to the ownership of the invention, patent rights, and royalty sharing.

In contrast, at SUML, there is only an awareness of the need to assist scientists in terms of

[43] Only if it does not violate any existing contractual obligations to third parties, and, if the participation of the university in the work is acknowledged by the researchers involved in all their national and/or international publications related to the new research findings (ibid).

writing patents, providing education in the patent laws, and informing academics on technology transfer processes, but, thus far, the institution does not have any formal bureaucratic processes in place. However, SUML is currently embarking in a new program on biotechnology defined around the practical use of research findings, which as such, could be classified as a type of “patenting process.” The low popularity of patents at SUML *may* be explained in light of earlier empirical studies showing that *patenting* and *licensing* activities constitute a relatively small channel for the transfer of knowledge from academia into the industry (Agrawal, et al. 2002: 51). However, putting the issue of the channel used aside, the reason may also be that there is no support for knowledge transfer (e.g. proper incentives), as our respondents had implied.

Interestingly, the one respondent who values patenting above all in his/her work is from SUML, i.e. a Master’s student who patented his/her work. However, in this case, the process was practically one’s own initiative, with the professors at the institute merely providing general advice. His/her motivation primarily came from the fact that Silliman University does not have clear-cut policies on patents, and he/she being an entrepreneur, thought it a must to protect the IP. Delving further into the experiences of the above student/respondent, we learned that financial support came from winning competitions and grants provided by the government and some business entities. Motivated by protecting one’s work, he/she learned more about patents (writing, laws, etc.) by simply searching for the information on the internet.[44] However, despite some external support, the bulk of the patent costs was paid by the student. The conflict that this particular student saw between *patenting* and *publishing* was that, one could not get a patent if one made one’s work a “prior art”[45] or if any results had been published while the patent was pending.

The above data findings *seem* to confirm the fact that, while it is possible for patenting,

[44] Our respondent informed us that the *application fee* in filing a patent in the Philippines currently costs P2,850 (approx. US$59), while the *Patent Cooperation Treaty* (PCT) is around P 35,000 (approx. US$731 – April, 2007 exchange rates). PCT is a treaty for rationalization and cooperation among contracting states (worldwide) with regard to the filing, searching and examination of patent applications and the dissemination of the technical information contained in the applications.

[45] *Prior art* means any disclosure of the contents of a claim prior to the application for patent. A patent on an invention is not valid if that invention has been described in prior art.

publishing, and commercialization activities to go hand in hand, there are always difficulties in the process. For example, findings from an early study indicate that the process of technology marketing[46] often occurs before a decision to file for patent protection is made (Owen-Smith et al. 2003: 1701). In our view, the above elements are, once again, important lessons related to the major *constraints* when it comes to university-industry collaborations namely: (a) one could not get a patent if any results had been published while the patent was pending, and (b) in trying to get a patent, it is helpful to get insights about the impact of a new invention, e.g. by using technology marketing (which could come in many forms, and therefore, this might actually mean publishing the results!).

In order to integrate industry relations in the course of one's daily academic activities, one of the respondents at SUML (a scientist), affirmed that the institution has sent student interns to work together with private industry partners. Some SUML researchers have also spent time in laboratories or worked in field projects with companies, as a learning opportunity. Other knowledge transfer activities at SUML include seminars, which often include industry participants who pay to attend, and learn/share their own knowledge with other internal and external stakeholders. At SUML, and based on the empirical material gathered, it seems that there are many opportunities for academia-industry collaboration in this regard, at least on the "research" front, and not necessarily on the "commercialization" level or the patenting process. This finding confirms an aspect discussed earlier in the literature section, namely; that industry *may* be more cooperative in alternative ways other than patents, for example, in writing scientific papers together with academics (Agrawal, et al. 2002: 48, 52).

The empirical data from academic respondents at SUML indicate that some of the best graduates join the faculty/institute. In the case of students/graduates who are self-financing, these usually work at NGOs involved in conservation and biodiversity, though many of these types of students also join the faculty/institute after graduation.

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[46] *Technology marketing* makes use of all forms of technology to maximize the effectiveness of marketing in the digital age. This means that a technology is "shopped" to particular licensees to search for information about the potential impact of a new invention (Owen-Smith et al. 2003: 1701).

According to one respondent (a senior administrative) at MSI, when students graduate from the institute they are assured that he/she has been well trained in undertaking research in a given field of interest/expertise. It was also mentioned that, the students are also well-rounded because the training includes conceptualization of ideas, proposal writing, and hands-on research. Students also become adept at doing field research-based activities. Our contact at MSI has also indicated that, after graduation, graduates do not encounter major difficulties in finding employment. He/she said that recent statistics show that 74 percent (56 out of 76) of their MS graduates and 100 percent (11 out of 11) of their PhD graduates are currently employed. Most of them move on into the fields of academia, consulting groups, or NGOs. In those cases where graduates join other schools and/or universities, the faculty staff at MSI, particularly their own academic advisers, do continue to collaborate with them on a regular basis, as far as research activities are concerned. In this way, the institute continues to help in building the capabilities of other educational and research establishments across the country.

5.4. History of the Institution and Dominant Academic Culture in the Unit/Institution

When inquired, an academic at MSI indicated that the conflict between *patenting* and *publishing* depends on who funded the research. Earlier findings (see literature review section, Chapter 4) reveal that publishing certainly is a much more important activity than patenting, at least as measured by count data, that more industries collaborate with universities on scientific publications rather than patents, and that the fraction of industry that engage both channels is quite small (Agrawal, et al. 2002: 48, 52).

It seems to us that to keep a balance in a situation where research is publicly funded, and thus must be available to all citizens, is a major challenge. One academic respondent commented that, however, this is assuming that public funding has adequately compensated the researcher for one’s work. This is something that is not common in the Philippines where many publicly employed researchers at universities are not paid adequately. The solution to this dilemma is to seek private funds, as, in our view, the government cannot afford to improve the working conditions or raise salaries of researchers. Another option for these researchers is to move into private HEIs, as these generally offer higher salaries and more benefits**.** But, unlike publicly funded research, the commercialization potential of privately-funded research has to be safeguarded in order not to discourage its main sponsors. Nevertheless, the preferences of individual researchers are an important factor, as indicated by one of the academic respondents while stating:

> "I personally prefer that the most number of people are benefiting. Generally I would think researchers would benefit more from publishing research results and then various industries could compete to develop it further. But this may not always be the case."

In the opinion of another academic (at MSI), conflicts may result when the product or technology developed through research is not yet patented and is commercialized by industry without prior consultation with the research units/university or the funding institution. When he/she was still both teaching and researching, the above academic preferred to publish in peer-reviewed journals although he/she also gave some importance to the transfer of knowledge into industry. This is mostly due to the fact that promotion in rank and professional status in academia depends largely on publishing outputs/accomplishments. As discussed in the literature review section, universities' staff promotions-criteria are often based on the number of publication titles, leading to a clear bias in favor of those research areas where it is common to publish several short papers a year (Becher, 1994: 157). In a similar vein, as identified in earlier studies, academic researchers *may* also vie for a promotion, even while facilitating commercialization since the latter can also enhance an academic's professional reputation (Goldfarb et al. 2003: 641), eventually leading to a job promotion or enhanced professional mobility.

Interestingly, now that he/she is Professor Emeritus, the academic respondent (at MSI) referred that he/she now values transferring knowledge into industry more highly, especially so across certain fields. This is not only due to the research grants which industry and several NGOs provide, but also since it enables him/her to transfer or extend his/her academic expertise to the various stakeholders across a certain marine industry. In Becher's study of academic cultures, the author refers to "inertia" (or what would some call "conservatism") built into the academic enterprise, as a result of the investment needed to attain a special expertise in a particular field (Becher, 1989: 114). Anyone who has spent years in the achievement of a close understanding of one particular knowledge area is unlikely to abandon it in favor of a new specialization, especially in areas where the linguistic and conceptual barriers are high, or where a well-established technical skill has to be replaced by another (*ibid*. p. 114-115). We presume that, in those cases like the one of our Professor Emeritus where conservatism in academia limited one's teaching and research activities, ever since he/she directed his/her attention to research alone, the choice was clear. We could see that he/she just altered the process a little, in this case, he/she chose to stay close to his/her practice and strengthened the dimension of transferring knowledge to the industry. At the collective level, it may be true that such actions can also be linked to issues of personal interest – i.e. to enhance one's career and status amongst one's peers.

Turning now to SUML, one of the academic respondents at the institution remarked that, at the moment, only few natural scientists at SUML are involved in overall research efforts, but virtually *none* is active in commercialization processes. According to this individual, this attitude is explained by the "social service" orientation of the institutions. Another academic respondent at SUML referred that, at IEMS (the unit at SUML) the academics and administrators are not aware of the commercial values of their ideas, since their outlook/orientation is that of *science* and not the commercial aspect of the research. This relates much to the existing literature referring to the different purposes/goals of the university and industry and that, within academia, existing reward structures determining individuals' behavior are largely based on scientific publications rather than commercial orientations (Bozeman, 2000: 634).

A comment from the above respondent illustrates this point:

> "The 'industry' has to be patient with the [academic] scientists. As I mentioned most of us [academics] are more interested in science and sometimes feel pressured to produce 'technology' from a small grant that is stretched over two to four years."

As for internal pressures to publish, according to the above respondent, unlike universities abroad, Silliman University does not have the "publish or perish" environment, rather there is a reward system for those who publish. They have a point system wherein teachers get points for publications, paper presentations in peer meetings, etc. These points are used for promotion and salary increases.

The above respondent added that IEMS has not been involved in any research efforts purely intended for commercial use. The same individual's comment on university-industry relationships in the Philippines in the context of marine science research in general is that: "they [academia and industry] seldom meet and thus rarely have opportunities to interact with each other." And that, as a result, both sides do not trust each other. "We [academics at IEMS/SUML] do see industry people during symposia but our interaction with them is minimal." In this context, the Master's student we were able to contact at SUML did not seem encouraged. In answering the question of whether he/she would say that partnerships with industry have had a major contribution to the improvement of his/her research projects/results, the respondent replied: "Not in the Philippines because any partnership will have *strings* attached to it which may not be pleasant always." He/she added that some partners want exclusivity in exchange for their investments, something that is good if they perform well but the opposite when they do not achieve expected outputs.

Despite the rich empirical findings, we have to be careful in generalizing the above observations regarding IEMS to all marine science institutes in the Philippines, considering the fact that the other two academic researchers at SUML and the majority at MSI, were, generally speaking, more positive towards university-industry relations. As indicated by an academic scientist at SUML (while referring to SUML in general, and not only the IEMS unit), the strongest partnerships in place are those between (some) science departments and conservation agencies locally and/or internationally-based. The results of such research efforts are used by local governments and local communities for improving biological resources. These types of partnerships have been developed/enhanced for several decades at SUML. This is a clarification to the comment of another academic at SUML earlier, i.e. that the IEMS unit has not been involved in any research efforts purely intended for commercial use, but overall, the SUML institute has had industry collaborations for decades.

A scientist at SUML, who has expressed positive views regarding partnerships with industry, highlighted that partnerships offer certain opportunities but that there are certain risks as well. His/her academic peers also tend to shy away from working with industry. But, as a means to improve the quality of research, more researchers (at SUML) are trying to work with the industry in appropriate ways that help further their academic/professional objectives, as well as broaden their target audiences. According to this scientist, some types of research do require working with industry. But, he/she continued, when industry starts funding research outright, certain *agreements* need to be put in place as to maintain academic and objective standards and to ensure that the established standards and reputation of the institution/research unit are maintained.

Personally, the above academic scientist (at SUML) does not see *publishing* and *transferring* knowledge into industry as two separate activities. In his/her opinion, publishing in peer-reviewed (scientific) journals allows everyone, including industry, to access the research findings. As such, the scientist said, transferring knowledge into industry should not be exclusive if one is employed in a public or private university operating under the assumption that all knowledge gained becomes accessible to the public domain. Industry can employ consultants and employees to undertake their own research. In our view, this case will depend on whether there are intellectual property issues involved, i.e. if a work is patented. But, in this scientist's opinion, publicly-funded and supported higher education and research institutions need to adhere to the ethics of providing information for public use. He/she added that if they receive support from the corporate sector to undertake research, the results should still be shared through proper peer-reviewed journals and outlets.

Nonetheless, the same scientist (at SUML) does see potential conflicts between commercialization of research/patenting and publicly available academic results/publications. According to him/her, if it becomes easier and more desirable to commercialize research findings through patents, this will make it more difficult for people to access freely the results of regular research that is intended to inform the public at large. What *might* happen, according to our respondent is that, although most university research findings are made accessible to the public, those findings that are deemed to have a financial value will tend to be hidden and sold to private companies. What the above respondent mentioned is not entirely similar, but is nonetheless related to, an aspect mentioned in the literature review section, outlining that a key aspect corporations and academia may *not* agree upon is the fact that a commercial company *might* choose to exploit a novel idea in-house and keep it secret rather than patent it and thus disclose it to the general public and industry competitors (Fisher, et al. 2003: 46).

Finally, one of the academic scientists at SUML added that the above topic is a difficult one since there are laws and regulations that determine what happens to patented and copyrighted/published results. In his/her opinion, universities should set internal *policies* on these critical issues so that information flows freely and is not controlled by commercial interests, alone. Some of the HEIs that this academic is familiar with (not necessarily in the Philippines) have adopted the policy that, when they patent a new finding/idea they still share the result with the public, as part of their institutional public-mandates.

5.5. Levels of Trust among university stakeholders and between university and industry partners

An academic from MSI, and he/she also believes this to apply to his/her peers at the institute, mentioned that he/she is willing to engage in collaborative efforts with industry, as long as the latter acknowledges the important role that academics play in the development of a product or technology, e.g. through the establishment of royalty grants or via research funds. Though the respondent could not speak generally on behalf of the entire institution, he/she shared with us his/her personal experiences. He/she has partnerships in place, e.g. with funding institutions and NGOs which grant funds for his/her research activities. Partnership agreements are often in the form of a contract/MOA for specific projects and specific periods of time. As for the granting institutions mentioned above, these are more concerned with patents, especially with regard to products/technologies developed using partners' research grants. In our view, the examples shown above, i.e. research grants and agreements via a MOA, in a way seal off the partnership between the actors. Somehow, having these kinds of commitment brings more *trust* into the partnership. However, sometimes these agreements may limit them in their activities. These findings are well in line with earlier insights shown in the literature review section, i.e. that universities (or in this case, the individual scientist/researcher) *may* depend on the interest of industry to justify pursuing IP, and that, that very dependence *might* limit universities' ability to capitalize on the few technologies they succeed in protecting (Owen-Smith et al. 2003: 1705).

According to the above respondent, industry insights originate, first and foremost, from the basic needs and commercial interests of the industry as a whole**.** This is where he/she finds the role of universities as critical since the key challenges in engaging in partnership with industry are around issues which constrain the smooth operations of the industry concerned. Institutions like MSI possess the expertise to resolve the problems and/or to be able to provide specific information needed by industry. In our view, in a way there is a cycle of Mode 1 and Mode 2 (Gibbons, 1994) that is evident in the research activities taking place at the university, where the applied knowledge for the resolution of problems and issues confronting industry is sourced or generated through basic research. The results and information derived from these basic studies become the validated basis for practical application to the needs of the industry.

For the above respondent, the designs of one's research proposals have the general goal to arrive at results and recommendations with *practical application* in resolving the issues/problems facing the local industry. In contrast, we recall that Fisher and colleagues consider consulting organizations as a model for university technology transfer processes. One reason for this may be that consultancies are working in fields that are closer to market needs and that some of the processes developed within the company would be appropriate in a university context (Fisher, et al. 2003: 45, 48, 49). Another reason would be that consulting activity is based on the capacity of specialized companies with highly qualified staff (Creplet, et al. 2001 in *ibid*. p. 47). With the use of available metrics, *some* consultancies perform better than universities in terms of patenting and commercialization (*ibid*. p. 45). Knowledge transfer, as we saw here, could flow from university to industry or vice-versa. One may serve as a model to the other and, in our view, *trust* is a factor that should play an important role in order for two actors (universities and consulting organizations that are usually for-profit) with different set of values, to collaborate.

As discussed in the literature review section (Chapter 4), licensing officers and scientists at universities search for information about the potential impact of a new invention but most corporations do not readily reveal valuable insights (Fisher, et al. 2003; Owen-Smith et al. 2003). It seems that this is also the case with the experiences of academic scientists in the Philippines. As such, a scientist at SUML mentioned that corporations in general do not give out valuable insights (e.g. patents that they hold). But corporations do release information obtained through research efforts they supported, if there are arrangements or mandates in place to ensure that this occurs. In his/her overall assessment of partnerships with industry (at SUML), these can be beneficial when all parties are aware of the relationship and the agreements between them. For example, in the Philippines many development projects are contracted by bilateral donors and development banks to the private (for profit) sector. These companies work very well with universities and government and are highly motivated to pursue development work for improvement of the country in an efficient manner. According to this respondent, the advantage that industry brings is a level of *accountability* and *efficiency* that is not always present in either government or in a university setting. He/she suggests here that the industry, by *contract*, is obligated to achieve certain objectives in a given period of time. The industry is often allowed some freedom on how the job gets done but by the nature of agreement, they must accomplish certain tasks in a given period according to certain specifications. Moreover, this scientist said that in contrast, the public sector, although accountable to people through an electoral process in some places, may not be so transparent. He/she added that this of course varies from country to country. As for academia, this will vary from institution to institution as well. But based on this scientist's experience, the former is less *task-oriented* with respect to development work, than the private and non-government sectors. In sum, the challenges lie in the development of open relationships with binding agreements that both sides follow and are accountable for. This scientist said that all organizations have their own interests, mandates, etc., and, in working together, clearly articulated agreements are needed for both sides to benefit.

5.6. Available Resources (human & financial)

The government, through the *Department of Science and Technology* (DOST), *Philippine Council for Aquatic and Marine Research and Development* (PCAMRD), and the *Bureau of Agricultural Research*, has provided research funds to MSI to undertake both basic and applied research. Basic research is funded as long as there is a clear direction regarding research output that would be used to develop technology or for purposes of management and conservation of resources. MSI has also received recognition and financial support e.g. from DOST and CHED for outstanding publications, innovative research findings and individual researchers. These awards have been used, amongst other things, to provide funds for students' research dissertations undertaken at the institute.

The government's support for commercialization of research is seen in the fact that MSI is also able to get support from DOST for projects aimed at scaling up marine products/solutions with commercial potential. In order to get government funding, outputs of research projects have to be in the context of technology that can be transferred, provide economic growth, and be useful for management/conservation of marine resources. With this requirement, government is helping to ensure that research outputs can be picked up by industry. According to our respondent from MSI, the university (central administration) provides an annual budget of P6 million (approx. US$126,300) for Personnel Services and P1.5 million (approx. US$31, 600) for Maintenance and Other Operating Expenses to MSI and it actively encourages the institute to collaborate with industry. This budget does not include funds for project implementation. Research project money comes from foreign funds and government support.

Turning to SUML, internal incentives in the form of financial awards for academic research that culminate in publications and bio-technological achievements are in place. The budget of the institute usually originates from external grants. We acquired the following figures from one of our respondents: The operations and research programs at SUML require about P10 million a year (approx. US$ 208,000), based on current faculty researchers (four PhDs, several Master's holders) and physical facilities. The expansion of SUML's oceanographic fisheries and marine protected area programs would require at least P20 million (approx. US$ 416,000) or more. If a biotechnology program is added, a minimum of P5 million (approx. US$ 104,000) more would be needed, or a total of P 25 million (approx. US$ 521,000) per year.

The support that SUML gets from the central government of the Philippines is mostly via grants. Other than that, the support it gets from CHED, for example, is spent on purchasing equipment and some amounts are spent on thesis scholarships (at the Masters level) and for travel of faculty to attend seminars. Recently, the university was recognized for its program in Marine Protected Areas by CHED and was awarded around P 1.3 million (approx. US$

27.000).[47] Additional funds are obtained via research grants from other entities. For example, IEMS was awarded research grants from the Conservation Foundation of Hong Kong to study *dugongs* and their habitat in the region of Northern Negros.[48] In the mid 1990s, SUML was also given a grant by USAID to conduct research on coastal resource management.

According to one academic at SUML, the university (central administration) is supportive of collaborative work with industry but, as such, it should *not* interfere with teaching duties. The university president encourages its faculty to undertake basic research. Alternative arrangements can also be made (e.g. sabbaticals) in case faculty members would like to concentrate on doing applied research outside the institute.

Thus, and in retrospect, the data gathered from the two case institutions reveal a more positive orientation from respondents at MSI regarding governmental support for university-industry partnerships, in light of the incubation park that was ordered by the Philippine president to be established (in December 2006) and the support coming from both the DOST and PCAMRD (see above). The important roles played by both the government at the national level and the central administration at the university level, were detected across the two cases. Nevertheless, a 'bottom-up' approach was also seen, for example, in the case of the establishment of the research park by UP MSI. Sardana and colleagues point out that the bottom-up approach of the Triple Helix is better suited to bring about valuable *networking* for the innovation involving industry and academia (Sardana, 2006: 372). Considering the different orientations present across the two case studies, i.e. MSI being a part of a flagship institution and SUML being a smaller institute, this *might* relate to Clark's statement about flagship institutions surviving even if they lack steering capacity, as these can continue to depend upon their prominent social/market position and political influence while gaining access to valuable resources and enhancing their competitive status (Clark, 1998: 5, 123**).** However, it may also be that over time, these types of HEIs have developed

[47] The exchange rates mentioned in this section are from April, 2007.

[48] Dugongs, or sea cows as they are sometimes called, are marine animals which can grow to about three meters in length and weigh as much as 400 kilograms.

the *institutional capacity* required at the lower levels of the organization to run their own academic affairs. Furthermore, the bigger, more established institutes serve as role-models for the smaller ones. For example, in our empirical data, there are glimpses of scientists at SUML commenting on how they have learned from the experiences of, not only MSI, but of the UP system as a whole.

With regards to funding, and as discussed in the literature review section, the financial basis of universities in the Philippines is mostly concentrated around public funds, however, as this wanes (see example on Table 7, below), it is essential for universities to turn to other sources of income (Clark, 1998; Mansfield, 1995; Sardana et al. 2006).

Table 7: Budget Appropriations for the UP System (with US$ rates from April, 2007)

Year	Total
2005	P4, 162, 794, 000 (approx. US$87,490,427)
2003	P4, 340, 096, 000 (approx. US$91,216,816)
2002	P4, 338, 995, 000 (approx. US$91,193,674)

Source: DBM

The decrease in budget from 2002 to 2005 does not seem much, making the appropriations almost stable within three years. This we find interesting because prices (oil, market products, etc.) continue to rise in the Philippines every year. To give an analogy, this is the same situation as in the minimum wage of a public sector employee in the Philippines, i.e. it has remained almost stable for a decade or so, while prices continue to rise.

The two institutes studied here are involved in a field that is rather costly, involving teams comprising tenured staff, post-doctoral staff, doctoral students and technicians who are heavily dependent on sophisticated laboratory apparatus and in-house accommodation/large spaces (Becher, 1994: 155, 158). With this scenario in mind, outside resources both human and financial are certainly required. While it was seen that both MSI and SUML exert some efforts to collaborate with, and turn to, industry for more funding, it was also detected that there is a stronger involvement (engagement with industry) in the case of MSI. In our view, this may be because the academics at MSI are more positive about such interactions (this could be explained by the level of trust they have towards the industry, the culture at the institute, to name a few). The fact that MSI is more involved with the industry than SUML might be a contradiction to Clark's findings that in most cases, it is the smaller universities that are prepared to be entrepreneurial (Clark, 1998: 5, 123). It *may* be that that MSI's resources and history reflect its well-established reputation, making it more attractive to the industry.

As shown earlier, in the Philippines there are already well-developed R&D programs for public-private sector partnerships in certain sectors of the economy/society (e.g. in agriculture). In recent years, governmental support in the field of marine research has been on the rise. This is not only insofar financial support but also in ensuring the protection and security of academic researchers at HEIs across the country. The government has also been encouraging the participation of private enterprises (e.g. in the crop sector) by providing financial incentives like investments in the development of new plant varieties (Acosta, et al. 2004: 2). With all these actions from the government, it seems that it is only the more active participation of the industry that is yet to be seen. But then again we do not have enough data to comment on the participation of the industry as our study did not focus on its activities.

In general, the Philippine central government makes research grants available to universities as well as to individual faculty members, and does favor those research proposals in collaboration with industry, another indication of Triple Helix in practice. Certain agencies of the government require that research projects which have the potential for immediate industry adoption have, at the start, the participation of industry (e.g. via the provision of raw materials and counterpart funds). As discussed in an earlier section of this chapter, the preconditions advanced by scholars like Turpin and associates (2002 in Sardana et al. 2006: 371) and Pavitt (2001 in Sardana et al. 2006: 371) are visible in a developing country like the Philippines. These are top-down policies wherein the government needs to play a dominant role in the development of sectors that are of vital importance to society. Also, as indicated by Peters and Fusfeld (1982 in Wu, 2000: 3), governmental funds available for applied research are likely to stimulate joint efforts between universities and industry partners.

5.7. Summary of Major Findings

1. Type of industry that collaborates with academia

- Examples are industries that are concerned with marine conservation, environment and tourism, to name a few. It is also apparent that these are industries comprising a “big” chunk of the country’s aquaculture output, such as the seaweed industry.
- The degree of collaboration depends on individual motivations of academics as well as the type of industry that is willing to collaborate with the institutes. Individual motivations include: a) the need to involve outside organizations in the activity; b) the need to make the work more relevant to the society and; c) the need to link their students to real life situations.

2. Institutional profile and organizational structure

- At MSI there are more opportunities to be enterprising and link up with outside organizations and groups. This is seen in the proposed establishment of the *National Science Complex and Technology Incubation Park* in UP Diliman.
- At SUML, the academics are more concerned with sharing research results with students and other researchers. However, they also benefit by raising funds via symposia and lectures, at the same time involving the government and local community with their work.

3. Internal processes and routines

- There is a formal process of knowledge transfer into industry at MSI; integrating research activities with industry as one of its priorities. It has also recently developed guidelines on intellectual property rights.
- At IEMS in SUML, commercialization of R&D is not a high priority, although at SUML in general, partnerships with industry regarding knowledge transfers have been going on for several decades. Also, except for a program on biotechnology that could entail some form of patenting process, there is only a general awareness of the need to assist

scientists in terms of IPR. As shown, the SUML student respondent who patented his/her work has succeeded in doing this independently.

- At the university level, the UP System has set up a technology licensing office and the university is now making an effort to formalize intellectual property rights issues and regulations. These areas have not yet been fully institutionalized at Silliman University.

4. History of the institution and dominant academic culture in the institution

- There are some conflicts as regards *patenting*, *publishing*, and *partnering with industry* at the two institutions. These basic dilemmas include, but are not limited to:

a) partnerships with the industry might mean “unnecessary exposure while developing one’s work;”
b) when the product or technology developed through research not yet patented is commercialized by industry without prior consultation with the research units/university or the funding institution;
c) a “social service” orientation might clash with the commercialization process; and,
d) sometimes, research results that are deemed to have a financial value tend to be hidden and sold to private companies.

- The great majority of academics in both institutes prefer publication more than patenting.
- With the lack of formal processes at SUML (and only some are in place at MSI), the data seem to indicate that academics act on individual motivations and respond to the situation in the best interests of their ongoing projects and agendas.

5. Levels of trust

- At SUML, academics are not encouraged by their own institution and also by the industry which does not readily give out valuable insights.
- On the other hand, an academic at MSI said that he/she and his/her peers are willing to engage in a collaborative work with industry given certain conditions, i.e. as long as the latter acknowledges the important roles that the academics play in the development of a technology.

6. Available Resources

- Both institutions reveal that they share the common reliance on governmental funding. However, it is not surprising that being a part of a flagship institution, MSI gets more financial support from the government than SUML. At both institutions, there is a general support by the government ('top-down approach') during the initial research and development stages.
- Incentives or awards to both institutes coming from the government as well as other external resources are usually in the form of research grants. However, at MSI, academics are also involved in consultancy work.

Chapter 6. Conclusions and Recommendations

6.1. Conclusions

In this study, "knowledge transfer" as a construct is intertwined with technology transfer, meaning, the product/solution is not the only thing that is transferred but also knowledge of its use and application. This study has attempted to find out *how* and *why* knowledge is being transferred between two marine science research institutes and related industry in the Philippines. In the course of our work, we have identified a set of key factors that helped determine the level or degree of industry-academia interaction, as the outcome of the review of the existing literature in the topic. These 'factors' composed the conceptual framework used in the study, while operationalizing and analyzing the empirical findings gathered via questionnaires and document analysis. From a theoretical standpoint, analysis of previous studies across the Asian region where the Philippines is located, as well as across the world, have shown the relevancy of the Triple Helix Model in fostering an innovative environment consisting of university spin-off firms, tri-lateral initiatives for knowledge-based economic development, and strategic alliances among industry, government laboratories, and academic research groups (Etzkowitz, et al., 2000).

The following factors, acting as the *independent variable(s) of the study*, and encompassing the broader category of 'facilitating factors for knowledge transfer from academia into industry', were identified from the literature review:

- Type of industry that the institution collaborates with
- Institutional profile, organizational structure, and location
- Internal processes and routines
- History of the institution and its dominant academic culture
- Levels of trust (among university stakeholders and between university and industry partners)
- Available resources (financial and human)
- Key aspects constituting government policy
- Incentives for universities to engage with industry

As shown in this study, the above factors directly or indirectly affect the level or type of interaction between the university/research unit and industry, thus acting as the *dependent variable* of the study. We will outline the major findings related to the above factors by going back to the research problem and questions that this study attempts to answer:

In Chapter 1, we presented the main research problem of the study as being:

- *"How is knowledge being transferred between the (two) marine science research institutes (case studies) and industry, in the context of the Philippines?"*

As a means of operationalizing the above problem, we have also formulated the following research questions:

1. How do government policies affect/determine the collaborative arrangements between universities and industry on the one hand, and the marine science research institutes and industry on the other?

2. Why is it important for universities and their respective internal units to form collaborations with the industry?

3. What are the key factors facilitating knowledge transfers from academia to industry?

4. How can the relationship between university and industry in the context of marine science research in the Philippines be characterized? (e.g. what is the overall assessment? What are the main constraining barriers?)

In line with our first research question shedding light on the role of the government, especially when it comes to funding, this factor is very apparent in the collaborative arrangements between universities and industry in the Philippines. Both marine institutions, as well as the two universities (the University of the Philippines or UP and Silliman University) rely heavily on government funding. Although a private HEI, Silliman University gets funding from the government having been selected as a Center of Excellence (COE) in various disciplines. UP, on the other hand, acquires most of its budget from the government. At the institutional level, both UP and Silliman University get annual support from the government having been selected as COE and Center of Development (COD) in the marine science field, respectively. During the initial research and development stages, both institutions acquire a general support from the government, an indication of the top-down approach. However, there is also an indication of the ‘bottom-up’ approach of the Triple Helix, seen in the case of the establishment of the Science Park at UP, which, as Sardana and colleagues point out is better suited to bring about valuable networking for innovative efforts involving industry and academia (Sardana, 2006: 372).

As for our second research question regarding *why* it is important for SUML and MSI, the two research institutes analyzed, to collaborate with the industry (i.e. the rationale for collaboration) the findings can be summarized along three main points, namely: (a) to make universities’ work more relevant by linking academic work with real life situations, solving real (industrial) problems, and bringing in a dimension from the industry that pure academics lack; (b) to obtain financial support from the partner industries and gradually reduce its dependency on the government; and, (c) to give back to the external community by sharing its knowledge. Looking closely at these points, each represents the three core dimensions: (a) an academic/knowledge dimension, (b) a financial dimension, and (c) a social dimension. Moreover, each one of these dimensions seems to be fulfilling the interests of three types of stakeholders: (a) academics and industry, (b) administrators, and (c) external community/society at large.

At MSI in particular, there is a very strong orientation towards the usefulness of knowledge created at the university. This is shown in the designs of research proposals that have the general goal to arrive at results and recommendations with practical application in resolving issues/problems facing the local industry. As for the IEMS unit (at SUML), it has not been involved in any research efforts purely intended for commercial use as of yet, but overall, the SUML institute has had industry collaborations in place for several decades. The main barriers that we saw as to the lack of collaborations with the industry at IEMS may be explained by the structural elements of academia (i.e. value orientation and reward systems) where its outlook/orientation is that of science (i.e. inward and/or knowledge oriented) rather than the commercial aspect of the research (i.e. outward and/or financial oriented).

At the individual level, academics see potential conflicts among patenting, publishing and commercialization of ideas and this we also saw as we assessed their responses. But as viewed by one academic scientist (at SUML), it is possible for one to consider publishing and transferring knowledge into industry as two activities that are not separated, in the same manner that in studies like Sardana and colleagues', academics view commercialization of knowledge and publications as both important (Sardana, et al. 2006). Our overall assessment of the university-industry collaboration in the Philippines is that, both academia and industry can benefit from this collaboration (at least in the case of MSI where there are ongoing collaborations), as seen in the knowledge transfers from university to industry or vice-versa. While it was clear that knowledge transfer is not yet a normal daily activity at both institutes, at MSI this process seemed dependent on the individual academic's arrangement with the external partner.

When it comes to the ways in which knowledge is transferred (the 'how' question), the data reveal that this process is partly determined by the *size* and *age* of the institution since these two factors are likely to have an impact on the organization of activities, academic culture, and the interaction with the external environment. As indicated earlier, the university president at SUML encourages its faculty to undertake basic research. At the central administration at MSI, there is an evidence of strong support for the institute to engage with the industry. Direct collaboration with the industry was seen to be encouraged only at MSI, the bigger institute, but that state still plays a major role in the academia-industry linkage. The proposed establishment of the Science Park in UP Diliman showcased initiatives in which the state develops strategies for economic development and involves both university and industry as key stakeholders. While there was not enough evidence in the study that government policies directly affect the activities of the marine institutes and the industry, it is clear in this example that government policies partly affect/determine the collaborative arrangements between university and industry. These findings are an evidence of the Triple Helix in practice in the Philippines.

In terms of intellectual property rights (IPR), it was seen that this has been more institutionalized at MSI than at SUML, having recently developed guidelines. At SUML, there is only a general awareness of the need to assist scientists in terms of IPR. At the university level, the UP System has set up a technology licensing office with an effort from the university to formalize IPR-related issues and regulations, areas that have not yet been fully institutionalized at Silliman University.

Overall, and in retrospect, the marine scientists included in this study tend to focus on their research efforts, not on its commercialization. Although this study restricts its analysis to *only* two marine science institutes in the country, it nonetheless sheds light on the ongoing interactions among university-government-industry in the Philippines, as well as the way in which other marine science-related interactions are being developed, maintained, and strengthened. Furthermore, this study also dealt with the types of barriers faced by the institutions. For example, a smaller, private institute like SUML (as compared to that of a flagship institution, MSI) is facing a slightly different set of issues when it comes to university-industry relations. Since very few studies have examined the institutional strategies and polices to increase the process of knowledge transfer from academia, our study provides an initial contribution to narrow this existing knowledge gap, particularly in the context of the role undertaken by higher education institutions in the Philippines. Thus, this study hopes to stimulate future research efforts aimed at scrutinizing the role of the university in the process of knowledge transfer to the outside world, not only in the field of marine sciences but across all the disciplines capable of contributing to the country's social and economic development.

6.2. Recommendations

In light of the findings and conclusions we have drawn from the study, we now present a few strategic recommendations to the study's main stakeholders or audiences:

To policymakers:

- While it is seen in the two case studies that the government is not totally in control of the universities, there is still a need to strengthen the funding base. Universities can still improve on their strategies in reaching out to industry since the latter is a key actor in providing alternative sources of funding. The move should be towards the proper coordination and integration of both top-down (state) and bottom-up (institutional) policies.

- Empirical data coming from both this study and the existing literature suggest that university and industry exist for different purposes and they have different outlooks/orientations. What might work best for the coordination of university and industry in the Philippines is the establishment of intermediary organizations such as technology licensing offices (TLOs). The common partnerships that we have are those of companies recruiting new graduates or researchers receiving grants to collaborate with industry. These partnerships are beneficial, but if not for mediators such as TLOs, they might be excluding small and midsize as well as start-up companies in the collaborations.

To managers and administrators of higher education institutions:

- Industry collaborations pave the way to new source of funding for universities. At the institutional (universities) level it might be helpful to look at possibilities for industry collaborations. Furthermore, changing or improving the administrative core, developing an outreach structure, and diversifying its income streams (Clark, 1998) might instill in the institutions an all-university culture of transferring knowledge.
- As for Intellectual Property Rights (IPR) and as far as the two cases are concerned, whereas in the case of MSI, which has recently developed guidelines on IPR what must follow is the application of these guidelines. In the case of SUML, there is still a need to set up a patenting and licensing office and formulate IPR guidelines. Based on this study, we believe that an internal unit responsible for IPR will encourage institutions to interact more with industry, under the assumption that their work will be safeguarded.
- Lastly, while *publication* and *patenting* (two knowledge transfer channels) activities are important, focusing on them would neither enhance nor bring about the commercialization of knowledge. The results of this study reveal that there is a need for a ‘holistic approach’ of academia-industry interaction consisting of a variety of channels and involving the whole of the institutions, from central administration to the faculty to the research unit/institute. There is also a need to adapt traditional academic values (Clark, 1998) to the new realities facing HEIs and the (national/regional) communities surrounding them.

Our final message is addressed to HE researchers and other social scientists (both in the Philippines and overseas). While designing and undertaking such studies, other types of interactions must be taken into account in the evaluation of industry–university relations, such as technology transfer. Here we refer to “technology transfer” not in the manner we referred to it in this report, not as one intrinsically linked to “knowledge transfer,” but as an advanced and a more complex process. Such may be feasible if looked from the point of view of big, private HEIs that have formal technology transfer processes in place. We never underestimated the role of other types of interaction but because of limited time and resources we were able to focus only on research contracts and patents, to name but a few. It would be interesting to actually look into not just the process of developing a product but the commercialization process (industry-focused) itself. It might also be worthwhile to look at the fundamental roles of universities in regional innovation systems (urban, provincial city or rural) and the factors explaining the variation in the roles (Gunasekara, 2006: 106).

From a conceptual/theoretical perspective, and given the limited scope of this study, in our opinion the Triple Helix has been rather useful to this study, especially as it highlighted the role of the government in fostering university-industry interactions. But given that the model might be limited if used in areas as exploring complex processes, it may be worthwhile to partner Triple Helix with similar approaches, e.g., alternative innovation models, this time not to look at how university-interactions are encouraged, but to look deeply at the barriers to industry-university interactions and how to address them.

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https://www.cia.gov/cia/publications/factbook

Commission on Higher Education, Philippines. Online at:
http://www.ched.gov.ph

Department of Budget and Management, Philippines. Online at:
http://www.dbm.gov.ph

Department of Science and Technology Media Service, Philippines. Online at:
http://dostweb.dost.gov.ph/media/article.php?sid=51

Department of Trade and Industry, Cebu Provincial Office. Online at:
http://www.dticebu.net.ph/03_a_04.html

The Forum Roundtable on Brain Drain in Philippine Education. Online at:
http://www.up.edu.ph/upforum.php?i=95&archive=yes&yr=2005&mn=7

The International Comparative Higher Education Finance and Accessibility Project
http://www.gse.buffalo.edu/org/inthigheredfinance/region_asia_Philippines.html

Marine Science Institute – University of the Philippines. Online at:
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Philippine Association of Marine Science Inc. Online at:
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Republic of the Philippines – Asian Development Bank Poverty Partnership Agreement. Online at: http://www.asiandevbank.org/Documents/Poverty/pa_phi.pdf

Silliman University Marine Laboratory. Online at:
http://su.edu.ph/marinelab/index.html

Southeast Asian Ministers of Education Organization - Regional Institute of Higher Education and Development. Online at: http://www.rihed.seameo.org

The United Nations Population Fund. Online at:
http://www.unfpa.org/focus/index2.htm

World Bank. Online at:
http://www.worldbank.org

Appendix

Appendix 1: Interview Guide

Questions for Academics

On the "commercialization" of ideas and/or knowledge transfer

1. Please rank how important it is for your research unit to develop collaborative relationships with industry while developing new commercial products and/or solutions to certain problems.

Please tick one.

Very important	Somewhat important	Not important	Not important at all

Please explain your selection.

2. How does the above process (positively/negatively) affect your daily academic activities?

3. Do you see any conflict between commercialization of research/patenting and publicly available academic results/publications? If yes, in what way?

4. How willing are your academic peers in engaging with industry, and why so?

5. Personally, which activities do you value more - publishing in peer-reviewed science journals or transferring knowledge to the industry? Why is it so?

Partnerships with the industry

6. Please discuss the partnerships that your institution has with the industry in terms of a) How many partner firms do you currently have? b) When did these partnerships start and how long have they been going on? c) How readily do corporations give out valuable insights (e.g. on the product, patents)? d) Does the government/university have control over these arrangements? e) What is your overall assessment of the partnerships with industry? Can you refer to a 'positive' and a 'negative' story/experience you may have had?

7. What, in your opinion, are the key challenges for an academic institution like yours in engaging in partnerships with the industry?

8. How does applied knowledge in the context of the partnership with industry contribute to the development of basic (academic) knowledge?

9. Would you say that partnerships with the industry have a major contribution to the improvement of your research projects? Why or why not?

10. How does your research center integrate industry relations in the course of your normal academic activities (e.g. internships for students at the industry partner, sabbatical period for researchers at industry labs, visit of industry-based researchers to academic labs, seminars, etc.)

Should you wish to say more about the institution's interaction with the industry that was not covered by these questions, please feel free to add comments.

Questions for Head of Research Center (Also an Academic)

University patenting and knowledge transfer

1. Does your unit have any processes in place in order to help scientists in the following tasks: (a) guiding them in writing patents, (b) educating them in patent laws, (c) filing of patents, (d) negotiating for transferring of technology, etc.? Overall, how much support (financial/non-financial) does your unit get from the university and/or faculty administrations? Please discuss.

2. Is your research institute willing to spend money on patents? Do you get the support of your industry partners in covering this cost? What is the average cost of patenting a certain product and who covers what?

3. How is the basic knowledge originated at your center and from the university as a whole, transferred into the commercial products/solutions (i.e. innovations) of your industry partners on one hand, and the market/society in general on the other? (e.g. company formation, licensing, students working in firms, etc.)?

4. To what extent have the rules, procedures and routines regarding knowledge transfer been formalized? (e.g. if you have a technology transfer office, hold yearly conferences, etc.)

The institution and its scientists

5. What types of incentives (financial/non-financial) does your research institute provide to scientists who respond to a commercial opportunity (e.g. collaboration with firms to develop new products/solutions)? In what form is this incentive awarded? (e.g. research grants) What is the role played by both the university and the faculty in such collaborations?

6. How participative are the scientists at your research unit in the commercialization of ideas? What are the positive and negative experiences from this involvement?

7. How important is the support (overall willingness to collaborate) by individual academics in the processes of knowledge transfer from academia to industry?

Partnerships with the industry

8. Please discuss the partnerships that your research unit has with the industry in terms of a) How many partner firms do you have? b) When did these partnerships start and how long have they been going on? c) How readily do corporations give out valuable insights (e.g. on the product, patents)? d) What is the role played by the government in these arrangements? e) What positive and negative experiences have you gained from these partnerships (provide concrete examples)?

9. What, in your opinion, are the major challenges (barriers) facing a research institution in the marine sciences in the Philippines with respect to industry partnerships? What do you think are the areas that need improvement, and how?

10. How much financial support does your research unit get from the university/faculty as well as government? Do you think that the technology transfer infrastructures of (name of institute) are economically self-sufficient to create and maintain partnerships with the industry, without relying too much on the industry partners themselves?

Should you wish to say more about the institution’s interaction with the industry that was not covered by these questions, please feel free to add comments.

Questions for the Director

Government Policy

1. How did the establishment of the Zonal Research Centers in the year 2000 affect your activities with the industry?

2. Describe in terms of percentage how much support the center gets from the government and other sources. What are these other sources?

3. What incentives (financial/non-financial) does the government give to research institutes like yours that respond to a commercial opportunity (e.g. collaboration with firms to develop new products)? In what form is this incentive awarded? (e.g. research grants)

4. In your own opinion, to what extent is the government, in its policies, supportive of the partnership between university and industry in the context of marine science (e.g. does it have initiatives for knowledge transfer)? What other institutions, either national or supranational (e.g. regional) support the engagement of research units at universities with the industry?

Students

5. Does your research institute provide students with alternative career options during and after graduation, (e.g. help them establish their own company on the basis of their research)? If so, what arrangements are currently in place?

6. What other formal processes are currently in place regarding the facilitation of knowledge transfers from your research institute to industry? e.g. a business incubator; traineeships for students, seminars with industry, technology transfer office, venture capital, alumni relations, etc.

7. Where do your graduate students go after their studies (private/public sector, overseas, own companies, etc.)? How easy is it for the institute/faculty to keep itself attractive as a career choice for talented scientists in the marine sciences?

The institution and its scientists

8. In what way is the institute's academic staff taking professional advantage of the partnerships with industry (e.g. do they engage in consultancy, spin-off firms, etc.)?

9. To whom are the intellectual property rights (IPR) of a research awarded, to the inventor or to the university? To whom are the property rights awarded in case of knowledge generated out of university-industry relations?

10. What types of legal and administrative frameworks (arrangements) are in place at your institution (university/research institute) with regard to IPR of marine science research findings generated internally? Do you find the existing framework adequate? Why or why not?

11. How much support does your research unit get from the university administration? How willing is the university as a whole (e.g. as its strategy) to collaborate with industry?

Should you wish to say more about the institution's interaction with the industry that was not covered by these questions, please feel free to add comments.