Research Studies on Tertiary Education Sector

Strategies to Develop University-Industry Linkages in Sri Lanka

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Executive Summary

This report documents the results of a study conducted to examine the present status of university industry (U-I) interaction in Sri Lanka. The study presents the academic and university perspective of university industry interactions with emphasis on types of interactions, barriers to successful interactions and promotional measures to improve U-I interactions**.**

The common types of U-I interactions were limited to what can be regarded as conventional types as the predominant types of university interactions with industry consisted of consultancies and training programmes while the predominant types of interactions by the industry with the universities consisted of university student internships, informal contacts with academics and attendance at seminars, symposiums, workshops and conferences. It was found that Engineering related departments to be having more interactions compared to other discipline based departments. As expected the least U-I interactions were found among Humanities based departments.

Both academics and industrialist identified lack of proper procedures, mechanisms and conducive structure for collaboration as important barriers hindering U-I interactions. Moreover, from the view point of the academics other prominent barriers to U-I interactions were lack of time due to heavy workload and lack of laboratory facilities to carry out research and development work for the industry, while the industry cited low commercialization potential of university research and lack of interest among academics to collaborate with industry as other prominent barriers.

Among the key suggestions to improve U-I interactions include setting up of an effective procedures and mechanism to facilitate U-I interactions, making more funds available to upgrade laboratory facilities and offer more opportunities to students and academics to visit the industry.

Finally the report, presents a practical U-I interaction model capable of overcoming the major issues raised by both the academics and industrialist.

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1. Introduction

1.1 Background

In the context of globalization, knowledge and technology innovation are increasingly recognized as sources of global competitiveness and economic development. The significance of university-industry interactions has become very important on the agenda of higher education policy-making, at both the national and institutional levels. Within the context of knowledge intensive economies, governments are increasingly aware of the importance of higher education institutions as strategic actors in both national and regional economic development, given their potential to upgrade skills and knowledge of the labour force and contribute towards producing and processing innovation through technology transfer.

Collaboration provides industry with the means by which to have access to advance technology and know-how at a lower cost and with less inherent risk as universities possess a large pool of expertise. The universities can benefit through additional public and private funding for research and development and new income through patenting and licensing thus create a win-win situation for both the universities and industries.

The topic of university-industry interaction is not new, but since the 1970s it has become more formal, frequent, and planned. It has also aroused a growing interest in governments and policy makers, from both developed and developing countries, who still regard it as an under-utilized scientific technological resource (Vedovello, 1998). Though late, the importance of university-industry interactions has received the attention of higher education policy makers in Sri Lanka. However, despite the recent interest on this topic there is lack of research in Sri Lanka to facilitate policy formulation. Therefore, this study is undertaken to address this knowledge gap in university-industry interactions in Sri Lanka.

1. 2 Objectives

The broad objectives of the study are to examine the present status of university-industry interactions and make recommendations to develop sustainable interactions. The specific objectives are as follows:

1. To examine the characteristics and operational structures of existing university-industry interactions;
2. To examine the potentials and constraints in establishing sustainable university-industry interactions;
3. To identify the conditions necessary for establishing sustainable University-Industry linkages;
4. To identify the role of the State and trade associations in facilitating university-industry interactions and
5. Based on the findings to propose strategies and models for university-industry interactions in Sri Lanka.

1.3 Scope of the Study

This study focuses on the present status and issues associated with University-Industry interactions in Sri Lanka. The study presents the academic and university perspective of university-industry interactions with emphasis on types of interactions, barriers to successful interactions and promotional measures to improve interactions. The study concludes with recommendations for action by various stakeholders including university, Industry and government. The report is intended, to be a guide to policy makers, academics and industrialist interested in developing sustainable partnerships between universities and industry.

1.4 Structure of the Report

The report is structured as follows. The next chapter consists of a comprehensive literature review on university-industry interactions. The chapter 3 contains a summary of the methodology used for the study. The chapter 4 presents the university perspective of university-industry interactions. It mainly consists of type of interactions with industry, importance of interaction, barriers to interaction and suggestions for improvement of interactions. The 5 chapter covers the perspective of the industry and contains the same topics as chapter 4. Finally, in the chapter 6 conclusions of the study and recommendations to develop sustainable university-industry interactions are presented.

2. Literature Review

2.1 Introduction

In the context of globalization market place is undergoing rapid changes in competition, technological advancement and a shift to knowledge based economies. Against this background importance of knowledge as a competitive weapon has increased dramatically (Dierdonck, 1990). Research enables advancement in knowledge and technology and thereby creates an environment conducive for innovation which is considered as the driving force behind economic development. Universities are known to be centers of wisdom capable of backing a countries innovation system.

The rapid technological changes and competition has made it necessary for industry to collaborate with university. This has enabled them to combine their efforts to foster the diffusion of knowledge and innovation within national innovation system.

In view of industry, the specific reasons for collaboration with university research centers are considered to be lack of in-house R&D, shortening product life cycle, cutback in R&D budgets, and changing nature of research priorities. University research centers also want to collaborate with industry as they increasingly need find new ways of generating income as the government intents to reduce R&D fund. It was also discovered that firms enter into university– industry relationships to gain access to students as potential future employees and to aid on product development (Links and Rees, 1991).

This chapter outlines the role of universities in the knowledge based society from the view point of the Triple helix model. Then a model is put forward based on literature on evolution of university-industry (U-I) interactions. This is followed by comprehensive discussion of technology transfer which includes background of technology transfer, the process of technology transfer, the mechanisms and advantages. Finally, some best practices of U-I interactions drawn from literature and some issues inhibiting U-I interactions are presented.

2.2 Role of the University in the Knowledge based Society

Universities play three major roles within an innovation system. First, they undertake a general process of scientific research and thereby affect the technological frontier of industry over the long run. Secondly, they partly produce knowledge which is directly applicable to industrial production (prototypes, new processes etc.). Thirdly, universities provide major inputs for industrial innovation processes in terms of human capital, either through the education of graduates, who become industry researchers or through personnel mobility from universities to firms (Schartinger et al., 2002).

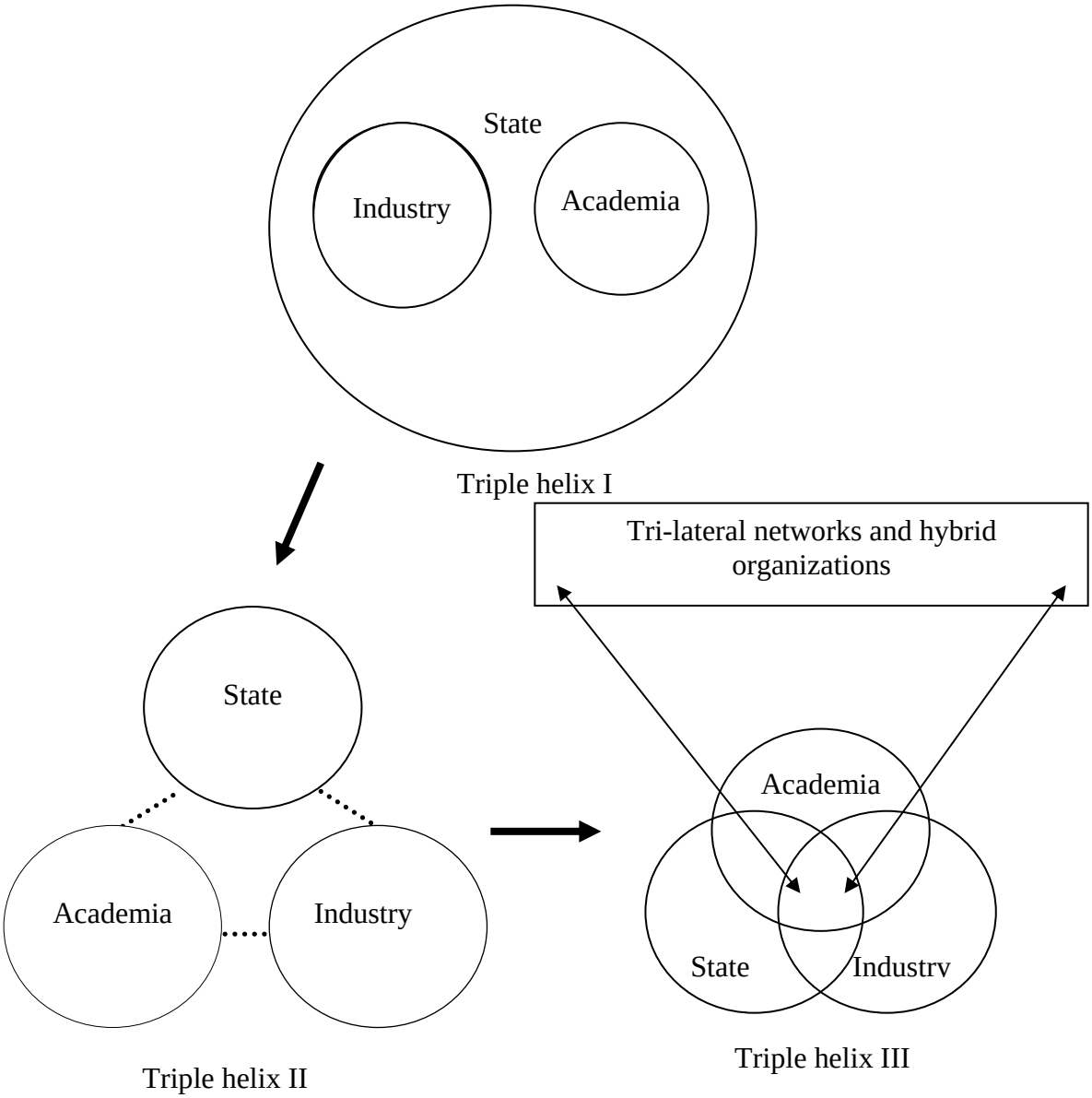

Figure 1: Triple Helix Models of University–Industry–Government Relations
Source: Etzkowitz and Leydesdorff (2000)

A group of scholars including Etzkowitz and Leydesdorff (1997, 1999 & 2000) states that the university can play an enhanced role in innovation in increasingly knowledge-based societies through forming direct links with industry to maximize "capitalization of knowledge", and that academia should be closely integrated with the industrial world. This view is referred to as the "triple helix" thesis. In the triple helix model (Figure 1) interaction among university, industry and government the three equal interdependent institutional spheres are said be the source of innovation and development. There types varying institutional arrangement of university-industry-government relations are presented by the triple helix thesis.

First, labeled as triple helix I in which the state encompasses academia and industry and directs the relations between them. The strong version of this model could be found in the former Soviet Union and in Eastern European countries under ''existing socialism'' (Etzkowitz and Leydesdorff, 2000). Secondly, triple helix II, consisting of separate institutional spheres where government, university and industry operate apart from each other. In this model the university provides basic research and trained persons. It is expected that firms in an industry should operate completely apart from each other in competitive relationships, linked through the market. Government is limited to addressing problems that can be defined as market failures, with solutions that the private sector cannot or will not support. The Sri Lankan situation is comparable to the triple helix II. Thirdly, triple helix III, consisting of overlapping, relatively independent, institutional spheres with hybrid organizations emerging at the interfaces. Triple helix I is viewed as a failed model as it discourages innovation rather than encourage. Triple helix II is seen as a way to reduce the role of the State in triple helix I.

Most countries and regions are presently trying to attain some form of Triple Helix III, with its university spin-off firms, trilateral initiatives for knowledge based economic development and strategic alliances among firms (large and small, operating in different areas and with different levels of technology) government laboratories and academic research groups.

2.3 Development of Interactions

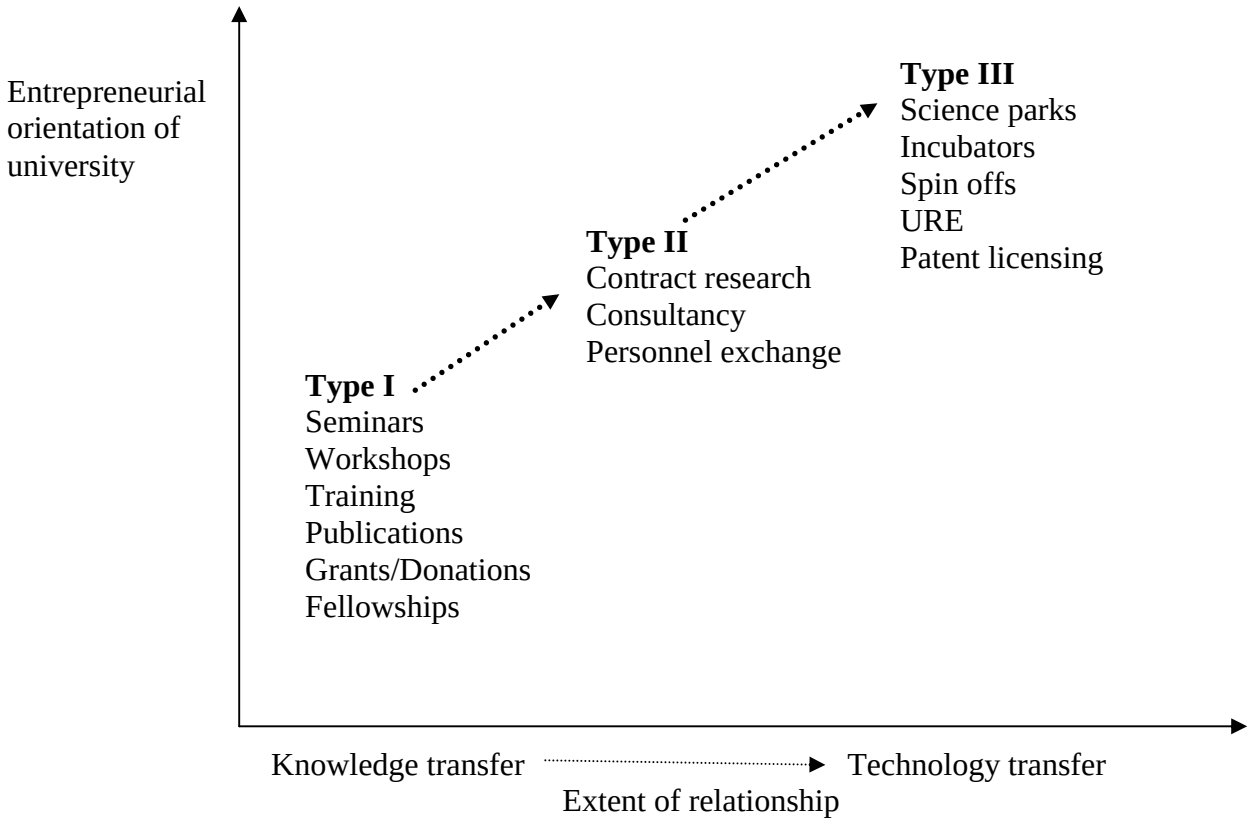

Figure 2: Typology of University-Industry Interactions

University-industry interaction cover a wide range of relationships that includes seminars, workshops, training, contract research, consultancy, spin-offs and many other interactions. As depicted in Figure 2, based on literature these interactions can be characterized along two dimensions, the strength of relationship between university and industry and the entrepreneurial orientation of the university into three major types namely type I, type II and type III. Entrepreneurial orientation is considered as a dimension due to transformation of the traditional role of universities from teaching and research to a step forward to be reckoned as entrepreneurial where economic development is integrated into the university along with teaching and research (Etzkowitz 1998).

Type I interactions are the initial stages of developing interactions and are basically short term relationships used as channels to transfer knowledge to the industry. These relationships generally involves research grants, donations for equipment and facilities, fellowships, scholarships and short-term modes of

information exchange such as university sponsored training programs, symposia and technical publications. This relationship creates an atmosphere for mutual understanding between the two parties.

In Type II, more intricate relationships generally have medium-term duration of approximately one to three years. In these interactions direct relationships are established with academic researchers through sponsored research and faculty consulting.

Finally, in Type III**,** university-industry technical cooperation spans many years and involves science parks, industrial incubators and similar arrangements involve the location of company facilities in the physical proximity of the university. This provides opportunities for both parties to closely interact over an extended period.

2.4 Technology Transfer

Traditionally, universities have been reckoned as the place of invention, education and research (Wallmark, 1997; Mian, 1994) while industry is the home of innovation, thus creating a kind of distinction. But, with the present trend, this is no longer the case as it has become clear that academics and industry must necessarily cooperate to bring about necessary development. The new university functions have been described (Etzkowitz and Leydesdorff, 1997) as the translation of knowledge into economic activity alongside research and teaching. A parallel can be found with this evolutionary process of the role universities and evolutionary process of technology transfer as examined by Matkin (1990) in the USA. He explains that traditionally the strong link between universities and industry has been established through “knowledge transfer”. That is, “knowledge” is transferred to the commercial world through the education and graduation of students, the publication of the results of research for use by scientists and practitioners, and the consultation of faculty members by industry. The late 1970s witnessed the set of activities labeled by Matkin as “technology transfer”, namely patent policies and administration, equity ownership in research-based companies, industrial liaison programs, and regional economic development including incubators and technology parks.

Technology transfer can be defined generally as the transfer of a technology, technique, or knowledge that has been developed in one organization and then

transferred to another where it is adopted and used (Melkers et al., 1993). In the context of this study it is the university which develops the technology and transfer to a firm in the industry.

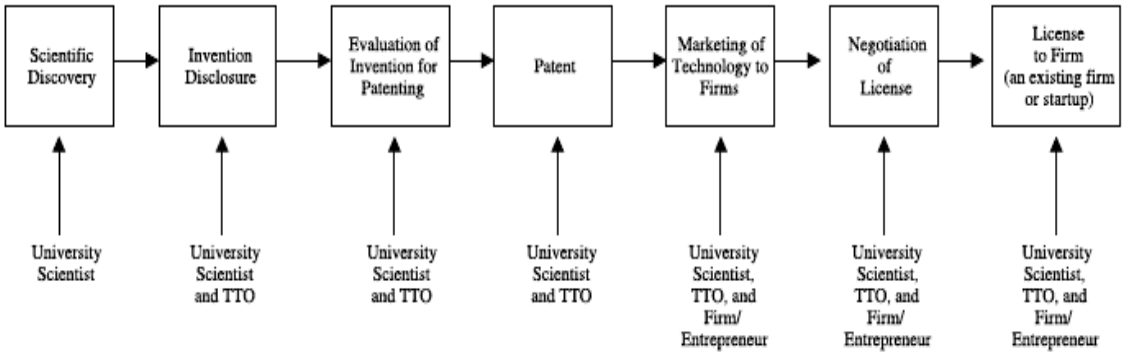

Figure 3: Typical technology transfers from university to firm

Source: Siegel (2003)

Technology transfer can take place within or across firms through movement of employees from one division or one country to another. However, the focus of this study is on commercial transfer of scientific knowledge from universities to firms. A typical technology transfer process is shown in Figure 3. The process begins with a discovery by a university academic. Then the scientist files an invention disclosure with the Technology Transfer Office (TTO) of the university. The TTO evaluates the commercial potential of the technology and decides whether to apply for a patent. One the patent is obtained the technology is marketed to a firm. This is followed by negotiations to finalize a licensing agreement. Finally the technology is converted into a commercial product.

2.4.1 Role of Technology Transfer Office (TTO)

The role of the TTO is to facilitate commercial knowledge transfers through the licensing to industry of inventions or other forms of intellectual property resulting from university research. The technology transfer office can be instrumental in developing relations with an industry. A dedicated transfer unit allows for specialization in support services, most notably, partner search, management of intellectual property, and business development (Stadler, 2007).

2.4.2 Technology transfer mechanisms

Different mechanisms can be applied in technology transfer between university research centers and industry according to their motivations and available resources.

Consultancy and technical services provision

One or more parties from the university or research center provide advice, information or technical services. They have formal written contract, generally short term and specific. Faculty members or senior researchers can be hired to consult during the time they are allowed to work outside the universities.

Joint venture of R&D

A contract is drawn between university research center and a contractor in which costs associated with the work are shared as specified in the contract. The two parties can work together from the stage of R&D to commercialization. It must be of mutual benefit to industry and the research centers, and commercially valuable data may be protected for a limited period of time. It provides some assurance that the best brain in the business will be brought together to bear on the problem, and that there will be a balance between long term, high risk research and short-term work which can be promptly commercialized (Moses, 1985).

Cooperative R&D agreement

This is an agreement between one or more university research laboratories and one or more firms under which the university side provides personnel, facilities, or other resources with or without reimbursement. The industrial parties provide funds, personnel, services, facilities, equipment, and other resources to conduct specific research or development efforts that are consistent with the laboratory's mission.

Licensing

Licensing is the transfer of less-than-ownership rights in intellectual property to a third party, to permit the third party to use intellectual property. It can be exclusive or non-exclusive and is preferred by small business. The industry as a potential licensee must present plans to commercialize the invention.

Contract research

It is a contract between a research center and a firm for contract R&D to be performed by the research center. Industry usually provides funds, the university provides brains with the time frame ranging from a few months to years. Through contract research, the industry wants to utilize the unique capability of the research centers that works for commercial benefit.

Spin-offs

An entrepreneurial spin-off arises when an entrepreneur leaves an organization to start a firm of her/his own. To be a spin-off, this must also include the transfer of some rights, e.g. knowledge, from the existing organization to the new firm. Spin-offs can be categorized depending on what organization they are spun off from, and on where the entrepreneur has gained her/his background experience (Perez and Sanchez, 2003). Spin-offs from academic institutions have received a lot of attention in recent times especially in hi-tech city clusters. Technologies developed in the institutions are commercialized through new enterprises wherein students and faculty may participate (Basant and Chandra, 2007).

Science Parks

Science parks have become a popular mechanism to promote university-industry interactions. There is no uniformly accepted definition of a Science Park, and there are several similar terms used to describe similar developments, such as “Research Park”, “Technology Park”, “Business Park”, “Innovation Centre”, etc. (Monck et al., 1988). United Kingdom Science Park Association (UKSPA, 1985)

defines a science park in terms of the following features: ‘‘A science park is a property-based initiative which: has formal operational links with a university or other higher education or research institution; is designed to encourage the formation and growth of knowledge-based businesses and other organizations normally resident on site; has a management function which is actively engaged in the transfer of technology and business skills to the organizations on site.’’

The first science park was established in Stanford, CA, in the 1950s followed by the Cambridge Science Park, UK, and Sophia Antipolis, France, in the late 1960s. In many European countries it was not until the 1980s and 1990s (UK included) that significant numbers of science parks were established (Storey and Tether, 1998).

Firms located in Science Parks were significantly more likely to have a link with a local university than off-park firms (Löfsten and Lindelof, 2002). Studies have shown a direct relationship between the proximity of the science park to the university and the probability that the academic curriculum will shift from basic toward applied research.

2.4.3 Advantages of technology transfer

The advantages of technology transfer accrue to both the major stakeholders the university as well as the industry.

Advantages to university and its research centers (Sanchez, 1995)

The advantages could be listed as follows:

- the opportunity to access the needs of the economy and to develop its activities accordingly through income from the sales of technology;
- the opportunity to place students in industry so that classroom learning can be related to practical experience;
- access to industry for both fundamental and applied research;
- access to the protected markets;
- business stature enhancement;
- improvement in new technology implementation;
- creation of goodwill;
- new product development and spin-offs;
- cost savings (lower production cost);

- patenting.

Advantages to industry (Sanchez, 1995)

The following are the advantages to the industry:

- a supply of better qualified graduates having more relevant training because industry's needs have been identified;
- access to a variety of post-experience training facilities it has helped to design;
- access to the university's physical facilities and the expertise of its staff;
- access to research, consulting and data collection of the university;
- an improved public image in the society in which it operates, which means that more talented students will be attracted to the industrial sector;
- gained technical knowledge;
- gained technology services not available before;
- quality improvement;
- cost savings;
- new markets;
- manufacturing and lead time reduction.

2.5 University- Industry Interaction Best Practices

2.5.1 Technology transfer in China

An overview of technology transfer at Tsinghua University which is one of the leading state universities in China would throw light on some of the best practices of technology transfer in China (Liu and Jiang, 2001).

This university has taken following measures to pursue technology transfer.

1. Establishment of the University–Industry Cooperation Committee of Tsinghua University (UICCTU)

Number of large Chinese and multinational companies including IBM, Siemens, Motorola, Hitachi, and NEC have joined this committee. The university provides various services for the member companies such as dispatch of special liaison officers to the companies and the formation of liaison networks between the

university and the companies, the circulation of R&D information and the collection of information on demands from member companies, the establishment of R&D and training centers with the companies, the direct training of senior staff for the companies or training through other means such as information technology, distance learning etc.

2. Technology transfer through collaboration with local governments

Tsinghua University has signed collaborative contracts with eight provincial and municipal governments, the collaborative contracts contain three main contents.

a. The transference of new technology to enterprises with local governments as the medium this involves improving communication between university and enterprises governed by local governments.

b. The establishment of R&D risk investment foundations in collaboration with local governments.

c. The establishment of technology transfer bases in collaboration with local governments. These bases play the role of incubation centers for new technology, distribution centers for R&D information and training centers for specific technicians.

3. Establishment of high technology companies in partnership with enterprises

High technology companies are established by enterprises contributing capital and universities investing in technology and become a shareholder by converting technology into capital. This method can solve the problems of both benefit sharing and the protection of intellectual property rights.

4. Building-up a Science and Technology Cooperation Network of Chinese Universities

The Tsinghua University with six other universities and the Science and Technology Development Centre of the State Education Commission set up this network. It is an inquiry system for information about research findings and

enterprise demands, built on the Internet. Its purpose is to build a bridge between universities and enterprises to improve the transfer of R&D results.

5. Collaboration with enterprises

The Tsinghua University has been highly successful in joint collaboration with enterprises. In 1998, about 43% research funds of the university came from collaborative projects with enterprises.

2.5.2 Best practice in European Union

K.U. Leuven Research & Development (LRD) Belgium

K.U. Leuven is the oldest and largest university in Flanders and Belgium. The technology transfer mission of K.U. Leuven is attained through K.U. Leuven Research and Development (LRD) which deals with contract research, patents, spin-offs and research parks. LRD has been identified as best practice in the EU benchmarking exercise. Being embedded in the largest university in the Belgian Innovation System, K.U. Leuven Research & Development (LRD) was founded in 1972 to manage the industry component of the university's R&D portfolio. LRD has considerable autonomy to mange their finance, physical resources and infrastructure. LRD organization structure is composed of research divisions. Researchers belonging to different faculties and departments at the university join force to integrate the commercial-industrial component of their knowledge portfolio in a research division at LRD. As a consequence, the research division concept introduces a "de facto" interdisciplinary matrix structure within the university. Today there exist 46 divisions, supported by about 220 faculty members and employing about 600 researchers and support staff, scattered across the various faculties and departments of the university. The LRD adopts a dual incentive mechanism LRD divisions are entitled to accumulate financial reserves based on the benefits they generate via industry science links. The decentralized method that exists within LRD therefore acts as an incentive mechanism in and off itself.

LRD divisions furthermore are entitled to participate both intellectually and financially in the spin-off companies that they have grown and developed. Finally, besides the aforementioned financial incentive mechanism at the level of the research division, incentives are given to individual researchers as well. Three types of incentive mechanisms at the individual level exist. First of all, researchers are entitled to salary supplements based on the net proceeds from their contract research and consultancy activities. Second, in case of lump sum and royalty payments proceeding from licensing agreements, individual researchers are entitled to receive up to 30% of the income generated (after expenses have been recuperated). Third, in case of spin-off creation, individual researchers can receive up to 40% of the intellectual property shares in exchange for the input of their know-how and goodwill (see Debackere and Veugelers, 2005)

2.5.3 Entrepreneurial university model

As argued by Etzkowitz (2000), universities around the world are increasingly shifting from their traditional primary role as educational providers and scientific knowledge creators to a more complex ‘‘entrepreneurial’’ university model that incorporates the additional role of the commercialization of knowledge and active contribution to the development of private enterprises in the local and regional economy. This can be called as the second revolution in which universities incorporates economic and social development as part of their mission (Etzkowitz, 1998). The first academic revolution transformed teaching university to research university and the second revolution has transformed the research university to entrepreneurial university.

The case of National University of Singapore (NUS) is used as a case study to illustrate the shift towards an entrepreneurial university. NUS has in the past been following the traditional model of having teaching as its primary mission, with research as a secondary function. While the 1980s and 1990s saw increasing emphasis on research. The major impetus for change came in the late 1990s, when a new division with view making the university more entrepreneurial was created that has come to be known as NUS Enterprise. After some early experimentation, NUS Enterprise began to take shape and introduced a number of major initiatives to reform university policies with respect to governance of technology

commercialization, and to inject a stronger entrepreneurial element in university education.

NUS enterprise took over functions involving knowledge commercialization, including technology licensing and industrial sponsored research, consulting, continuing education, and publishing. It also took over and revitalized the university- wide Entrepreneurship Center that has educational, research as well as other promotional functions related to entrepreneurship. The NUS enterprise introduced two new units: (i) a Venture Support unit to provide focused assistance to faculty, students, and alumni engaging in new venture activities; and (ii) an Overseas College Program (NOC) to launch new experimental programs in international entrepreneurship education. Among the key initiatives introduced by NUS Enterprise is the re-organization of the technology licensing office to make it more ‘‘inventor friendly,’’ with less emphasis on maximizing licensing revenue, and greater focus on getting greater deployment of NUS technology to the marketplace, whether through licensing to existing firms or spinning off new firms. Through the new Venture Support (NVS) unit, a number of new programs were launched to provide assistance to NUS professors and students to commercialize their inventions and knowledge. These include the provision of Incubator facilities on campus and in the Silicon Valley, and the establishment of a seed fund that provides very early stage seed funding to NUS spin-off companies. A separate student start-up fund was also established to provide smaller seed funding to new ventures started by students.

In terms of education programs, the new Entrepreneurship Center established within NUS Enterprise was tasked with the mission to significantly expand the teaching of entrepreneurship courses to all students on campus, particularly students in engineering, computing and science. A technopreneurship minor program was introduced that can be taken by any undergraduate student.

Under the NOC program, NUS began a program to send its brightest undergraduate students to five entrepreneurial hubs in the world to work as interns in high-tech start-up companies for one year, during which they would also take courses related to entrepreneurship at partner universities in each of the region. In essence, the NOC program represents an experiment in learning entrepreneurship by ‘‘immersion,’’ i.e., by immersing the student as an ‘‘apprentice’’ in a high-tech start-up or growth enterprise in a foreign location to expose them to the tacit

aspects of entrepreneurial practice and foreign business culture (see Wong, et al., 2007)

2.6 Some Issues Inhibiting University Industry Interaction

The barriers to university-industry interaction discussed in this section are certainly not exhaustive, it does represent some of the more frequently cited issues inhibiting a more productive collaboration between universities and industry.

Universities and industries are two different social entities as a result they differ considerably in the nature and objectives of their activities. These dissimilarities (Table 1) create friction between the two entities and limit their interactions.

One important barrier that has been widely discussed in literature is the inevitable cultural difference (Decter et al., 2007, Barnes, 2002, Cyert, 1997, Siegel, 2003) arising due to these differences. Cultural barriers are pervasive in U-I interactions, given that stakeholders operate under diverse organizational environments and have different norms, standards, and values (Siegel, 2003). Firms typically do not want researchers to publish their results and share information with colleagues and the general public. Instead, they view technology as something to be kept proprietary and used for strategic advantage in the pursuit of profits.

Table 1: Difference between Academic and Industrial Research

Typical aspects	University	Industry
Focus of the R&D	Basic research; curiosity-oriented	Applied research; exp. develop.
Basic rationale	Advance knowledge	Increase efficiency
Aim	New ideas	Profits
Characteristics	Idea-centered	Practical, product-centered
Framework	Open	Close, confidential
Evaluation	By peers	By the boss
Schedule	Open-ended	Tight, predetermined
Recognition	Scientific honors	Salary increases

Source: Vedovello(1998)

The academics believe that the body of knowledge generated through scientific activity is subject not to private, but to public ownership. This is contradictory to the norms of most industrial organizations. They tend to regard their scientific and technological know-how as proprietary hence, one need not be surprised to find the dilemma “freedom of publication versus secrecy of the research findings” as a

major topic in the barrier literature on university-industry collaborations (Dierdonck, 1990**)**.

In university-industry collaboration, given the early stage of technology development, financial barriers to innovation may be strong given the imperfections of the financial markets for these early stage ventures. This is often a motive for why governments provide additional funding for industry–science collaboration (Veugelers and Cassiman, 2005).

Issues concerning the ownership of the intellectual property rights also create tensions (Cyert and Goodman, 1997). The scientist would want protection of proprietary rights of inventions even before proceeding with the partnership. But the acquisition of such rights may be an expensive, long, and difficult process. Industry may also expect ownership of the technology by virtue of its investment in the development process. As pointed out by Hall et al., (2000) in some cases intellectual property right issues represent an insurmountable barrier which prevents the sought-after research partnership from ever coming about.

According to a study by Siegel et al., (2003) industrialist commonly perceived that universities are too aggressive in exercising intellectual property rights. This results in a hard line on negotiations, excess concern on the part of university administrators that they will not realize sufficient revenue, and unrealistic expectations.

Time is another barrier for both partners. The industrialist most often thinks in terms of months, while the academic researcher often provides himself with years to accomplish a certain research interest (Dierdonck et al., 1990).

3. Survey Methodology

This chapter describes the methodology adopted for the study. The survey was targeted at University departments and companies in the industry. The sample framework for university department was prepared based on details available in the university statistical handbook published by the University Grants Commission. For the study nine universities namely Sabaragamuwa, Colombo, Kelaniya, Sri Jayewardenepura, Moratuwa, Peradeniya, Wayamba, Ruhuna and Open University were selected. A structured questionnaire was used for data collection. A self administered questionnaire was sent by post and email to the respondents.

In the absence of a complete sample framework for industry from which to draw a random sample, this study used a sample framework developed based on MBA student class register at University of Colombo, Kelaniya and members directory of the Postgraduate Institute of Management Professional Association (PIMPA) to capture a wide spectrum of the industry sector in Sri Lanka. It has to be noted that majority of the MBA students and members of PIM Professional Association are holding senior posts in private sector companies in Sri Lanka. A self administered questionnaire was given to MBA students and email was used to administer the questionnaire to the PIM professional Association members. Further, personal interviews were conducted with some senior academics and senior executives of companies.

The survey began in May 2007 and concluded by end of September 2007 after two reminders 46 valid questionnaires from universities and 36 valid questionnaires from industry was returned. The response rate for postal questionnaire from universities was 15% while the response rate for emailed questionnaire was less than 10%. The response rate from industry was about 20% from MBA students and 10% from members of the PIM Professional Association.

The questionnaires administered to university academics and industry composed of questions relating to aspects shown in Table 2 (See Appendix for detailed questionnaires)

Table 2: Contents of the Questionnaires

University questionnaire	Industry questionnaire
Department information and details of respondent	Company information and details of respondents
Services offered to industry	Types interaction with university
Industrial sectors with which interactions were undertaken	Usefulness of interactions with universities
Coordination of interactions	Research and development activities
Constraints to U-I interactions	Constraints to U-I interactions
Suggestions for improving U-I interactions	Suggestions for improving U-I interactions

4. University Perspective of University-Industry (U-I) Interactions

This chapter provides a brief overview of the university system in Sri Lanka and R&D status. Next the chapter presents the university perspective of U-I interactions. This comprises of department characteristics, types of U-I interactions, barriers to U-I interactions and suggestions by academics to improve U-I interactions

4.1 Overview of University System in Sri Lanka

The history of higher education in Sri Lanka dates back to 1870 when the Ceylon Medical School was established. However, the origins of modern university education can be attributed to the establishment of the Colombo University College in 1921. Subsequently the first University in Sri Lanka, the University of Ceylon was established in 1942.

In 1979, the University Grants Commission was established as the apex body to oversee the function of the university system in Sri Lanka. The university system has gradually expanded with the increase in student intake from 4950 in 1980 to 16,635 in 2006. Over the past two decades as shown Figure 4, the number of universities, faculties, departments and teachers has increased. At present, there are 15 universities comprising of 78 faculties, 425 departments and academic staff strength of 3818. The universities are almost entirely funded by the government. However, government allocation to the university system has remained at a relatively low level of less than 0.5% of GDP.

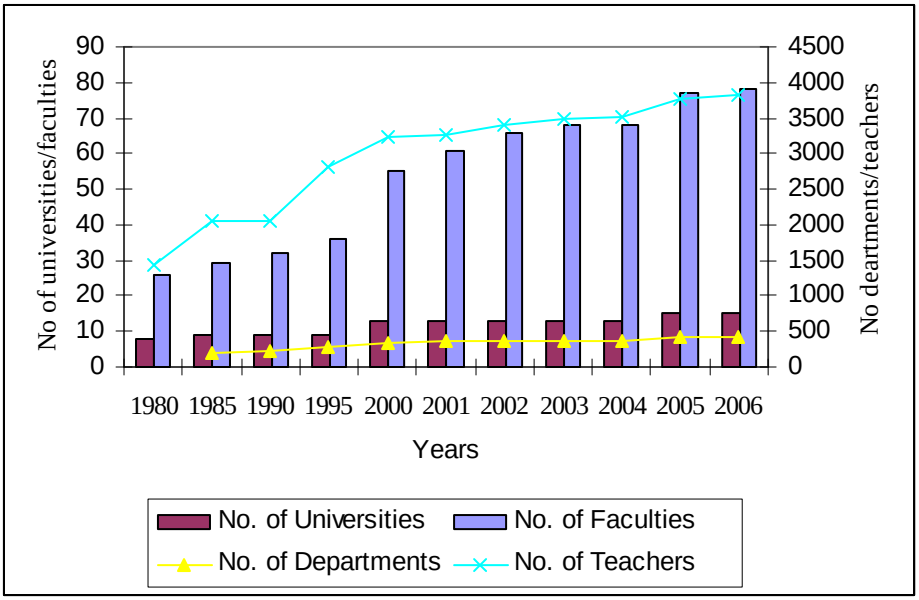

Figure 4: University Statistics
Source: University Grants Commission (2007)

The present teacher to student ratio remains around 1:15. The academic staff comprising of Professors and Senior Lecturers and Lecturers amounts to 3646 of which 11%, 43% and 38% are professors, senior lecturers and junior lectures respectively(Figure 5). Of the senior academics 719 are PhD holders (UNESCO, 2005).

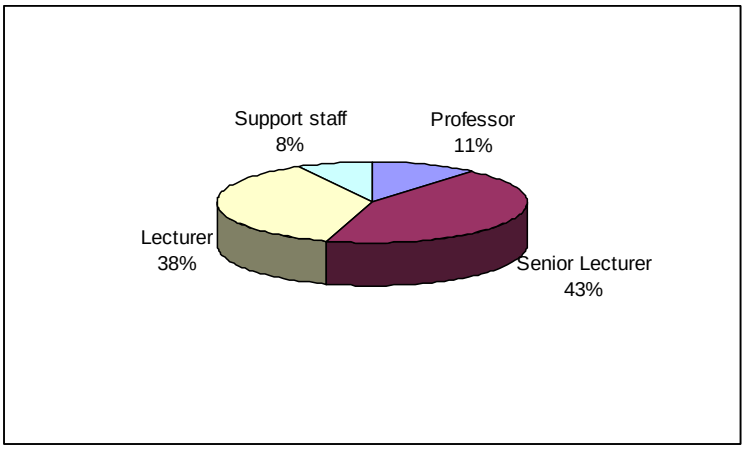

Figure 5: Composition of University Staff
Source: University Grants Commission (2007)

The Figure 6 depicts the distribution of senior academics comprising of Professor and Senior Lecturers among the major disciplines of Arts, Engineering, Management and Sciences taught in the universities. It is evident that majority of

senior academics in the country are specialized in Arts and Science related disciplines.

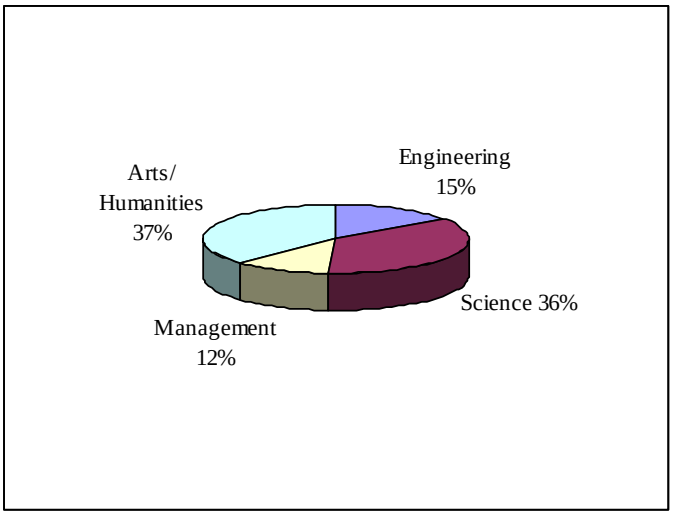

Figure 6: Distribution of Academics among Disciplines
Source: University Grants Commission (2007)

As far as research and development in the country is concerned the outcomes are far below expectation. Number of international papers in Science and Engineering annually published by Sri Lankan Scientists is limited to around 100 papers. According to the National Intellectual Property Office of Sri Lanka, the number of patents granted annually to residents between 1995 and 2002 remained stable at about 55–62 on average. A recent study shows that, whereas individual inventors claimed 72% of patents and private institutions 22% in 2000, just 6% went to public institutions. Although, published statistics are not available, patents granted to universities and academics are likely to remain low. A major reason for the poor outcome from research and development in the country is due to low priority given by the government to this important area. On average less than 0.2% of GDP is allocated for R&D which is far below allocations by countries in the region like India and Pakistan.

4.2 Results of the Study

4.2.1 Characteristics of the sample departments

Table 3: Characteristics of the Study Sample

University	No of departments	Discipline	%	Position of respondent	%(Number)
Colombo	04	Engineering	26.1	Dean	4.3(2)
Kelaniya	02	Information Technology	10.9	Head of the department	43.5(20)
Moratuwa	08	Science	34.8	Professor	17.4(8)
Open University	01	Management	8.7	Senior Lecturer	30.4(14)
Peradeniya	16	Humanities	19.6	Lecturer	4.3(2)
Ruhuna	03				
Jayewardenepura	02				
Sabaragamuwa	06				
Wayamba	04				

The study covered nine universities as shown in Table 3 which included two newly established universities. In total data were collected from 46 departments in the nine universities. Five major disciplines including Engineering, IT, Science, Management and Humanities were covered. The majority of the responses were received from Science and Engineering based departments. The respondents were mainly heads of department and senior Lecturers in the relevant departments.

4.2.2 Department characteristics

Table 4: Staff Composition

Department staff	Number	Average per established university department/(new university department)
Professor	69	1.6(0.7)
Senior Lecturer	288	6.5(4.0)
Lecturer	219	3.9(7.0)
Technical staff	96	2.4(1.3)
Administrative staff	54	1.4(0.4)
Total	726	

As shown in Table 4 majority of the academics are senior lecturers and on average each department of established universities had about 1-2 professors and 6-7

senior lecturers. However, in newly established universities there is a dearth of senior academics with a potential to initiate U-I interactions.

Table 5: External Funding Sources

Departmental external funding		
Received funds from external sources		65.2%(20)
Industry (private)	60%(12)	
Industry (public)	40%(8)	
Private foundations	5%(1)	
International agencies	95%(19)	
NGOs	25%(5)	
Not received funds from external sources		34.8%(16)

As far as funding of departments are concerned all most entirely they are funded by government funds. However, a significant number of departments state that they have received support from external funding sources of which considerable number reports to have received funds from international agencies followed by private and public sector industries. Most of the funding from international agencies comes in the form of equipments, research funding and donations while industry support mainly comes in the form of sponsoring various events such as symposiums, seminars and exhibitions. It is rare to find instances where industry has provided funds to conduct joint research or to purchase laboratory equipments.

Table 6: Adequacy of Laboratory Equipments

Item	Response
Adequate for teaching	32.6%(15)
Inadequate for teaching	54.3%(25)
Adequate for research	30.4%(14)
Inadequate for research	50.0%(23)

It is pertinent look at the capacity of departments to undertake research and development work for the industry. From the point of view of the academics more than 50% state that the facilities available in their departments particularly laboratory facilities are neither adequate for teaching nor research. This situation could have implications on their capability to collaborate in research and development activities with the industry.

4.2.3 Types of interaction with industry

The survey revealed that 76% of the departments have collaborated with the industry in some form. The broader definition of industry in this study includes private sector companies, public sector organizations, Non-governmental organizations and international organizations. The most common types of interactions found are described in Table 7. As far as university interaction with the private and public sector organizations are concerned the main form of interaction is student internship as 65% of the departments report to have placed their students for training in these organizations. Detail analysis of other types of interactions is presented in Table 8 and Figure 6.

Table 7: Common Types of Interaction with Industry

Type of interaction	Description
Student internship	Placement of undergraduate students in the industry to provide exposure to activities of the industry
Consultancy	Refers contractual agreement between an academic and industry, the academic provides advice information or technical services. Mostly it includes conducting routine tests or providing advice to industry
Contract Research	University academics undertaking to conduct research commissioned by industry
Training	Refers to provision of training to employees of industry to improve knowledge and skills useful for the job
Seminars	Sessions conducted by academics provide awareness to industry on current issues related
Workshops	Sessions conducted by academics to provide awareness to industry on current issues related industry

Table 8: Types of Interaction between universities and Industry form the Perspective of Academic Researchers

Service	Total	Eng	IT	Science	Mgt	Humanities
Consultancy	52.2%(24)	91.7%	20.0%	56.3%	25.0%	22.2%
Contract research	39.1%(18)	66.7%	-	43.8%	25.0%	22.2%
Training programmes	60.9%(28)	75.0%	60.0%	68.8%	50.0%	33.3%
Workshops	36.9%(17)	41.7%	40.0%	43.8%	25.0%	22.2%
Seminars	34.8%(16)	41.7%	20.0%	43.8%	25.0%	22.2%
Use of laboratory facilities	17.4%(8)	33.3%	-	25.0%	-	-
University patents	2.2%(1)	8.3%	-	-	-	-
Prototypes developed by university	4.3%(2)	16.7%	-	-	-	-
Others	17.4%(8)	-	20.0%	25.0%	50.0%	11.1%

One of the main objectives of this study was to identify type of interactions between the university and industry. As shown in the Figure 6 the predominant types of interactions include consultancy and training programmes as 52.4% and 60.9% of the departments report to have had at least one interaction over the past year. However, as far as frequencies of interactions are concerned on average it is less than 2 per annum.

When the interactions are analyzed based on the five major disciplines it is clear that Engineering related departments are having the most interactions with industry followed by Science, IT and management based departments. Humanities based departments have the least number of interactions with the industry. It is interesting to note that more than 90% of Engineering related departments has undertaken consultancy assignments for the industry. In contrast less than 25% of humanities related departments report to have undertaken consultancy assignments.

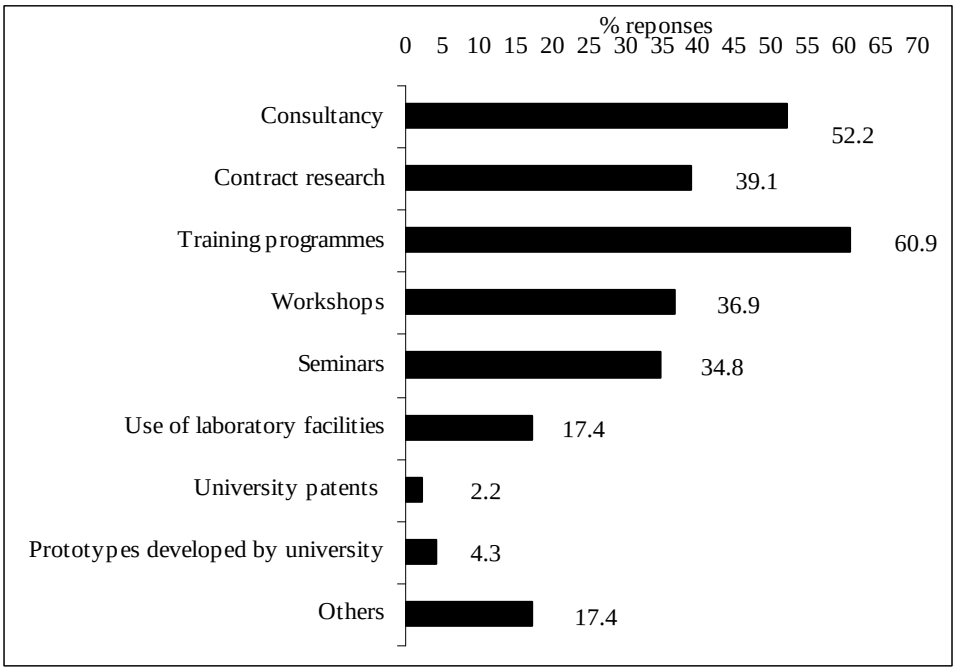

Figure 7: Types of Interactions

Table 9: Distribution of Interactions by Disciplines across Sectors

Sector	Total	Eng	IT	Science	Mgt	Humanities
Industry (private)	34.8%	75%	20%	38%	25%	
Industry (public)	30.4%	33%		44%		22%
Private foundations	8.7%			19%		11%
International agencies	28.3%	17%		44%		44%
NGOs	21.7	17%	20%	38%		11%
Others	15.2%	17%	20%	19%	25%	

The Table 9 indicates that engineering and science based departments mainly interact with industries while humanities based departments mainly interact with international agencies.

Table 10: Coordination University-Industry Interactions

Coordinator	response
Individually	56.5%
by U-I interaction unit	10.9%
by the research team	6.5%
by the Dean/ department head	34.8%

The coordination of university-industry interactions have been mainly undertaken by individual academics and only 10.9% of the interactions are handled by the university-industry interaction cell/unit.

It should be noted that as an endeavor to promote cooperation between University, Industry and Community interaction Cells were established in 9 Universities namely Sabaragamuwa, Colombo, Moratuwa, Peradeniya, Vavuniya campus, Eastern, Uva wellasa , Ruhuna and Kelaniya and at the Institute of Indiginious Medicine with funding from the University Grants Commission. These cells came into operation in early 2007. However, only 59% of the respondents knew about the existence of an university-industry interaction cell in their respective universities.

4.2.4 Perception of academics on barriers to University-Industry interaction

One of the aims of this study was to identify the barriers constraining university academics from interacting with the industry. They were asked to evaluate 16 different barriers on a five point Liker scale ranging from very great extent to not at all.

Table 11: Constraints to University-Industry Interactions

Item	Mean score		
	Total group	Interacting group	Non interacting group
Time constraint due to heavy teaching and administrative work	2.5	2.6*	1.9*
The university structure is not adapted to the needs of industrial collaborations	2.9	2.9	2.9
University norms and procedures hamper collaboration with industry	2.9	3.0	2.8
Inadequate laboratory facilities	3.0	2.8*	3.9*
Academics are not aware of the possible channels for getting sponsored research and consultancy assignments	3.1	3.1	3.0
Geographical location of the university results in less access to the industry	3.1	3.1	3.2
Inadequate infrastructure(communication, transport, journals, books etc)	3.2	3.1	3.6
The university has no policy towards collaborations with industry	3.3	3.8	2.9
Lack of autonomy to work with industry	3.4	3.4	3.3
Lack of motivation and entrepreneurial spirit among faculty	3.5	3.6	3.4
Industry is not interested to collaborate with universities	3.5	3.6	3.2
Collaboration with industry limits the free choice of research topics	3.6	3.6	3.5
Our research capabilities are not relevant to the industry	3.8	3.8	4.3
Academics don't feel confident enough to undertake industry oriented research	3.9	3.9	4.1
Collaboration with industry has a negative influence on the pedagogic mission of a university	4.2	4.2	4.2
It is not the mission of the academic researcher to collaborate with industry	4.3	4.2	4.6

Note: Likert scale 1-Very great extent, 2- Great Extent, 3- Somewhat, 4- Very Little, 5- Not at all
*- significant at 5%

The constraints which inhabit university-industry collaboration as perceived by university academics are presented in Table 11. The dominant responses are; lack of time to undertake industry related research due to heavy academic work load and lack of proper procedures and mechanism to collaborate with industry. The absence of university policy and framework to promote partnership is seen as a major constraint on the development of University-industry interactions. The results indicate that most of the Universities lack clear policies and procedures on the promotion of cooperation with industry. As a result there are no mechanisms to promote and communicate with industry. This affects the ability of academics to market their ideas and

the industry to know about the potentials of universities to assist them. This is also further confirmed by the fact that about 56% of U-I interactions are coordinated by individual academics without any institutional support. Furthermore, due to lack of funding from government and other sources to strengthen research capacities there are inadequate laboratory facilities within universities to carry out research for the industry.

Comparison of interacting and non interacting groups reveals that there are significant differences with regard to their perception about time constraint and inadequate laboratory facilities. Lack of time has been cited as more serious by non interacting group while lack of laboratory facilities has been cited by interacting group. Probably the interacting academics are more capable of time management than non interacting academics. Furthermore, interacting academics may have practically experienced lack of laboratory facilities to collaborate with industry.

Table 12: Results of Factor Analysis

Item	VARIMAX loadings	OBLIMIN loadings
The university structure is not adapted to the needs of industrial collaborations	0.833	0.861
Time constraint due to heavy teaching and administrative work	0.796	0.823
Lack of motivation and entrepreneurial spirit among faculty	0.737	0.772
The university has no policy towards collaborations with industry	0.713	0.754
University norms and procedures hamper collaboration with industry	0.678	0.713
Inadequate infrastructure(communication, transport, journals, books etc)	0.663	0.651
Inadequate laboratory facilities	0.571	0.633
Industry is not interested to collaborate with universities	0.476	0.552

Note: % of variance explained 41.28%, Only loadings above 0.4 are displayed, Bartlett's test of sphericity was statistically significant at 5% & KMO value was above 0.6.

The constraints were factor analyzed (PCA) and both varimax and oblimin rotations were done. Only factors with factor loading above 0.4 were retained. This analysis too revealed that time constraint and lack of proper procedures and mechanisms hinder interaction with industry. Moreover, it also reveals that lack of laboratory and infrastructure facilities inhibits university-industry interactions.

4.2.5 Perception of academics on promotional measures of University-Industry interaction

It is important identify the effectiveness of measures to improve university-industry interactions as per the perception of academics. The Table 13 presents the perception of university academics on promotional measures on a four point Likert scale ranging from not at all effective to very effective.

Table 13: Perception of Academics on Promotional Measures

Item	Mean score		
	Total group	Interacting group	Non interacting group
Improve laboratory facilities and other infrastructure	3.6	3.5	3.6
Encourage industrial visits by students	3.5	3.5	3.8
Encourage regular industrial visits by staff	3.5	3.5	3.3
Publicize university activities relevant to industry	3.5	3.6	3.7
Setup U-I interaction cells in universities	3.3	3.3	3.5
Involve staff from industry in teaching programmes	3.2	3.2	3.4
Conduct seminars, workshops for staff from industry	3.2	3.2	3.3
Give more autonomy for academics to work with industry	3.1	3.2	3.4
Government tax concessions for companies collaborating with universities	3.0	2.9	3.6
Provide consultancy/collaboration linked increments and promotions	2.9	3	2.6
Make it obligatory for academics to undertake a certain amount of work with industry	2.6	2.7	2.6

Note: 1-not at all effective 2-slightly effective 3- effective 4- very effective

The main effective steps to promote interaction as perceived by academics are improvement of laboratory facilities, encouragement of industrial visits by academics and students and giving publicity to university activities relevant to industry and setting up of university-industry interaction cells in universities. Further analysis of the improvement measures by factor analysis presented in Table 14 also confirms the above findings.

Table 14: Results of Factor Analysis

Item	VARIMAX loadings	OBLIMIN loadings
Encourage industrial visits by students	0.799	0.845
Include industrial internship in the curricula	0.774	0.756
Publicize university activities relevant to industry	0.698	0.681
Government tax concessions for companies collaborating with universities	0.651	0.663
Conduct seminars, workshops for staff from industry	0.636	0.745
Improve laboratory facilities and other infrastructure	0.632	0.746
Setup U-I interaction cells in universities	0.561	0.644

Open ended questions and discussion with academics reveal that personal contacts of academics have been instrumental in establishing links with the industry. Further team work, on time delivery and quality of work were found to be instrumental in establishing sustainable interactions.

5. Industry Perspective of University-Industry (U-I) Interactions

This chapter presents the perspective of the industry on university-industry interactions. The chapter begins with presenting the characteristics of the sample firms used for the study. Then the types of interactions by industry with universities are discussed. This is followed by the industry perception of barriers to interactions with universities and finally, possible suggestions to improve university-industry interactions are presented.

5.1 Results of the Study

5.1.1 Characteristics of the firms

Table 15: Characteristics of the Sample Firms

Status of firms		Sector		Size of firms			
				Employment		Turnover	
Public listed	24.2%	Manufacturing	19.4%	Less than 100 employees	28.6%	Less than 20 million	9.4%
Private limited liability	54.5%	Trading	8.3%	100-1000 employees	37.1%.	Less than 50 million	6.3%
State owned	15.2%	Service	38.9%	1001-2000 employees	11.4%	Less than 100 million	9.4%
Other	6%	Construction	11.1%	More than 2000 employees	22.9%	Less than 500 million	18.8%
		Information technology	19.4%			More than 500 million	56.3%
		Other	2.8%				

Note: Information is related to 36 firms

The characteristics of the sample firms are shown in Table 15. The sample for the study consisted of 36 firms of which majority were private sector firms of which 55% were private limited liability firms. The sample mainly covered service, manufacturing and information technology sectors. Majority of firms had employee strength of more than 100 employees and more than Rs 100 million annual turn over.

5.1.2 Types of interactions with university

It is been recognized that firms, in their search for solution for technical issues, product development or in their process of implementing an innovation, would interact with external sources like universities to access knowledge, information and technology to complement their internal R&D capability. The survey attempted to identify such interactions by firms with universities, the results are depicted in Figure 8. The results reveal that a considerable number of firms (36.1%) did not have any kind of interactions with the universities. Among the interacting firms, the predominant types of interactions are limited to what can be regarded as conventional types consisting of university student internships, informal contact with academics and attendance at seminars, symposiums, workshops and conferences. These types of interactions require less structured organizational approaches. However, an important observation made is the absence of a considerable number of advance type interactions which requires a more structured organizational approach such as contract research, joint research, consultancy and projects which are likely to significantly contribute to innovation.

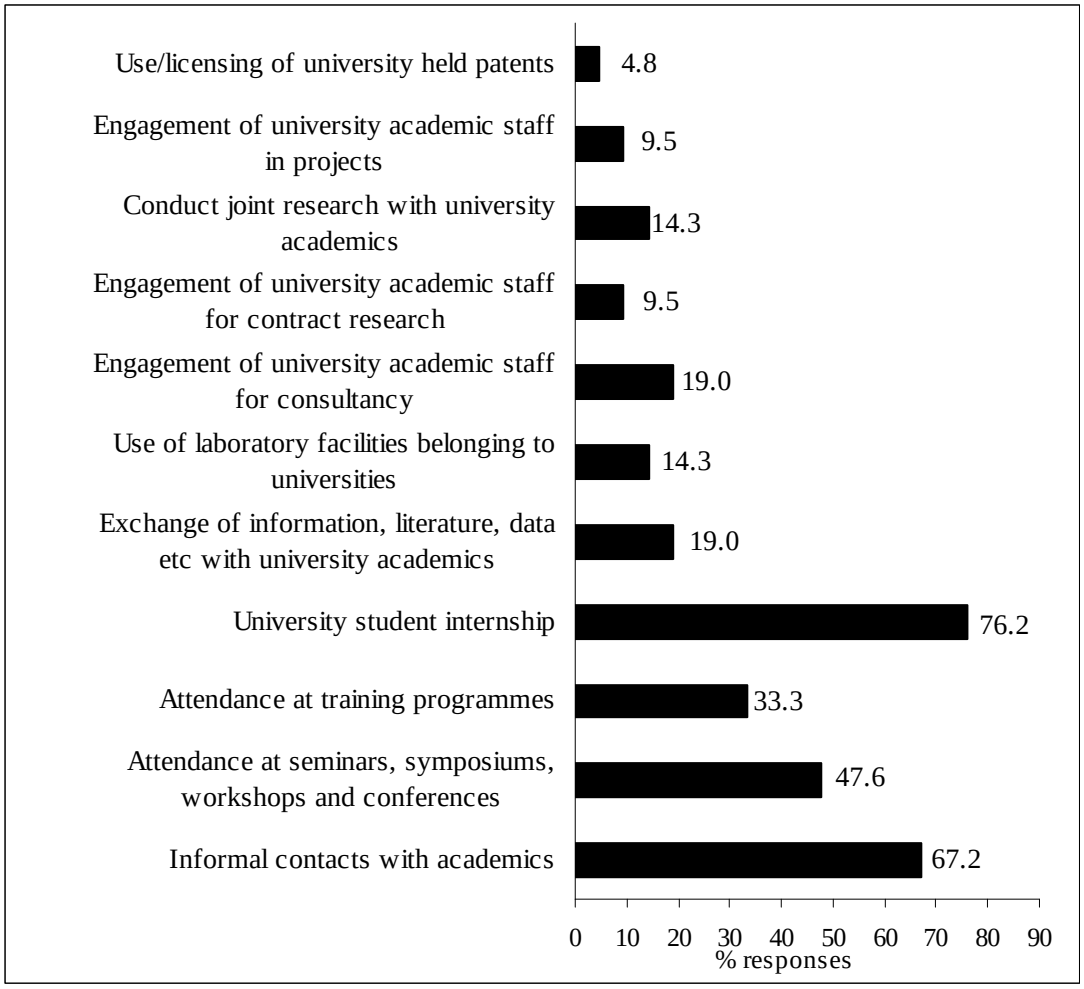

Figure 8: Types of Interactions

5.1.3 Research and development (R&D) situation in the industry

Scholars recognize that firms' R&D activity is an essential ingredient for increasing the firms' ability in coping with technical progress. Empirical research has shown that very high R&D intensity is positively related to rapid growth, whilst at the opposite extreme lack of any R&D or very low R&D intensity is often associated with stagnation or decline of firms. Annual R& D expenditure by private sector firms are shown in Table 16. It is clear that 50% of firms spend less than 0.5% of their annual turn over for R&D. This is despite the fact that a significant number of firms (56.3%) in the sample are large firms with an annual turnover more than Rs. 500 million. It was revealed that only 37.2% of the firms had a separate unit devoted for R&D. Furthermore, majority of the firms or 88.8% were in the view that universities should actively engage in R&D activities for the industry.

Table 16: Annual R&D Expenditure

As a % of annual turnover	
Less than 0.5%	50%
Less than 1%	22%
Less than 5%	13%
More than 5%	16%

5.1.4 Importance of interactions with universities

To asses the importance of interactions with universities a set of Likert scale questions were used. Scores of usefulness of interactions are presented in Table 17. Results reveal that recruitment of high quality graduates rank in the first position followed by obtaining access to new ideas an know-how and useful for continuing education for staff. Reduction in house R&D cost was the least important benefit of interactions. Ranking for importance reveal that the industry is interested in conventional benefits rather than looking at interactions from the view point of product development and innovation. This could be due to the lack of more advance type of interactions with universities at present as discussed in the previous section. This also indicates that the industry has lower expectations from the universities to contribute to innovation and technological development.

Table 17: Scores of Usefulness of Interactions with Universities

Item	Mean score	Rank
Obtain access to new ideas and know-how	2.0(n=33)	2
Useful for new product development	2.3(n=33)	4
Useful for product improvement	2.3(n=33)	4
Useful for quality improvement	2.3(n=33)	4
Useful for solving technical problems	2.3(n=33)	4
Recruit high quality graduates	1.8(n=33)	1
Reduce in-house R&D(research and development) cost	2.5(n=32)	5
Useful for continuing education of our staff	2.2(n=32)	3

Note: 1= highly useful, 4= not useful, n-sample size

5.1.5 Perception of industry on barriers to university-industry interaction

In order to evaluate the constraints faced by industry in their interactions with industry. They were asked to evaluate 16 different constraints on a five point Likert scale ranging from very great extent to not at all. The results are presented in Table 18.

Table 18: Constraints to University-Industry Interactions

Item	Mean scores		
	Total group	Interacting group	Non interacting group
There is no proper mechanism to collaborate with universities	1.9	2.3*	1.2*
Low commercialization potential of university research	2.0	2.3*	1.3*
Universities are not interested to collaborate with us	2.3	2.7*	1.5*
Lack of funds to initiate collaborative work with universities	2.4	2.6	2.1
Lack of motivation and entrepreneurial spirit among academics	2.5	2.7	2.1
we are not aware of expertise/ facilities available at universities	2.5	2.6	2.2
University research is not sufficiently applied	2.7	3	2.1
Most universities lack adequate research facilities	3.1	3.1	3.2
Academics are not competent enough to undertake consultancy/industry oriented research	3.3	3.3	3.1
Poor communication between the universities and us	3.6	2.9	3.2
Our business is not big enough to seek assistance from universities	3.9	3.9	3.9
Geographical location of our facilities results in less access to universities	3.9	4.0	3.7
We don't know whom to contact at universities to initiate collaborative activities	4.1	3.8	4.4

Note: Likert scale 1-Very great extent, 2- Great Extent , 3- Somewhat , 4- Very Little, 5- Not at all, *- significant at 5%

The dominant barrier is the lack of a proper mechanism to collaborate with universities. This is a common barrier identified by both the universities and industry. Another important barrier identified was the low commercialization potential of university research this could be due the dearth of industry oriented

research in Sri Lankan universities as well as the poor awareness of the industry about the research carried out in universities. Lack of interest among academics to collaborate with industry was also seen as an important barrier. A Study by Woolgar (2007) reveals that lack of interest on the part of academic faculty to be an important impediment to U-I interactions in Japan and this was attributed to issues relating to adequate incentives and recognition. Furthermore, lack of funds to initiate collaborative work with universities was seen as an impediment. In the early stage of technology development, financial barriers to innovation may be strong given the imperfections of the financial markets for these early stage ventures. This is often a motive for why governments provide additional funding for university-industry collaboration (Veugelers and Cassiman, 2005).

It was interesting to note that the non interacting firms found the dominant barrier to be more severe. The least important factor inhibiting interactions was the lack of awareness about whom to contact in the universities to initiate collaborative activities. The constraints were as before subjected to factor analysis and result confirms the above findings.

Table 19: Results of Factor Analysis

Item	VARIMAX loadings	OBLIMIN loadings
1. There is no proper mechanism to collaborate with universities	0.831	0.832
2. Low commercialization potential of university research	0.804	0.801
3. Lack of motivation and entrepreneurial spirit among academics	0.783	0.781
4. University research is not sufficiently applied	0.728	0.727
5. Lack of funds to initiate collaborative work with universities	0.670	0.672
6. Universities are not interested to collaborate with us	0.664	0.668
7. Academics are not competent enough to undertake consultancy/industry oriented research	0.661	0.657
8. Most universities lack adequate research facilities	0.585	0.583
9. we are not aware of expertise/ facilities available at universities	0.575	0.578

5.1.6 Perception of industry on promotional measures of University-Industry interaction

In order to understand the effectiveness of measures to improve interactions, the respondents were asked to evaluate 12 different suggestions for improvement on a four point Likert scale ranging from not at all effective to very effective. The results are presented in Table 20.

Table 20: Perception of industry on Promotional Measures

Item	Mean scores		
	Total group	Interacting group	Non interacting group
Encourage industrial visits by students	3.3	3.2	3.4
Involve staff from industry in teaching programmes	3.2	3.1	3.3
Setup a mechanism to link universities with industries which can act as an intermediary between universities and interested industrialists.	3.2	3.2	3.3
Encourage regular industrial visits by academics	3.1	3.0	3.3
Jointly(university and industry) organize informal meetings, talks, communications	3.1	3.2	2.8
Encourage industry representation in university committees	3.1	3.1	3.2
Publicize university activities relevant to industry	3.0	3.0	3.1
Encourage academic representation in industrial committees/chambers/boards	3.0	3.0	2.9
Improve laboratory facilities and other infrastructure	2.9	2.9	3.0
Government tax concessions for companies collaborating with universities	2.9	3.0	2.8
Setup industrial parks closer to universities	2.6	2.7	2.4

Note: 1-not at all effective 2-slightly effective 3- effective 4- very effective

Among the promotional measures encouragement of students to visit industry is the most effective measure from the view point of the industry followed by setting up of mechanisms to promote interactions. Involvement of staff from industry in academic programmes and regular visits by academics, informal meetings and industry representation in university committees are some of the other major promotional measures.

6. Conclusions and Recommendations

The analyses in this study has attempted to address the issues pertaining to university-industry interactions from the perspective of the two important stakeholders the university and industry. On the basis of the study, following conclusions can be drawn.

6.1 Conclusions

6.1.1 University perspective

1. Most of the established universities have qualified (with PhDs) senior academic staff with the potential to initiate U-I interactions. However, newly established universities lack senior academic staff to initiate such interactions.
2. As far as funding for university departments are concerned a significant number reports that they have received some sort of funding from external sources other than the government.
3. About 50% of the academics complain that the facilities particularly laboratory facilities at their disposal are insufficient to conduct research and development work.
4. The predominant types of university interactions with industry consist of consultancies and training programmes. However, the frequency of such interactions are on average is less than two per year. Engineering related departments are having more interactions compared to other discipline based departments. The least interactions are found among Humanities based departments.
5. Coordination and management of interactions at universities are mostly done by the individual researchers or the dean of the faculty or the head of the department. The newly established interaction cells are yet to play a significant role in managing interactions.
6. From the view point of the academics prominent barriers to U-I interactions are lack of time due to heavy workload, lack of proper procedures/mechanisms and conducive structure for collaboration.

7. According to the academics upgrading of laboratory facilities, encouragement of staff and student visits to the industry and promotion of university activities relevant to industry are important for promotion of U-I interactions

6.1.2 Industry perspective

1. The study revealed that a considerable number of firms did not have any kind of interactions with the universities.
2. The predominant types of interactions with the universities were university student internships, informal contact with academics and attendance at seminars, symposiums, workshops and conferences.
3. The research and development (R&D) within industry was not satisfactory as majority of firms invested less than 0.5% of annual turnover on R&D. Further, more than 60% of the firms did not have separate facilities or personnel to undertake R&D.
4. According to the industry the most important benefits of U-I interaction are recruitment of high quality graduates followed by obtaining access to new ideas and know-how and useful for continuing education for staff. Research and development related benefits were given low priority.
5. The prominent barriers to U-I interaction cited by industry are lack of proper procedures and mechanism, low commercialization potential of university research and lack of interest among academics to collaborate with industry.
6. Industry suggestion for improvement of U-I interactions include setting up of mechanism to promote interactions and involvement of staff from industry in academic programmes and regular visits by academics to the industry.

6.2 Recommendations

The study has highlighted the issues and constraints of the two main stakeholders in U-I interactions. Recommendations comprise of steps necessary to overcome the obstacles in establishing sustainable partnerships.

As both the academics and industrialist have emphasized the need to setup a strong mechanism to facilitate U-I interactions. There is an urgent need to setup such mechanism with involvement of all the stakeholders to create a conducive environment to enable closer collaboration between the universities and industry. Since the University Grants Commission (UGC) has already taken some positive steps towards this end it would be appropriate to use it as a base to develop this mechanism.

In 2007, university-industry community interaction cells were setup in ten universities by disbursing Rs. One million as seed money. In terms of organizational structure, establishing this specialized cell within a university is instrumental in developing relations with an industry. The dedicated unit should be equipped with experienced personnel with industry experience with effective facilitating and negotiating skills capable of providing support services, partner search, commercial knowledge transfers, and business development. At the same time, unit should maintain close relationships with academics in the different departments and have the proper incentive mechanisms in place to spur the interest of academics to involve in solving industry problems. The cell should formulate a clear set of policies and procedures to overcome bureaucratic barriers in disbursement of research funds and procurement and also ensure academics are adequately reward for their efforts.

Since University-industry interactions in Sri Lanka is a relatively new phenomenon it is unlikely to receive proper leadership direction and monitoring from within the university. Therefore, it would be appropriate to have higher level body to provide direction to interaction cells setup at the University Grants Commission. This apex body could be named as UICIC (University Industry Community Interaction Center) setup under the guidance and supervision of the University Grants Commission. The center should comprise representatives from both the universities and the industry in advisory capacities and should recruit personnel with strong leadership qualities and experience in industry and university affairs to provide the much need guidance to the cells at universities.

As far as industry is concerned given the scale of local industries it is highly unlikely for each firm to come up with a liaison office of its own to interact with universities. Therefore, the more feasible approach would be to setup liaison offices with the involvement of the industry association like the chambers of

commerce and industry. The Federation of Chamber of Commerce and Industry of Sri Lanka has already taken some positive steps in this direction by establishing the industrial relations forum to bring academics and industrialist into one forum. Similar forums could be setup by other industry associations and upgraded to U-I liaison offices by improving industry and university participation, physical and human resource capacity to forge strategic partnerships with UICIC and Cells at universities.

The state can play a supportive role by providing R&D grants for university-industry collaborative research and tax concessions to industries using local technologies. Moreover, the Government should draft policies to encourage local R&D efforts. The proposed model to improve U-I interaction is presented in Figure 9. This model has the potential to overcome most of the issues raised in this study.

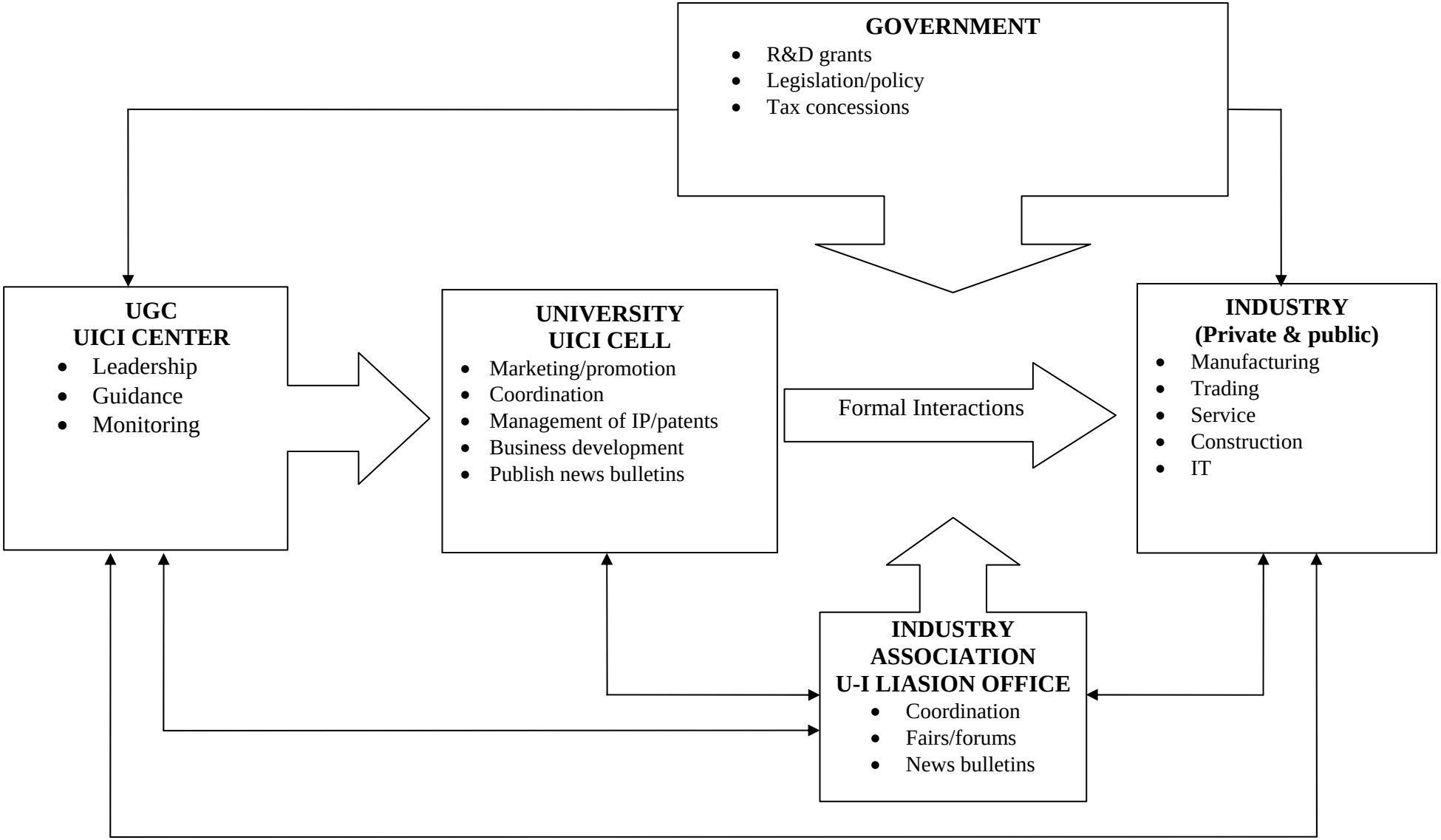

Figure 9: University-Industry Interaction Model

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Appendix-Questionnaires

Questionnaire for University

Study on University Industry (U-I) Interactions in Sri Lanka

This research is being carried out by a researcher from Sabaragamuwa University of Sri Lanka to study the present status of University-Industry interactions in Sri Lanka. We are interested in finding out the characteristics of existing interactions and constraints and potentials for developing sustainable University- Industry interactions.

All information provided will be kept anonymous and confidential. Only our research team will see your questionnaire.

1. Name of University:

2. Department:

3. Designation of Respondent:

Dean	☐
Head of the department	☐
Professor	☐
Senior Lecturer	☐
Lecturer	☐

4 Did your department receive any funds from the following sources during the past two years

Industry (private)	☐
Industry (public)	☐
Private foundations	☐
International agencies	☐
NGOs	☐
Others, please specify	☐

5 Total number of academic staff in the department

Professor	☐
Senior lecturer	☐
Lecturer	☐
Technical staff	☐
Administrative staff	☐

6. Please describe your department's laboratory facilities
   The laboratory facilities are

Adequate for teaching	☐
Inadequate for teaching	☐
Adequate for research	☐
Inadequate for research	☐

7. Does your department collaborate with industry?

Yes	☐
No	☐

8. If yes what services does your department offer to industry

Consultancy	☐
Contract research	☐
Training programmes	☐
Workshops	☐
Seminars	☐
Use of laboratory facilities	☐
University patents	☐
Prototypes developed by you	☐
Others, please specify	

9. Does your university/department have an Industry Liaison Office/University-Industry interaction unit?

Yes	☐
No	☐

10. Has your department undertaken any collaborative research and development/consultancy projects during the past two years with

Industry (private)	☐
Industry (public)	☐
Private foundations	☐
International agencies	☐
NGOs	☐
Others, please specify	☐

11. How many research proposals/consultancy reports were submitted by your department during the past two years?

Industry (private)	☐
Industry (public)	☐
Private foundations	☐
International agencies	☐
NGOs	☐
Others, please specify	☐

12. Your interactions with the industry was coordinated by

Individually	☐
Through U-I interaction unit	☐
Research team	☐
Dean/ department head	☐
NGO	☐
Others, please specify	☐

13. If your department had successful collaboration with industry, what were the success factors?

14. Constraints to University-Industry interaction

Please indicate to what extent the following factors prevent your department from interacting with the industry

1-Very great extent 2- Great Extent 3- Somewhat 4- Very Little 5- Not at All

		1	2	3	4	5
1.	Our research capabilities are not relevant to the industry	☐	☐	☐	☐	☐
2.	Academics don't feel confident enough to undertake industry oriented research	☐	☐	☐	☐	☐
3.	Lack of motivation and entrepreneurial spirit among faculty	☐	☐	☐	☐	☐
4.	Time constraint due to heavy teaching and administrative work	☐	☐	☐	☐	☐
5.	It is not the mission of the academic researcher to collaborate with industry	☐	☐	☐	☐	☐
6.	Academics are not aware of the possible channels for getting sponsored research and consultancy assignments	☐	☐	☐	☐	☐
7.	Collaboration with industry has a negative influence on the pedagogic mission of a university	☐	☐	☐	☐	☐
8.	Industry is not interested to collaborate with universities	☐	☐	☐	☐	☐
9.	Collaboration with industry limits the free choice of research topics	☐	☐	☐	☐	☐
10.	Inadequate infrastructure(communication, transport, journals, books)	☐	☐	☐	☐	☐
11.	Inadequate laboratory facilities	☐	☐	☐	☐	☐
12.	Lack of autonomy to work with industry	☐	☐	☐	☐	☐
13.	The university structure is not adapted to the needs of industrial collaborations	☐	☐	☐	☐	☐
14.	University norms and procedures hamper collaboration with industry	☐	☐	☐	☐	☐
15.	The university has no policy towards collaborations with industry	☐	☐	☐	☐	☐
16.	Geographical location of the university results in less access to the industry	☐	☐	☐	☐	☐
Others, please specify		☐	☐	☐	☐	☐
Others, please specify		☐	☐	☐	☐	☐
Others, please specify		☐	☐	☐	☐	☐

1-Very great extent 2- Great Extent 3- Somewhat 4- Very Little 5- Not at All

15. Suggestions for improving university industry interactions

Please indicate the effectiveness of following measures for improving interaction between university and industry

1-not at all effective 2-slightly effective 3- effective 4- very effective

	1	2	3	4
1. Include industrial internship in the curricula	☐	☐	☐	
2. Encourage industrial visits by students	☐	☐	☐	
3. Encourage regular industrial visits by staff	☐	☐	☐	
4. Improve laboratory facilities	☐	☐	☐	
5. Involve staff from industry in teaching programmes	☐	☐	☐	
6. SetupU-I interaction cells in universities	☐	☐	☐	
7. Publicize university activities relevant to industry	☐	☐	☐	
8. Conduct seminars, workshops for staff from industry	☐	☐	☐	
9. Tax concessions for companies collaborating with universities	☐	☐	☐	
10. Make it obligatory for academics to undertake a certain amount of work with industry	☐	☐	☐	
11. Provide consultancy/collaboration linked increments and promotions	☐	☐	☐	
12. Give more autonomy for academics to work with industry	☐	☐	☐	
Others, please specify	☐	☐	☐	
Others, please specify	☐	☐	☐	
Others, please specify	☐	☐	☐	
Others, please specify	☐	☐	☐	
	☐	☐	☐	
	☐	☐	☐	
	☐	☐	☐	

1-not at all effective 2-slightly effective 3- effective 4- very effective

16. Do you have any other suggestions for improving university industry interaction?

Thank you very much for taking part in this survey.

Questionnaire for Industry

Study on University Industry (U-I) Interactions in Sri Lanka

This research is being carried out by a researcher from Sabaragamuwa University of Sri Lanka to study the present status of University-Industry interactions in Sri Lanka. I am interested in finding out the nature of existing interactions, perception and constraints for developing sustainable University- Industry interactions.

All information provided will be kept anonymous and confidential. Only the researcher will see your questionnaire.

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3. Name of your company:

4. Address and company website:

5. Your designation:

CEO	☐
GM	☐
Head of Department/Division	☐
Senior Manager	☐
Junior Manager	☐

6. The **main** sector in which you do business?

Manufacturing	☐
Trading	☐
Service	☐
Construction	☐
Information technology	☐
Others, please specify	☐

7. Legal status of your company?

Public listed	☐
Private limited liability	☐
Partnership	☐
Sole proprietorship	☐
State corporation	☐
Others, please specify	☐

8. Total number of employees in your company (as at 31st August 2007)

Number of employees	

9. Annual turn over of your company

Less than one million	☐
Less than 10 million	☐
Less than 20 million	☐
Less than 50 million	☐
Less than 100 million	☐
Less than 500 million	☐
More than 500 million	☐

10. Of the followings what type of links your company has with universities?

Personal contacts with university academics	☐
Attendance at seminars, symposiums, workshops and conferences	☐
Attendance at training programmes	☐
University student internship	☐
Exchange of information, literature, data etc with university academics	☐
Use of laboratory facilities belonging to universities	☐
Engagement of university academic staff for consultancy	☐
Engagement of university academic staff for contract research	☐
Conduct joint research with university academics	☐
Engagement of university academic staff in projects	☐
Use/licensing of university held patents	☐
Others, please specify	

11. Do you think universities should engage into R&D (research and development) activities for industry?

Yes	☐
Indifferent	☐
No	☐
Don’t know	☐

12. How useful would be interactions with universities to your company?

1-highly useful 2- useful 3-moderately useful 4-not useful

	1	2	3	4
13. Obtain access to new ideas and know-how	☐	☐	☐	☐
14. Useful for new product development	☐	☐	☐	☐
15. Useful for product improvement				
16. Useful for quality improvement	☐	☐	☐	☐
17. Useful for solving technical problems				
18. Recruit high quality graduates	☐	☐	☐	☐
19. Reduce in-house R&D(research and development) cost	☐	☐	☐	☐
20. Useful for continuing education of our staff	☐	☐	☐	☐
Others, please specify	☐	☐	☐	☐
Others, please specify	☐	☐	☐	☐
Others, please specify	☐	☐	☐	☐

13. Does your company have a section/unit/division/department devoted to research and development (R&D)?

Yes	☐
No	☐

14. What percentage of your annual turnover is utilized for R&D (research and development)?

Less than 0.5%	☐
Less than 1%	☐
Less than 5%	☐
More than 5%	☐

15. If your department has successful collaboration with industry, what are the success factors?

16. Constraints to University-Industry interactions

Please indicate to what extent the following factors prevent your company from interacting with universities

1-Very great extent 2- Great Extent 3- Somewhat 4- Very Little 5- Not at All

	1	2	3	4	5
1. Differences between the universities and my company in values, mission, or priorities (e.g., academia vs. corporate values)	☐	☐	☐	☐	☐
2. Academics are not competent enough to undertake consultancy/industry oriented research	☐	☐	☐	☐	☐
3. Lack of motivation and entrepreneurial spirit among academics	☐	☐	☐	☐	☐
4. Low commercialization potential of university research	☐	☐	☐	☐	☐
5. There is no proper mechanism to collaborate with universities	☐	☐	☐	☐	☐
6. Poor communication between the universities and us					
7. Most universities lack adequate research facilities	☐	☐	☐	☐	☐
8. Universities are not interested to collaborate with us	☐	☐	☐	☐	☐
9. We are not aware of expertise/ facilities available at universities	☐	☐	☐	☐	☐
10. We don't know whom to contact at universities to initiate collaborative activities	☐	☐	☐	☐	☐
11. Our business is not big enough to seek assistance from universities	☐	☐	☐	☐	☐
12. Lack of funds to initiate collaborative work with universities	☐	☐	☐	☐	☐
13. The university structure is not adapted to the needs of industrial collaborations	☐	☐	☐	☐	☐
14. Geographical location of our facilities results in less access to universities	☐	☐	☐	☐	☐
Others, please specify	☐	☐	☐	☐	☐
Others, please specify	☐	☐	☐	☐	☐

17. Suggestions for improving university industry interactions

Please indicate the effectiveness of following measures for improving interaction between university and industry

1-not at all effective 2-slightly effective 3- effective 4- very effective

	1	2	3	4
1. Include industrial internship in the curricula	☐	☐	☐	☐
2. Encourage industrial visits by students	☐	☐	☐	☐
3. Encourage regular industrial visits by academics	☐	☐	☐	☐
4. Improve laboratory facilities and other infrastructure at universities	☐	☐	☐	☐
5. Involve staff from industry in teaching programmes	☐	☐	☐	☐
6. Setup a mechanism to link universities with industries which can act as an intermediary between universities and interested industrialists.	☐	☐	☐	☐
7. Publicize university activities relevant to industry	☐	☐	☐	☐
8. Jointly(university and industry) organize informal meetings, talks, communications	☐	☐	☐	☐
9. Government tax concessions for companies collaborating with universities	☐	☐	☐	☐
10. Setup industrial parks closer to universities	☐	☐	☐	☐
11. Encourage academic representation in industrial committees/chambers/boards	☐	☐	☐	☐
12. Encourage industry representation in university committees	☐	☐	☐	☐
Others, please specify	☐	☐	☐	☐
Others, please specify	☐	☐	☐	☐
Others, please specify	☐	☐	☐	☐

1-not at all effective 2-slightly effective 3- effective 4- very effective

18. Do you have any other suggestions for improving university industry interaction?

Thank you very much for taking part in this survey