Role of public policy in linking university and research centres with industry in Sri Lanka

R. M.W. Amaradasa
University of Wollongong

Role of public policy in linking university and research centres with industry in Sri Lanka

A thesis submitted in fulfilment of the requirement for the award of the degree of

Doctor of Philosophy

from

UNIVERSITY OF WOLLONGONG

by

R.M.W. Amaradasa

MSc, BSc

Faculty of Commerce

2004

Thesis certification

I, R.M.W. Amaradasa , declare that this thesis, submitted in fulfilment of the requirement of the award of Doctor of Philosophy, in the Faculty of Commerce, University of Wollongong , is wholly my own work unless otherwise referenced and acknowledged. The document has not been submitted for qualifications at any other academic institution.

R.M.W. Amaradasa

29th Mar 2004

Acknowledgement

A person conducting research leading to the Doctor of Philosophy degree needs commitment, tolerance and the ability to overcome frustration, and also apart from one's own wisdom, possesses an analytical mind and self-confidence. Despite this the credit for completion of a PhD thesis research work does not purely go to the researcher, but it needs sharing with many others. I will therefore, try to mention a few of those who should share what I achieved during my PhD programme.

Firstly, my sincere gratitude to Prof Sam Garrett-Jones and Dr Stewart Russell who were behind me in guiding my research work. Sam's conceptual thinking and Russell's advise on methodologies and thesis structure shaped my thesis very well in the direction of the present outcome. Also, I am grateful to Sam for accepting me as a Doctoral student under his supervision.

Secondly, I wish to acknowledge the respondents and the interviewees from Sri Lankan Universities, Research Institutes, Industries, ministries and other government organizations, who provided me with data and valuable inputs for my research. My gratitude is also due to the interviewees from India and specially to Prof V.V.Krishna of the Jawaharlal Nehru University (JNU) of New Delhi, India, who encouraged and arranged appointments for my field visit to selected Indian Institutes and key personnel in those institutions.

My gratitude is also due to the Board of Management and Director of the National Science Foundation for facilitating my research by providing funds, study leave and other services. My special appreciation to the Director of NSF for encouraging inputs at different stages of my research. The financial support provided by the Swedish International Development Agency (Sida) is highly appreciated , without which I could not have registered for the degree at the University of Wollongong, Australia.

My special thanks are due to Mr Asoka Silva, the former Deputy Director-General of the NARESA of Sri Lanka for his encouragement, guidance and direction from the beginning of my career as a young scientific officer at the NARESA and for extending the same towards the thesis.

I also wish to thank Dr Chandra Gulati of Dept of Mathematics, of University of Wollongong for the initial guidance on statistical methods and to Ms Tara Croft who provided me with useful advice on qualitative analysis and techniques.

Love to my wife and daughter who shared with me the intention to complete my research on scheduled time by sacrificing family life.

My thanks are also due to the Sri Lankan community in Wollongong who took the trouble to take care of my well-being when and where necessary. Also, my thanks to Rasika, Deepika and Viraji of the NSF, Sri Lanka who helped me to organize the questionnaire survey by providing extra assistance for typing and other secretarial work.

Finally, I greatly appreciate the untiring contribution by Colin Salter , the editor of my thesis who brought it to a much better readable form.

Abstract

The promotional mechanisms employed in University-Research-Industry (URI) relationships have been considered a strategic factor in the development objectives of the industrialized countries. Such promotional mechanisms are based on recognized conceptual frameworks, which have been carefully examined by researchers. However, little work has been done in this field with respect to problems of less industrialized countries especially in small developing countries. The objective of this study was therefore to compare the URI characteristics and promotional mechanisms of developed countries with those in operation in small developing countries like Sri Lanka.

The methodology employed for this study included exploratory survey, follow-up interviews, interviews with decision-makers and case studies while analytical tools in the grounded theory approach were used to deal with qualitative data.

The URI relationships which are used as instruments to generate economic benefits, show wide discrepancies in performance among different countries. The promotional mechanisms, widely prevalent in industrialized countries, emphasized the importance of framework conditions. The characteristic features of the URI relationships in developed countries are better described in the international literature in terms of models, concepts and systems such as National System of Innovation. An analysis of literature shows that less industrialized countries need to have a better understanding of issues related to the operation of those relationships that are less rigorously influenced by theories and concepts developed in industrialized countries.

The study revealed that the relationships in Sri Lanka are based on the lower end of the spectrum, characterized by short-term orientation that include education and training, and service-based relationships. Lack of structural mechanisms, financial constraints, regulatory rigidity, inadequacy of laboratory facilities and absence of inter-organizational communication seems to be the major features that curtail

relationships. It was observed that process related constraints and weaknesses are widespread in all three types of organizations, in addition to the weaknesses related to the framework. Accordingly, three sets of issues based on internal and external factors for a particular type of organization were developed which could be widely used as check list of issues for any developing country. This checklist was tested with new forms of organizations which have evolved to overcome such weaknesses, by adopting the responsive-adaptive approach. The new forms of organizations show features such as heterogeneity, organizational diversity and trans-disciplinarity as well as internal transformation, influence of one type of organization upon another, creation of new organizations and networks. These features are more prevalent in organizations in developed countries.

The findings lead to conclusion that the URI relationships in developing countries show in a broad context similarities to those of developed countries but at the same time differ in nature. The concepts and models used in developed countries to explain the URI relationships can also be used to explain those in developing countries. The importance in understanding micro level conditions and taking remedial measures to overcome negative impact is imperative. Finally, the public policy interventions that are necessary to promote URI relationships, while eliminating weaknesses in the framework and micro-environment are proposed in this study.

Table of contents

List of tables

List of figures

Abbreviations used

AbC	- Agro-business Centre
ACCIMT	- Aurthur C Clark Institution of Modern Technology
ADB	- Asian Development Bank
AgEDIS	- Agro Enterprise Development & Information Service Center
AT	- Action taken
BI	- Business Incubator
BIT	- Bilar Institute of Technology, India
BOI	- Board of Investment
BT	- Biotechnology
CARP	- Council for Agricultural Research Policy
CEA	- Controlled Environment Agriculture
CSIR	- Council for Scientific & Industrial Research of India
DBT	- Dept. of Biotechnology of India
DOA	- Department of Agriculture
DSIR	- Department of Science & Industrial Research of India
DST	- Department of Science & Technology of India
EDC	- Engineering Design Centre
EN	- Existing
EP	- Expected
FDI	- Foreign Direct Investment
FICCI	- Federation of Industry & Commerce Chambers in India
FITT	- Foundation for Industrial Technology Transfer
GDP	- Gross Domestic Product
GERD	- Gross Expenditure on Research & Development
HRD	- Human Resource Development
HTDE	- High Tech Development Zone of China
ICB	- Industry Consultation Boards
IFF	- Industry Facilitating Forum
IITD	- Indian Institute of Technologies, Delhi
IMF	- International Monetary Fund
IP	- Intellectual Property
IT	- Information Technology
ITI	- Industrial Technology Institute of Sri Lanka
MNC	- Multinational companies
NARESA	- Natural Resources Energy and Science Authority
NARS	- National Agricultural Research System

NASTEC	- National Science and Technology Commission
NBRO	- National Building Research Organization
NCUIIC	- National Committee on University Industry Interactions in Chemistry
NERD	- National Engineering Research & Development
NGO	- Non Government Organization
NIC	- Newly Industrialized Countries
NRDC	- National Research & Development Council of India
NSF	- National Science Foundation
NSI	- National System of Innovation
OECD	- Organization for Economic Cooperation and Development
PAEA	- Protected Agricultural Entrepreneurs Association
PG	- Postgraduate
RSE	- Research Scientists and Engineers
SEA	- South East Asia
SEMEDEC	- Small and Medium Scale Enterprise Development Corporation
SISIR	- Singapore Institute of Scientific & Industrial Research
SME	- Small and Medium Enterprises
STPD Project	- Science and Technology Personnel Development Project
SWT	- Seminars, Workshops and Training Programmes
TBIU	- Technology Business Incubation Unit
TG	- Target Group
TH	- Triple Helix
TOR	- Type of Respondent
TRP(China)	- Teaching Research Products Assistance
TT	- Technology Transfer
UGC	- University Grant Commission
UIIC	- University Industry Interaction Cell
UNESCO	- United Nations Educational, Scientific and Cultural Organization
UNIDO	- United Nations Industrial Development Organization
UOM	- University of Moratuwa
UOP	- University of Peradeniya
URI	- University - Research - Industry
USA	- United State of America
US-AID	- United State Agency for International Development

Key definitions

1. URI relationships

Any relationships among universities, industry and research institutions or among individuals in these institutions, in the form of educational & training, service or R&D based interaction are considered University-Research-Industry (URI) relationships in this thesis.

2. Framework conditions

Conditions, which are beyond the direct control of the individuals or institutions, are considered as "Framework conditions". Legislation and regulations, public promotional programmes, structural and incentive systems and institutional settings are examples for Framework conditions (Extracted from Polt, W. etal (2001)and modified).

3. Micro level conditions

Procedural and behavioural conditions that can be changed by direct influence by the individuals (and institutions) are considered as Micro level conditions.

Chapter one – Introduction

Chapter one will deal with why the research topic is important, the objectives of this thesis and the motivation to conduct the research. It will also outline the research process and the structure of the thesis. In the description of the structure of the thesis, it will make a brief introduction to the methodology and analytical tools used , the process of analysis and the expected outcome.

1.1 What is URI relationship ?

University-Research-Industry (URI) relationships can be defined in many ways. Conceptually, the relationships among universities, industry and research institutions are considered in this thesis as any interaction taking place in the form of educational and training, service or R&D based interaction (Konishi 2000). Education and training based interactions can be carried out in the form of exchange of ideas on skill requirements or specific nature of skill developments of the human resource. Service based interactions can take place in the form of testing, certification, trouble shooting and short term consultancies on solving a specific problem of a commercial enterprise. The R&D based relationships can be carried out in a more structured form, which are usually extended over a long period with specific resource allocations. Also, these three types of interactions can take place in a combined form in a specific relationship between firms and universities or research institutes. In other words, the relationship between a firm and a university or a research institute may consist of a combination of the above three forms (or modalities) of interactions. Within these modalities, these relationships can take place either in a rather informal manner (e.g. personal contacts – informal) or in a more organized manner (formal). They can also comprise a combination of formal and informal relationships depending on the context. All of these interactions can be classified as URI relationships.

In my thesis, I take the above three modalities of relationships and the diverse manner of operations (i.e. formal/informal manner) as the contextual framework of URI relationships.

1.2 Background

University-Research-Industry (URI) relationships are regarded as one of the central instruments to develop technological capabilities in a country. The intense nature of these relationships can vary from country to country, according to the technological advancement, knowledge base and the industry base of the country. Also, the nature and characteristics of these relationships can be different depending on the availability of resources, social and cultural issues and policy environment.

Industrialized countries may need to maintain technological frontiers and leading edge research where URI relationships are instrumental to provide complementary skills and resources. In this context, industrialized countries seem to have taken various measures to promote URI relationships, ranging from structural development approaches such as S&T parks, innovation centres, incubators, and collaborative research centres, to create incentives and passive promotional approaches and incentives such as various tax concessions, loans and grants schemes. The other passive promotional approaches seem to be the facilitation and promotion of Intellectual Property (IP) issues, and information flows between users and producers of knowledge. In this context, governments in industrialized countries play a crucial role through long range planning followed by a catalytic role.

Globally, universities, industries and research institutes have a social responsibility to fulfil societal needs for a better quality of life. One of the purposes of URI relationships may be the satisfying of social needs whilst achieving their own aims. The social responsibilities of universities, industries and

research institutes in industrialized countries are equally applicable for less industrialized countries.

However, less developed countries do have lower capabilities for leading edge research due to a number of factors including a lack of skills, competencies and weak industrial bases. Hence, the goals of URI relationships in less industrialized countries may vary in terms of intensity and nature.

The typical features of less industrialized countries are: less developed S&T infrastructure; less developed industry base; and to some extent inadequate skills at the required levels. However, the firms in these countries still need to keep competitive in the local market or limited export market. In this context technological capabilities have become a major determinant of the competitiveness which in turn support industrial growth. Hence, firms in less industrialized countries also need to capture the required skills and know-how to become competitive. This can be achieved through building networks and relationships with academic and research organizations either within or outside the country. However, to understand the technology borrowed from outside, a substantial level of know-how is required for these companies. This can be achieved in many ways. One method is to recruit skilled staff who can understand or access the knowledge to utilize the technology efficiently. Otherwise, companies need services of technical experts who can explain the new technology. Even after acquiring the technology, they may need process related changes or modifications to suit the environment or raw material. This needs purposeful access to the local S&T base. Collaboration with the S&T institutions in the country seems to be the most appropriate and productive solution as the people in those institutions have better knowledge on local conditions and materials. Such collaborations can also be cost-effective in the long term as capability building through technology adaptation reduces the knowledge gap between the knowledge "Producers" and "Users".

These three reasons may drive the local firms to become involved in relationships with local S&T base, i.e.

1. To become competitive in local & export markets,
2. To understand borrowed technology, and
3. To adapt the technology to suit local conditions.

Firms in less industrialized countries are regarded as technology borrowers from industrialized countries.

However, the local S&T base in less industrialized countries shows its own weaknesses. Inefficiency in S&T institutions and problems related to relevance of their research activities to industrial growth are two such weaknesses. On the other hand, the industries are working on their own agenda despite the need to overcome many weaknesses such as a lack of technological capabilities. Hence the governments in less industrialized countries need to play a more active interventionist role rather than acting as a catalyst to facilitate relationships between firms and universities or research institutes.

In order for the government to intervene effectively, it needs to better understand the features of existing relationships, how these are different /similar to relationships in industrialized countries, and what are the concepts and models suitable for less industrialized countries before embarking on either copying or introducing new policy instruments.

This calls for systematic study of existing relationships, their similarities and differences to features in industrialized countries, and appropriateness models in industrialized countries to explain the relationships in less developed countries.
The research in the Sri Lankan context is expected to provide important insight to the situation of a small developing country and look for more appropriate policy recommendations. The findings can be used as a guideline for any other small developing country which possesses a similar level of technological and industrial advancement.

1.3 Objectives of thesis

I argue that despite those weaknesses of Science and Technology (S&T) sector and low level of industrial development, the URI relationships in developing countries show many similarities to those of developed countries. Also, theoretical frameworks used in industrialized countries can be used to explain the nature and trends of these relationships. However, the difference in the actors participating in the process creates changes in the nature and characteristics of relationships. Interactions in developed countries may focus on advanced technologies and basic research while the interactions in developing countries may focus on efficient utilization of resources. As explained above, firms in developing countries tend to import technology from abroad rather than developing locally. However, they need to interact with the local S&T base for understanding and process changes for efficient utilization of resources. According to Noisi, Saviotti et al (1993), developing countries such as Sri Lanka are believed to involve in minor and adaptive nature of innovations such as scaling down of products, processes, and plants, as well as the substitution of some raw materials to others. This leads to the question as to whether the URI relationships seen in less developed countries show the same characteristics of the relationships as in industrialized countries. Alam, Jayakumar, et al. (2003) report that research based relationships are still lacking in the Indian context. To answer this in the context of small developing countries it is necessary to investigate and capture the characteristics of relationships in small developing countries like Sri Lanka, in relation to similarities and differences to those relationships of industrialized countries. Hence, the first objective of this thesis is to;

Objective 1: find whether the characteristics of university, research, industry relationships seen in the industrialized countries can be seen in small developing countries?

The hypothetical context on this line is, the URI relationships in small developing countries shows similar characteristics in general, but in particular confine to

limited modalities of relationships. The existing relationships are dominated by education and training based relationships and service based relationships rather than R&D based relationships. Most of these are informal relationships due to there unorganized nature and resource limitations. Hence, this leads to the research objectives to explore the existing characteristics of URI relationships in Sri Lanka.

The issues that underline the URI relationships in industrialized countries are well explained in the innovation related theoretical framework. Starting from the theory of linear model of innovations up to the most modern interactive theories such as National Systems of Innovation (NSI), mode 2 and triple helix concept are more extensively used in the literature to explain and conclude various characteristics of relationships in industrialized countries. (The review of theoretical frameworks is covered in the chapter two). However, the critical literature on operations of the relationships is limited. Hence, the second question arises in this context is whether these theoretical frameworks are adequate to explain URI relationships in developing countries? This leads to the second objective of this thesis:

Objective 2: To what extent is the theoretical framework developed in industrialized countries appropriate for the analysis of relationships in small developing countries?

The hypothetical context in this line of argument is that the theories and concepts developed in industrialized countries can be used to explain the differences of characteristics in small developing countries when compared to industrialized countries. This leads to an investigation of the deficiencies in framework conditions such as the absence of an institutional arrangements, the lack of capabilities in industries for absorption and adaptation of imported technologies, inadequate resource allocations by the Government, inadequate funds for modernization of government laboratories, absence of S&T personnel in adequate numbers and a lack of the appropriate skills. However, the context of issues affecting the non-R&D mode is quite different to that of the R&D mode of

relationships. The R&D mode is more controlled/motivated by the framework conditions, which are generally discussed in the concept of NSI. But the non R&D mode is more controlled by process related conditions where NSI does not give clear explanation. Also, these process related conditions are less discussed in the literature.

The governments regard the URI relationships as an important concept and hence intervene in several ways to encourage industrial technology and economic development by formulating necessary policy instruments (Baba 1988). In other words, URI relationships have been considered as facilitating processes for promoting innovative behaviour in the work of the actors in the National System of Innovation (NSI) of a country. This helps to keep up with changes in the technological and extract opportunities for industrial growth in the local and international market. However, governments in developing countries tend to implement policy tools that are seen in the promotional context of developed countries, without taking the trouble to effectively understand the country specific conditions that are critical for operational context and performance. For example, constraints in most developing countries such as a weak industrial base, less developed skills and a lack of R&D capabilities, including level of R&D expenditure can usually be overcome by adapting generic policy interventions. Governments can also intervene by copying the establishment of promotional structures, seen in developed countries. Despite the presence or absence of such policies, how different actors of the URI spheres react to the emerging requirements appear to have country specific formula. This seems to be the real nodal dynamism in developing countries that needs the attention of the interventions. Sutz (2000) emphasizes that understanding micro strengths are equally important to promotional mechanisms such as structural mechanisms. Hence, research issues need to go beyond generic policy interventions and be concerned about bottom level (micro level) elements that retard/promote the potential to generate interactions. On the basis of this argument, the third objective of the thesis is developed as:

Objective 3: To recommend policy interventions to promote URI relations for technological innovations with special reference to the micro level dynamism of the actors and organizations that support/constraint interaction.

The hypothetical context in this connection is that the existing policy tools and directions in Sri Lanka, are on the one hand, inadequate to address the framework conditions required to promote relationships and, on the other hand, do not have capabilities for "Conscious effort" to promote the evolution and designing of instruments based on the understanding of the micro level issues. An understanding of micro level conditions in the policy making process also needs a conscious effort. In this context a review of policy statements in Sri Lanka is conducted and details are given in chapter three.

1.4 Thesis structure

Chapter two is devoted to a review of literature connected to the taxonomy of relationships, theories and models related to innovations. The major role of this thesis is to identify the role of public policy processes in linking industries with universities and research institutes in small developing countries. In this context, the need for understanding micro level conditions is highlighted as a prerequisite to formulate policy interventions, specially in the event that framework conditions are inadequately addressed in terms of existence and functionality. Hence, this thesis uses existing models and concepts related to interactions to support the arguments and discuss limitations rather than developing new models and concepts. This taxonomy will cover literature on types of relationships, and factors connected to the motivation and barriers, funding, coordination and the actual benefits. The taxonomy of those factors, which are described in chapter four, are borrowed from the literature that is based on developed and large developing countries and specific factors are picked out for this research problem. The relevance of these factors is assumed to be applicable even for small developing countries.

Models of innovations were reviewed to determine and highlight issues for testing in developing countries. The Linear model, a few selected interactive models, mode 1 and mode 2 of knowledge production, and the triple helix model were discussed in these contexts. The characteristics of mode 1 and mode 2 are highlighted and the features of the transition period are proposed. These features are used to investigate whether they can be seen in the developing country context. Chapter two also discusses the role of government intervention in terms of stimulating innovation processes, the importance of universities and research institution set up, and facilitating SMEs through incentives. The lessons and examples from the NIC and large developing countries are highlighted to illustrate the diversity of government interventions used in those countries.

Chapter three is devoted to describing an overview of the Sri Lankan context to provide the reader an understanding on S&T infrastructure, existing industrial and S&T policies and recent initiatives to promote URI relationships in the country. This chapter also gives the reader a coverage of the level of industrial development of Sri Lanka, weaknesses of the system and an existing policy tools and initiatives. A brief overview of similar contents in Indian context is also given in this chapter for comparative purposes.

The research problems are framed based on the objectives of this thesis and the literature review that are discussed in chapters one & two. Chapter four defines the research problem and identifies what sort of empirical evidences are needed. The major characteristics of URI relationships were identified for investigation using the literature. This chapter will also contain the assumptions, and scope of the research (defines the limits of the research and specific terminology used in the thesis). Finally the research objectives and hypothesis based on those objectives are formulated.

Chapter five is devoted to the methods used to investigate and conduct the research. Research design, the reasons for selection of the method and samples, techniques used and preparation for analysis are described in detail in this chapter.

The research method consisted of four stages. As I had to begin from basics, starting from identification of characteristics of existing relationships among the URI actors, the research process commenced with a semi structured postal questionnaire to the sample of academics, researchers and industrialists. In the second stage of the research, the respondents of stage one were interviewed. The data gathered was used to obtain an in-depth understanding of the features of what is happening in these relationships. The issues that evolved from the data were categorized for analysis. Based on the recommendations of the respondents, a snowball sample of important individuals in URI spheres was also interviewed. The third stage consisted of obtaining views and opinion of the managers and persons involved in policymaking processes through semi structured interviews. The interviews in this stage were used to triangulate the outcome of stages 1 and 2 and to describe the evolving process of trends and directions. Finally, based on the interviews undertaken, four new forms of organizations that evolved within the URI institutional framework were investigated to see how they operate and perform in relation to the findings from the survey and interviews. A similar form of organization in the Indian context was taken as a comparative example. A detailed account of the method and the reasons for doing so is given in chapter five.

The framework of analysis designed is represented in the figure 5.1. The analysis process was arranged to match with the data collection process. For example, the data gathered from the questionnaire survey were analysed using quantitative methods. The quantitative method focused on identification of major characteristics and factors affecting those characteristics.

The details of the analysis of the questionnaire survey and findings are given in chapter six. This chapter not only identifies the major characteristics of the relationships and the factors affecting those characteristics, but also raises the questions that need in-depth explanation, if one wants to understand the underlying issues affecting the relationships. These questions are brought forward to the qualitative analysis, which follows chapter six.

The chapter seven mainly deals with the second research question on " What are the reasons for the availability of existing characteristics?". The qualitative approach (coding and clustering approach) was used to analyse interview data (data from stage 2) for better understanding of the issues raised by the informants. Interviews were transcribed and notes were prepared for open coding. Open codes were divided into two major categories where one category dealt with comments on framework conditions to promote relationships. This category was then analysed with quantitative terms by counting the frequencies of appearance of codes. This process enabled the extraction of the most important framework conditions that appear in the Sri Lanka context. The details of the analysis and the findings are given in the seventh chapter. This chapter gives details of the qualitative analysis process to highlight the framework issues that underpin the relationships. It also attempts to answer a set of framework related questions that arise in chapter six.

Having analysed the framework conditions, the rest of the codes were revisited to develop themes and conceptual frames related to process related issues. This enabled the identification of the major process related issues which could be considered as the major concerns in promoting relationships in a developing country context. The analysis identified fifteen micro level issues which can be re-allocated to three sets of issues influencing the type of organization. The details of the analysis and the findings are given in the eighth chapter.

Four examples of new forms of organizations that evolved in the Sri Lankan context and one example in Indian context are described and matched with the findings derived from the qualitative analysis in chapter seven and eight. This chapter shows how these new forms of organizations are geared to overcome the process related problems, which are prominent in the universities, industries and research institutes. The descriptions on each of the new forms of organization and interpretations are given in chapter nine.

As the major outcome of the research was to identify the characteristics of relationships and come up with policy recommendations for the government, these findings are used to propose the role of government policies to promote relationships.

The final chapter (ten) is devoted to overview the research questions against the findings, and bring out the policy implications for the governments, which are produced as a set of recommendations for policy initiatives. Chapter ten also deals with the limitations of the findings, and the novelty of the research methods and findings. It also proposes the areas that need further research.

1.5 The scope of the research

The research is focused on the URI relationships in Sri Lanka. The existing Government organizations, universities, research institutions and manufacturing industries who are dealing with Science, Engineering and Agriculture were taken as informants. The informants are divided in to two major groups. One is operational level informants (for example academia, researchers and practicing industrialists-type1) and the other is the managers and persons who are more directly involved in the policy-making process (type2). Multinational organizations were excluded in the research for two reasons. One is the number of multinational companies operating in Sri Lanka is minimal. The other reason being that Multinational organization do operate in a completely independent set of norms where the government has very little control and hence the government intervention for promoting relationships will have a very limited or negligible impact on multinationals. For examples, the MNCs operating in Sri Lanka do not have any product/process developments in the country and all the R&D work is done in foreign laboratories.

To narrow down the scope, informants were selected from five industrial sectors namely food S&T, rubber, fisheries, textile and clothing, and IT. The selection of industrial sectors was decided on the knowledge of the researcher about the

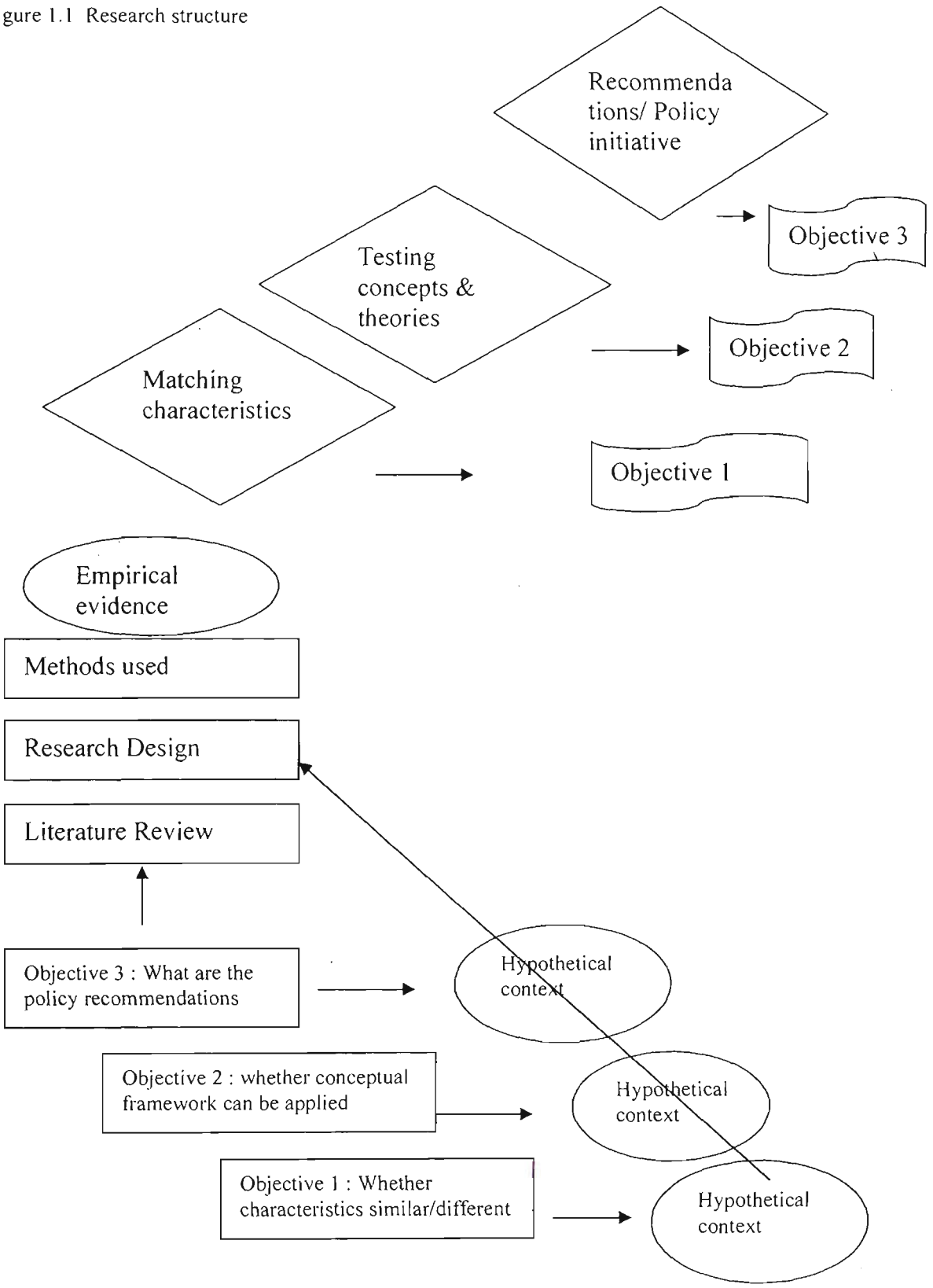
potential for URI relationships in those sectors and the importance of the sector in the economy. The details of the definitions, scope, assumptions, hypothesis and activities planned to achieve the objectives are given in chapter four.

1.6 Brief overview of Sri Lanka[1]

Sri Lanka is regarded as a small developing economy with limited technological capabilities and a weak industrial base. The agriculture sector dominates the economy while the manufacturing sector show continuous growth during the last decade (Fernando and Amaradasa 1998). The low level of Gross Expenditure on Research & Development (GERD), R&D manpower and industrial R&D are regarded as underlying issues for the prevailing backward nature of technological advancement. Non-relevance of university curriculum for industrial needs has been emphasized and remedial actions have been taken (Anonymous 1995). The research institutions are also reported as ineffective to fulfil the needs of the industry (Wignaraja 1998). Universities confront increasing challenges of producing marketable graduates and adapting application oriented courses. This situation has provided a remarkable environment for the industries, universities and research institutes to collaborate for mutual benefits.

[1] Details of the Sri Lanka context is given in Chapter three.

Figure 1.1 Research structure



Chapter two - Literature review

2.0 Introduction

The first chapter sets out the objectives of this thesis. The literature review intends to review the available knowledge related to the objectives of this thesis. They are:

With respect to Objective 1 on "Characteristics of relationships":

1. What are the characteristics of URI relationships in developed countries and large developing countries?
2. Can these characteristics be used to test and explain the relationships in small developing countries such as Sri Lanka?

With respect to objective 2 on theoretical frameworks and concepts:

3. How are URI relationships theoretically framed and how do they explain the URI relationships in industrialized countries?
4. Is the scope of these theoretical frameworks adequate to explain the situations in less developed countries specially, small developing countries like Sri Lanka?

And, finally with respect to objective 3 on policy interventions:

5. What are the policy interventions practiced in developed countries and NIC to promote technological growth in industries?

The available literature falls under two categories: Comparatively abundant promotional literature which describes the new mechanisms, schemes, projects and programmes to promote these relationships; and critical literature specially in the case of developing countries. In this context, the researcher looked at the promotional literature as well as critical literature in both developed and developing countries. Before embarking on an attempt to answer the above questions, I would like to reiterate the importance of the URI relationships, both in

general and why it is important to understand the nature of these relationships in different contexts.

2.1 Why relationships are important

As given in the key definitions in this thesis, the URI relationships is considered as "Any relationships among universities, industry and research institutions or among individuals in these institutions, in the form of educational & training, service or R&D based interaction". The importance of the URI relationships emerged in developed countries as a key agenda specially in higher education policy making circles at both national and institutional levels during the latter part of the 20th century. In the context of knowledge intensive economies, the governments have increasingly considered the importance of higher education and research institutes as strategic actors in economic development. For example, in the USA the linkages were not active until 1965 (Baba 1988). Subsequently the federal support has stimulated the creation of relationships in new forms to meet technological advancement. Such developed countries have considered URI relationships as a means to keep up leading edge research capabilities, to improve applicability of knowledge for social needs and to use the resources for international competitiveness. OECD (2002) observed the increased commercialisation of public research and accelerating development of formal mechanisms for industry science relationships in OECD countries.

In this context, universities, industry and research institutions act as complementary organizations where they share resources to achieve common goals. The LINK programme in the United Kingdom is a good example for Government intervention towards such intentions. Furthermore, the developed countries increasingly provide the necessary indirect services such as venture capital, intellectual property protection laws to promote knowledge creation and utilization. In other words, all the components of the National System of Innovation (NSI) are stimulated to provide necessary back up support for URI relationships.

Furthermore, Leydesdorff (2000) has observed that universities, industries and governments are involved in taking the other's role where one type of organization influences the changes in the other type. This phenomenon is described in the triple helix concept which will be discussed later in this chapter. Furthermore, Gibbons, Limoges et al (1994) observed the changing role of modern universities to fulfil the roles of teaching, research and socio-economic roles as well.

2.2 Why understanding URI relationship is important

The importance of understanding URI relationships can be looked at in two different opposite ways.

Firstly, it is noted that the nature of the linkages in developed countries vary from country to country and , hence, the instruments used to promote relationships also vary. There is no standard formula for promoting relationships. Formation of new structures with new functions, allocating financial and other sources for the new forms such as university based incubators, facilitating spill over concept, and promotion of venture capital are general features of the evolution of linkages in developed countries. These structures seem to have promotional effects in general. The real contribution of such structures for technological development has not been evenly been demonstrated. For example, Dierdonark, Debackere et al. (1990) reports that the academia in Belgium indicates that technology transfer mechanisms may offer some limited help. This suggests that the operations of these structures need to be evaluated critically to see the effect of the environment in which it operates. This shows that understanding how the external environment shapes the relationships is important to maximize the effectiveness of these structures.

Secondly, individual organizations respond to the changing environment and undergo changes. For example new forms of organizations evolve within traditional forms of organization. It is important to understand these changes and the contributing factors to forecast what kind of organizational attributes will evolve in the future.

With the disappearance of geographical boundaries due to globalisation and IT revolutions, institutions became more open to collaborations and responsive to the challenges and structural problems. In this context, the role of the policy intervention in stimulating and supporting the evolution process is increasingly emphasized in international research (Turpin 1996). In order to intervene effectively, it is important to understand the features, trends and conditions that shape URI relationships.

Finally, as the URI linkages are a relatively new phenomenon having developed over the past three decades even in most industrialized countries, and inadequately tested in developing countries, the range of diverse realities are still not fully reflected in the international literature. In this context, it is useful to review some examples from developed countries.

2.3 Characteristics of URI relationships

Interactions among University - Industry - Government Research Institutes (U-I-R) take place depending on social, cultural, economic differences and the level of technological advancement. The modalities of URI linkages can be categorized based on three basic approaches such as education based, research projects based and services based approaches. These approaches seems prevalent in developed countries as well as developing countries. Alam, Jayakumar et al. (2003) have observed that the relationships in the Indian context are dominated by education & training mode and service mode relationships.

These interactions were found to have taken on a variety of different formats. At one end of the spectrum prestigious institutions may be linked to major high tech firms for multi-year joint R&D. At the other end, a small institution may find relationships with a local company by providing technical assistance to upgrade existing low level technology and management of techniques, or by offering further education programs to upgrade competencies. The taxonomy of the URI relationships, accordingly, can be described based on the involvement of

organization and coordinating procedures. The main variables that can be used in categorization based on involvement of organization procedures are organizational resource involvement, (in terms of personnel, equipment and financial), length of agreement and degree of formalization (Bonaccorsi and Piccaluga 1994).

Studies done in many countries provide evidence for the existence of some common characteristics of collaborations such as type, motivation factors and barriers (to initiate as well as to continue existing relationships).

2.3.1 Types of linkages

The major characteristic of linkages is the type of relationship. As said above the type of linkages can be varied according to the involvement of the organizational and individual resources. These are categorized into a number of ways including categorizing according to the formality of the linkage (Souder 1993). Personal contacts (formal and informal) and the exchange of people seem to play crucial roles in initiating and coordinating linkage programmes. The importance of informality seems to be an unchallenged reality, even after years of formalization efforts for collaborations (OECD 1992; Sutz 1998). Informal networks are considered as the building blocks and decisive ingredients for the establishment and successful operations of. Research and Development (R&D) related corporations and communications between industries and universities (OECD 1992). On the other hand, structural mechanisms which are often established under government patronage have shown successful results in countries like Australia (Turpin, Aylward et al. 1999). A study undertaken by Turpin, Aylward et al (1999) revealed that a Collaborative Grants Programme and Postgraduate awards (Industry) programme (before integration in to SPIRT programme) were successful mechanisms to promote university industry research partnerships. Incubators, S&T parks, industrial parks, liaison officers, and industrial chairs are well established structural mechanisms that can be seen in developed countries.

2.3.2 Motivation

Bonaccorsi and Piccaluga (1994) grouped the motivation of firms to enter into relationships into four categories namely: delegating selected development activities; lack of resources; and increasing the predictive power by getting access to scientific frontiers. The access to scientific frontiers, which is a private asset that needs internal investment, has been regarded as the most important motivation factor by Bonaccorsi and Piccaluga (1994). Arnold and Truriaux (2001) also concluded that in Ireland, most firms are interested in information about international scientific developments through relationships, and some firms fund university research to obtain them. However, for industries in small developing countries, the motivation factor may take different forms. With the increasing level of competition, industries in developing countries need to acquire new knowledge to develop their products and processes, which is the only way to keep up with the competition. The Multi- National Companies (MNC)s always have the benefit of receiving technological know-how from their parent firms and hence very little efforts are being made to develop in-house R&D capabilities in Sri Lanka and contacts with local S&T base. In contrast, the SMEs which have to depend on informal ways to catch the technological know-how may show a substantial level of informal contacts with outside industries, scientists and technologists within and outside the country. Therefore, the SMEs need to consider relationships with universities and research institutes as an easy way to access new knowledge. Hence, for industrial firms the drive for linkages may take different forms including risk reduction, earlier access to S&T knowledge and networks of experts, access to research skills, cost reduction through delegation of certain R&D activities, new instrumentation and methodologies and to recruit new employees (Souder 1993).

For universities and research institutes motivation factors are assumed as more homogeneous. As such the following parameters are selected as motivation factors for the research. For universities and research institutes, it can be finance for research, exposure to application -oriented research, personnel economic benefits through consulting, opportunity to publish and desire to product/process

development. The academia may motivate for additional parameters such as, better insight into curriculum development, support for postgraduate students, support for student employment and up to date material for teaching (Souder 1993; Wong 1999). Dierdonark, K.Debackere et al. (1990) expressed their doubts about the desire of industry to get access to technologies developed in universities or research centres alone as generally industry does not rely on universities and research institutes for commercially viable technologies.

2.3.3 Barriers

Souder (1993) has identified a comprehensive list of barriers to relationships starting from "barriers to making appropriate contacts" to "Proprietary rights". It was noted that this list can be basically categorized in to three groups. The first group which affects the initiation of these relationships includes: difficulty in making appropriate contacts; cost and nuisance of searching for partners; time commitments required to find suitable partners; lack of familiarity with forms and procedures; and lack of awareness of university capabilities and industrial capabilities. The second set comprised of barriers to continue the existing relationships. For example, cultural differences, lack of explicit rewards & incentives, lack of technical expertise, lack of research orientation, image and pride, staff resistance, uncertainty of choices, dissimilar motives, bureaucracy, low level of absorptive capacity of industry, lack of commitment, lack of communication needs, low level of industrial research, and weak capabilities in universities and research institutes are a few intrinsic factors which can be grouped into the second set of barriers.

The third set of factors (can be named as conflicts rather than barriers) can be seen in the literature that presumably surface at the maturity of relationships. These include publication restrictions, confidentiality agreements, proprietary rights, lack of negotiations and lack of clear understanding at the point of initiation. As it is assumed that the relationships in Sri Lanka have not matured enough to take

these factors as barriers, this set of barriers has been omitted from the research design.

2.3.4 Actual benefits and achievements

Linkages are assumed to offer benefits to achieve their organizational goals and personnel benefits. The actual benefits and achievements brought in to the system through these linkages will be examined. Benefits such as recruiting trained personnel to the industrial organizations (Arnold and Truriaux 2001), commercialisation of technologies developed through these programs, increasing profits by capturing new markets or increasing market share of the existing market, capturing scientific expertise which was not available before, new product/process development, and solving a technological problem are the common benefits that can be expected by industrial firms.

On the other hand, opportunity to carry out applied research with industry which is instrumental to foster a degree of confidence and trust, funds for research, upgrading laboratory facilities, commercialisation of research results, product process development and financial benefits to individuals are common benefits that can be expected by universities and research institutes. Also universities may have an additional benefit as employment and training for students would become much easier through industrial relationships, However, the personnel benefits arising from a successful linkage program cannot be measured due to the complex nature of personal benefits.

2.3.5 Management and coordination

In addition to management practices of the relationships, communication and coordinating practices are also important characteristics of these relationships. Managerial ability is considered as one of the capability related factors that would encourage innovation (Dodgson and Bessant 1996). As it was not possible to extract any useful literature that discussed different variables related to

management and coordination, it was decided to design my own set of factors related to those variables. Accordingly, the management and coordination of relationships are considered in the form of institution specific coordination mechanisms such as independent project office, commercial/service arm and contact offices in institutions or industries, and person embedded mechanism such as coordination through individuals (e.g. research students) and researchers. In the meantime, communication mechanisms are considered as a process oriented approach. For example, communications through regular meetings, official correspondence, site visits, informal talks and communication through personal contacts are considered as major communication channels that can be seen in the relationships.

The issues related to small developing countries where in most of the time the structural arrangements are absent or in infant stages, are not adequately expressed in the policy literature. However, in the above context, small developing countries with less market opportunities and limited production capabilities may be operating under different sets of factors that determines the level of interactions for technological growth and hence, the U-I-RI interactions in these countries may take different shapes within the socio-economic environment. This requires a different set of policies and government interventions to be adopted in these countries. Hence in this study, it is assumed that small developing countries do not operate in a vacuum; some features of these interactions are in existence while some of them are being evolved in developing countries.

These relationships are supported and constrained by the elements of the NSI and other process related S&T environment of a country. The S&T environment can be described in terms of institutional arrangements, interactive mechanisms, policy interventions as well as behavioural features which should be considered as the elements of the National Systems of Innovation. Hence the study expects to provide inputs into concepts and innovation theories in relation to the importance of framework and process related issues where systems are being evolved.

Increased understanding of these issues will help clarify the role of the government intervention in the facilitation of these relationships.

As argued earlier, the URI relationships fall within the theoretical framework of innovations, Triple helix and mode 2 concepts, and hence, it is logical to review the literature on innovations. The following section will review the theoretical frameworks and concepts used to describe URI relationships.

2.4 Review of literature related to theories of technological innovations

Relationships between S&T and economic growth are too complex to explain. Many relate economic growth with expenditure on research & development. Traditionally, the assumption was that R&D leads to new products/processes where technology can be disseminated to the production sector. This linear process begins with scientific research followed by technology development, scaling up, manufacturing and finally marketing. This "Linear process of innovation", which expects that investment in basic research would yield economically beneficial results (but no guarantee), cannot describe fully the process of innovation. However, the linear model of innovation cannot be thrown away due to many reasons. For example, Tait and Williams (1999) argues that the linear model of innovation is seen in certain industries such as agrochemical or Pharmaceutical industries and in micro-electronics even in developed countries. Furthermore, in the context of small developing countries, where it possess weak industrial bases and hence innovative contributions by commercial organisations are limited and where the government is expected to invest public money in S&T , the linear model appears to take a prominent role.

2.4.1 National System of Innovation (NSI)

According to Lundvall (1992), the dynamics of process of innovation is characterised by firm level elements and their relationships with many elements in national boundaries such as public policies, inter-firm networks, financial

institutions, R&D infrastructure, and national education & training systems. *Vice versa,* such features of these interactions may vary from country to country where the relationships among these elements take different forms at varying degrees, which are characterised by the National System of Innovation (NSI). Although the NSI is shaped by the country specific elements such as social, political, economic and cultural features, the landscape of the national systems can be indicated in terms of internationally comparable factors and country specific factors. The internationally comparable factors such as traditional R&D indicators(R&D intensity) and stock of research scientists and engineers (RSE) per unit of labour force shows the overall scenario of basic attributes of the NSI, but it does not adequately describe the complex operations and the nature of interactions among the actors in the network.

With respect to country specific factors, (Sutz 1998) argues that the role of the government on innovation is considered as "to assure smooth operation of a smart network of incentives able to encourage and facilitate the networking between the players and the creators of the innovations and to push each part of the system in to the innovation road". This interpretation considers that the NSI as a supplier of conditions for innovations. As such the weakness of the NSI concept is that it has little concern with respect to acting as an influencing or intervention agent. It assumes that once the conditions are supplied the system will operate automatically fulfilling the expected functions.

This assumption might work in countries where the systems and subsystems are well developed. In developing countries where the systems and subsystems do not operate efficiently (due to many reasons) one cannot expect the adequacy of supplier conditions (only) to generate innovations. These inadequacies are felt in developed countries also. For example,

> "The National Science Foundation(US) funds broadly interdisciplinary research—including many university-based centres that focus on industrial problems with explicitly behavioural and social dimensions. The Government-University-Industry Research

> Roundtable seeks to identify and to illuminate issues at the forefront of our nation's science and technology enterprise and it examined issues in moving social and behavioural sciences knowledge across government-university-industry boundaries". (anonymous 1992)

2.4.2 Triple Helix

On the other hand, in the Triple Helix (TH) concept, it is believed that the Government, industry and academia are moving to take other's roles through negotiation, reorientation and influential processes. Triple helix mode I configures the situation where nation states direct academic and industry relationships. Triple helix mode II represents the Government, Research and Industry as three separate entities with strong boundaries dividing them but interacting between two in a weaker form. Triple helix mode III brings out the nature of one sphere stepping into functions of the other spheres and evolving hybrid organisation at the interface (Etzkowitz and Leydesdorff 2000). According to (Etzkowitz and Leydesdorff 2000), the approaches of different countries can fit into one of the above three modes of the triple helix models. For example, approaches of the socialist countries such as the East European countries fit in to the Triple Helix mode I and approaches of most of the developed countries fit in to the Triple helix mode III.

In Triple Helix mode III, to function the complex processes effectively , requires various institutional, interface , network and communication capabilities, which reflect on themselves leading to dynamic processes of transformation. Major features of the existence of the triple helix model are described as

- Internal transformation within each helices
- Transforming influence of one helix upon another
- Creation of new organisations and networks that institutionalise trilateral linkages and interfaces

- Recursive effects of these networks on the separate spheres and on society as whole

As it can be seen, the Triple Helix concept demonstrates interventionist features in the URI relationships which promote innovation within national boundaries, through the continual transformation of influence on the other helices (Sutz 1998). In relation to small developing countries, like Sri Lanka, the appropriateness of the TH concept on URI relationships is vague and always criticized. People tend to reject the concept at a first appearance as the TH concept is mostly concern about research based (knowledge production) relationships (very limited in small developing countries) rather than education & training based and service based relationships. In my opinion, the TH concept does also consider relationships other than research mode relationships for knowledge production. On the other hand, even in non-research modes of relationships, there is a role of knowledge generation and transfer. Hence, I wish to argue that the TH concept can still be used to explore the process related issues of innovations in small developing countries.

One of the weaknesses of the TH concept is that the term "Government", to my understanding, does not represent the role of the state in public policy making process. Rather it discusses the role of public bodies including research institutions. As system failures are more complex in developing countries, it requires more and more public policy interventions which is one of the major agents in negotiation, influence and reorientation. Hence, the role of public policy should be considered as an interacting helix in addition to the triple helix to explain the relationship in developing countries.

As the level of industrial research is very low in small developing countries, the limited consideration of the triple helix concept to research seems to be inappropriate. However, the features of the TH concepts can still remain to be used for testing and trend seeking purposes. What differentiates National System of Innovation from the Triple helix is that the former makes use of historical

analysis and comparative analysis of different countries. Triple helix on the other hand draws on the effectiveness of linkages between University- Industry-Government partnerships for enhancing the effectiveness of innovation within the national boundaries which shape the course and direction of the innovative behaviour at the micro and institutional level (Sutz 2000). Hence the research problem will be addressed in the light of NSI concept to deal with the framework (supplier) conditions and in the landscape of the TH features for the process related conditions. Sutz (1998) proposes that the state of the NSI is a supplier condition for innovation while the state of the triple helix is an interventionist agent for relationships (Table 2.1).

Table 2. 1 Roles of NSI and TH[2]

	Framework conditions	Micro level conditions
NSI	Supplier role of framework conditions (e.g. legal, institutional, financial, regulatory structures)	
TH	Interventionist role (e.g. determining research priorities, regulatory interventions, behavioural interventions etc)	

2.4.3 Mode 1 and Mode 2

For universities, which play a major role in the knowledge production process of the NSIs, it is important to review the theoretical background connected to them. In this context, the mode 1 and mode 2 processes of knowledge production explain the circumstances.

Historically, academic institutions encounter the generation of new knowledge as a social responsibility. Hence, teaching and research are now co-existing roles of a academic institution all over the world. The conduct of research has become the secondary role of academic institutions (first revolution of the academic

[2] Constructed based on Sutzs (1998 & 2000)

institution). This is also called mode 1 of knowledge production, which rests on the idea of complete autonomy for science and the disciplines of science, and has well marked out boundaries in which academic pursuit is undertaken. Traditional behaviour, and the subsequent revolution in the academic institutions, face new challenges governed by society to make knowledge production more accountable. Thus the new regime of knowledge production started emerging where the problems are not set within a disciplinary framework, rather there is close interaction of actors through out the process of knowledge production.

The outlook of universities in the mode1 and mode 2 domains are well explained by Gibbons (1994). In this context, the system attributes and their features in the transition period can be observed as given in the above table. The way in which the transition from Mode 1 and Mode 2 is projected as a new perspective appears to be only partially relevant to developing countries and the rate of transition once again is decided by an integrated interactive approach blending scientific, technological, socio-economic and cultural aspects which has a reflexive effect that shapes the modes of interactions as well. This is where the role of government interventions can make a paradigmatic shift in the process of interactions.

Table 2. 2 Features of Mode 1, Mode 2 and transition period

Issue	Mode 1 features	Transition	Mode 2 features
Framework	Autonomy of science and the disciplines of science had well marked out boundaries	New disciplines Formation of teams	Problems are not set within a disciplinary framework . Problem solving capacity on the move
	Highly institutionalised	Various actors come in	Less institutionalised
	Pure research more prominent and receives more recognition	Intervention to pressurise market orientation. Form teams around demand driven areas	Patent application and consultancy services on the rise.
Knowledge production	Generated under more stable cultural conditions	Governed by the balance of demand and supply	More open system of knowledge. Not planned or coordinated by a central body. Knowledge is generated in the context of application
	Physical and financial resources more important	Pressure for limited resources. Income generation driven activities.	Application of knowledge is more important.
Behavioural patterns	Regulations and academic quality more important	Evolving workable arrangements. Care for credibility, confidentiality.	Flexibility, trust and response time are critical factors
	Diffusion of knowledge is confined to one place Formal diffusion methods	Formal scientific output decreases.	Social diffusion not confined to a place or context.

Sources : Gibbons 1994 & self

2.5 Policy interventions

This section highlights the role of public policy interventions taking into account the examples from developing and newly industrialized countries. Both financial and non-financial interventions, where the latter is equally important for developing countries, are discussed below.

2.5.1 Government interventions in general

Government interventions to foster interactions have a considerable variety based on different setting in different countries. Polt, Rammer et al. (2001) considered that,

> " the comprehensive, stringent and long-term oriented S&T policy, balance between Technology Transfer with fundamental research activities in public science and intervention to address market and systemic failures without disturbing market efficiencies have been distilled from experience of different countries as good practice approach " .

Policy interventions can be categorized based on their purpose such as interventions towards promoting framework conditions. This includes infrastructure, funding and other issues related to long term objectives and process related interventions such as management practices, procurement and flexibility which may result in changing the behaviour of institutions and individuals. These two types of intervention may produce spill over or overlapping effects. For example, framework related interventions such as incentive schemes can affect the actors behaviour.

2.5.1.1 Interventions related to framework conditions

With respect to frame work level intervention, government intervention in supporting structural mechanisms such as liaison offices, university innovation centres, Technology Innovation Programmes, University

Companies, Teaching Companies, joint R&D programmes and University Industrial Parks may be capable of fostering frequent and informal contacts, and more effective formal interactions. OECD (2002) has observed the accelerating development of such formal mechanisms in OECD countries. In relation to incentive schemes, the government can also offer financial incentives to firms , and specially to SMEs, to contract out R&D work to universities.

Government intervention can either end up at the creation of framework conditions (leaving the different actors to perform the rest of the functions according to their mandates) or continue finetuning and providing additional interventions in the form of process related interventions or new forms of framework related interventions. To continue the interventionist's role, a government needs to perform a coordinating and consensus building role while participating and allocating resources at different stages. For this to happen, evaluation on impact of interventions and incentives needed to be put in place.

2.5.1.2 Process related interventions

The facts on process related interventions are comparatively little known in the literature. The reason for such scarcity may be that process related interventions are mostly practiced at the institutional level rather than at the macro level and hence contain case/situation specific behaviour. Macro level regulatory mechanisms can be regarded as another set of process related interventions.

The influence of government in determining research programmes, which can be regarded as process related intervention, varies from country to country. For example, in Japan, Germany and also in India, the major research programmes are closely related to government policy (Rothwell and Zegveld 1981). Although, it is obvious that the government support linked to an overall industrial strategy can have an integrative effect, in many countries, the government involvement in determining directions of

research is relatively small. Behaviour of institutions and individuals can be altered by regulatory interventions. For example, regulations related to human mobility and freedom can change institutional outlook and individual character.

In these circumstances, the most common policy instruments related to promoting innovations which many developed and developing countries are using is to encourage investment in collaborative R&D by respective enterprise sectors in the form of tax incentives, variety of research grants and loans, and government backed venture capital (Mani 2002). These policy interventions are clearly articulated for developed countries as those enterprises are usually technology leaders or close to the leaders and need to keep up-to-date with basic research. Developing countries are perceived to be assemblers or imitators of technology that are usually developed elsewhere and imported through various channels. In this direction, more advisable policies are for government interventions to promote technology flow into the developing country economies and conduct adaptive R&D to suit local conditions and materials (Niosi, Saviotti et al. 1993). Interventions for the promotion of process of adaptation and imitation need not be only financial instruments but also non-financial instruments such as policy instruments on human resource development and other non-financial incentive schemes. In other words, for developing countries, non- financial based interventions are equally important compared to the developed countries. The common non-financial interventions, specially to promote SMEs, could take the form of;

- Encouragement of network of cooperative research associations
- Provision of technological and market information services
- Assistance with exports
- Provide access to government funded R&D infrastructure
- Decentralization of innovation assistance to avoid bureaucratic delays and simplify application procedures

- Encouragement of a variety of cooperative efforts among small and medium sized firms (which will help scaling up in production and marketing)
- Encouragement of increased involvement of research associations in problems of production, management and marketing
- Increase involvement of industry in decision-making and the implementation of government measures (Rothwell and Zegveld 1981).

These general measures have greater impact on industrial innovation than R&D specific measures such as allocation of funds for basic research. Empirical studies have shown that innovation specific government measures will only have the desired effect on innovation in industry when they complement, and not replace, or compete with, more general government measures (Rothwell and Zegveld 1981). In terms of R&D specific interventions, governments need to have an understanding of framework induced needs, and needs induced by general measures to make compatible interventions at lower levels. This again calls for the need to have continuous monitoring and evaluation mechanisms to make intervention more effective.

Against this background, it is worthwhile to see the policy instruments adapted by selected newly developed countries and large developing countries. The intervention related to interactions is broadly fit into innovation policies, and therefore, the lessons are looked at from the point of view of innovations.

2.5.2 Features of interventions in NIC countries and selected developing countries

South East Asian (SEA) economies have witnessed many organizational development processes involving industry and universities with various interaction modes. For example, industry liaison offices involved in education based interaction modes such as seminars and training activities to establish

linkages with industry and to generate income. These offices also arrange and administer consultancy services, which seems to be the most economical activity. For example the industry liaison office in the Chulalongkorn University of Thailand has witnessed 70% of total revenue from consultancy services (Sripaipan 1993).

Most of the research based interaction modes in NICs are initiated and funded by the governments in various channels. RDAS programme in Singapore , STDB programme in Thailand and the Technology Development Board in India are a few examples. These funds are usually channelled in as grants, soft loans or incentive schemes. The facilitation of commercialisation of research results through various schemes is another move that can be witnessed in NIC countries. For example, the Chulalongkorn University in Thailand uses patent committees to select research work for patent applications under the universities name. The net profit is shared between the university and the researcher equally (Sripaipan 1993). Similar examples can be seen in most of the SEA countries.

It is also witnessed that new structures such as science parks and incubators have been established in close proximity to industrial R&D bases such as research institutions and universities to house new teaching based companies bringing laboratory and new production to closer interaction. The aim of these structures is varied within the overall framework of facilitation of interactions with industry. For example, SISIR in Singapore provides incubator facilities for enterprises to carry out R&D work within the SISIR. Various incentive schemes such as support for application for grants and production development assistance schemes are instrumented to motivate the enterprises to participate. These instruments are targeted to subsidize laboratory equipment, and rent for accommodation, consultancies, staffing, technological information, material for testing and certification of final products.

Most of the NIC countries witness incentive scheme for R&D work in industries in the form of tax concessions. The schemes target encouraging in house R&D

and collaborative work, infrastructure development and improving skills of the workforce. For example, the Philippines provide incentives for R&D programs including income tax holidays, capital equipment incentives and tax deduction for infrastructure work. Malaysia, employs doubled tax deductions on monies spent on approved training or infrastructure and equipment for approved training to upgrade the workforce's technical skills and double tax deductions on monies spent on infrastructure and/or conducting R&D in-house, in addition to fiscal measures to support technology development.

This evidence shows that the universities and research institutes in South East Asian countries undergo changes to shape their functions to fit the demands of society. Governments in turn facilitate industrial innovations by various measures such as pressurizing and encouraging interactions, providing incentives for technology development and incorporating necessary reforms in the legal framework. The success of these efforts is witnessed by the increase of the manufacturing sector output of those countries. However, very little evaluation is done on the effectiveness of the new forms and their internal functions. For example, it has been reported that although the science park and incubators are situated close to universities, the technologies employed in the incubates generally do not emerge from universities. In this context, the role of the academia in the development process is little known. Also, it seems venture capital companies tend to avoid start-ups, especially those using new technology that has an even greater risk of failure.

The case of **Singapore** has shown policies directed to increase the number of Research Scientists and Engineers (RSEs) that followed a sharp increase in research intensity. The government has made emphasised enhancing research consciousness in local technology based SMES. It is evident from the fact that the density of scientists and engineers engaged in R&D per 10,000 labour force has increased from 27.7 in 1990 to 69.9 in 1999. This effected by increasing the enrolment for science and engineering courses in polytechnics and universities.

In the case of **Malaysia,** the major weakness of the system of innovation seems to be the shortage of technically skilled manpower to engage in R&D, and absence of a strong technology based SME sector. This prevents Malaysian firms from absorbing the positive spill-overs from the MNCs that operate in their manufacturing sector. The Government of Malaysia seems to have understood this weakness and it seems they have taken steps to establish a human resource development fund (in 1992) with a matching grant from the government to stimulate private sector involvement in training and retraining of staff. Also, in order "to further develop innovative capability, the Malaysian government is increasing its investment in scientific and technical education. It is targeting to expand the relative student population ratio to 60 per cent for science and technology. The training institutions will also be conducting more advanced skill courses geared towards high technology and higher value added activities of the industry".(Abdullah 1997).

In the case of **Brazil**, the government intervention in technology development has manifested itself in terms of financial schemes for domestic technology development (through grants, incentives, loans and venture capital) and the creation of an adequate supply of highly trained S&T personnel.

The case of **India** seems to be different in nature as it is believed to have a large pool of technically trained personnel and a centrally controlled adequately sophisticated network of institutional infrastructure. Hence, it seems the issue of RSE is not appreciated as a factor in innovation policy debates, although the RSE density is significantly low compared to many developing countries. India has established a few grants schemes/loans for the enterprise sector with a view to enhance interactions with government labs. Despite this situation, it is believed that the interactions are still operated at a low key, probably due to a low demand for innovations from the enterprise sector. Shortage of RSE in the enterprise sector could have been attributed to the combination of factors such as low demand for innovation in the enterprise sector, lack of incentives (financial and social) for RSE to join the enterprise sector. The lack of demand for innovation in

enterprise sector calls for government intervention in terms of incentives to employ RSEs.

Indonesia is also reputed to have a well-developed public research sector. The policy directions are geared to redirecting the programs of public sector research institutions towards industry and other national users by shifting the funding basis towards the open market (Turpin 2000). The key feature of policy development in Indonesia emphasize better links between the different sectors and institutions, which includes development of links between R&D institutions, higher education institutions and productive sector. However, the major challenges in policy directions seems to be attracting longer term benefits from FDI and to stimulate and expand the domestic technological base. After an economic crisis, Indonesia seems to have set priorities taking into account the social and political imperatives to minimize the impact of economic crises on basic human needs. Hence, Indonesia appears to be moving towards concentrating on innovation incentives for agricultural production (Turpin 2000).

In **China,** a highly centralized ' communist" country, close academia-industry interactions were almost non-existence up to 1985. The URI relationships are characterized by the low investment in the industrial R&D and an inadequate pool of expert personnel. The S&T reforms initiated in 1985 brought forward the importance of interactions and opened the path to the establishment of various mechanisms in linking users and the producers. The formation of Teaching Research Production (TRP) associations to facilitate Technology Transfer (TT) to SMEs, signing of TT contracts to carry out industrial research projects, establishment of R&D centres in engineering and technology, establishment of High Technology Development Zones (HTDZ), which is similar to Science Parks, to develop high tech products in close cooperation with universities and Chinese research institutes, establishment of incubators in university premises and promotion of spin off companies can be seen as major structural changes taken place after the reforms. The changes are supported by tax incentives and special financial schemes. Many of these efforts are provided with a network of financial

resources comprised of R&D institutions, Banks and Zones. In HTDZ the R&D institutions mainly provide Venture Capital for the initiation of NTEs, the Banks provide funds for expansion of NTEs and Zones provide investments mainly for the development of the infrastructure.

However, the so called market driven approach seems to have not produced the expected results probably due to lack of demand and inadequate legal protection for IP (Kharbanda 1999). Also, it shows that organizational structural changes are inevitable to meet effectiveness of new functions.

The existing constraints are recognized as;

- Lack of coordination between educational training and industrial demand
- Weight to faculty resources & funds instead of social demand by the academic institutions
- Lack of mobility of R&D personnel due to rigidity of regulations.
- Dominance of TT interfaces in the region of R&D institutions.

The lessons from the case of China is that although the structural and financial mechanisms are made with the state intervention and patronage, the system still shows inefficiencies in terms of technological development in industrial settings.

The problems identified are;

- Technologies developed by academic institutions do not match the interest of the enterprises
- Technologies developed by the research institutions are not tested for commercial applications
- Insufficient funding by the enterprises either for in house R&D, or to academic and research institutions to execute industrial projects
- Funds devoted to R&D are too scattered with the result being critical investments for R&D have not matured into commercial applications (Kharbanda 1999).

The case of **Taiwan** shows that programs to promote innovations such as setting up of incubators, establishment of university research centres for development of industrial technologies, and policies to enhance UI relationships have still not produced the expected level of innovative capabilities and profits. In this context, formation of formal office for patenting and licensing, setting up a process for evaluation of performance and learning the issues and practices in universities with respect to linkages are emphasized (Wu2000).

The experience of the **Latin American** countries shows the operations of relationships in two modalities such as institutional effort and situational effort. In the context of situational effort, it is characterized by the micro strengths that seem to be stronger in relation to institutional efforts. The relationships are initiated based on personal interest, previous working experience and personal contacts. It also cantered on a specific well-defined problem in the industry. A prerequisite seems to be the partners ability to communicate on hard technological terms. In this back ground, the features of the micro strengths are the accumulative nature of interests, development of innovative web and widening the scope of the problem (Sutz 2000). As the nature of the bottom-up micro-strengths show weaknesses in relation to consolidation, expansion and diffusion, it may need a third partner to facilitate development and mature. This can be the case for many developing countries where such interventions are required to become matured. Sutz (2000) argues that many things are not done in developing countries because people do not know that they can be done although URI relations have potential-if the diffusion process works properly.

In contrast top down policies are basically institutionalised approaches designed for the management of relationships through different schemes and financed with public and foreign donor agencies. However, the many shortcomings have been observed in these mechanisms in Latin American countries.

According to Sutz (2000), the shortcomings are;

- Firms involvement below expectations, both in quantitative and in qualitative terms
- Lack of "Knowledge relevance" of the problems when industrial demand finally begins to spread
- Low impact on the general behaviour of firms regarding relationships with universities

These shortcomings relate to the features of the National System of Innovation, which is evolved through the historical and cultural essences. The NSI is supposed to provide the network of institutional arrangement to support innovations on one hand and social awareness of the positive role of the knowledge for the economic growth on the other. In the absence of these pre-requisites, the mechanisms to foster URI relationships are bound to face both lack of demand and of scope (Sutz 2000). In this context, Sutz (2000) proposes that the understanding of the micro-strengths of the URI relationships is needed in order to improve the top down policies to counter-balance the above shortcomings.

The above features of different countries emphasize the importance of policy interventions in line with human resource development and incentive schemes. However, the fine gradients of these interventions are country and culture specific.

> "The knowledge of why, where and how governments should intervene in the process of industrial innovation currently stems largely from empirical studies of the nature and the extent of the hindrances to economically and socially desirable innovations, and on the effectiveness of alternative government policies to remove these hindrances. The pressure to construct such policies have grown as a result of a number of economy related , industry related and by and large by the acceptance of the argument that the innovation plays a key role in stimulating economic development. The

traditional S&T policy statements are seen not to provide sufficient impulse and direction to technical change. Hence, major role of the governments lies on formulation and implementation of innovation related policy, which contain elements of both S&T policy and industrial policy" (Rothwell and Zegveld 1981).

2.6 Importance of research for developing countries in general, and to Sri Lanka in particular

Section 2.5.2 shows that most of the developing and NIC countries focus on promotional mechanisms to encourage URI relationships. This trend is seen in all OECD countries also (Polt 2001). However, Sutz (2000) emphasized the importance of understanding the micro level process related to issues in order to formulate more appropriate policy tools to promote industrial growth. Developing countries tend to assume that the framework conditions worked in a developed country will give similar results in a developing country also where it ignores the differences of micro level conditions. This mode of thinking is even promoted by the donor agencies in their packages of donations/grants and loans. Therefore, framework conditions may tend to impose alien procedures where conflict of interests can occur. On the other hand, framework conditions can act to remove negative micro level conditions that may naturally create an impact on other related conditions. The way this behaves depends entirely on the social and behavioural attributes of the countries. Therefore, it has become necessary to have an understanding of micro level process related issues.

The next question is "why it is important to Sri Lanka?". Knowledge about the most important framework conditions and the micro level process related conditions in Sri Lanka is low due to its unexplored nature. This limited literature on Sri Lanka context provides some insight to scan the nature of URI relationships and related issues. For example, it has been found that the URI relationships are operated at a low key in Sri Lanka due to inefficiencies and weak capabilities in

the R&D sector, including universities (Wignaraja 1998). In the mean time, weak capacity of industrial managers to assess the economic implications of technology, inability to compete with imports in terms of quality and price and private sector interest only in short-term benefits and not in R&D are identified as key issues for lack of industrial growth (Ramanathan 1988).

However, these investigations have not looked into the broader framework conditions and process related issues on one hand. On the other, the changes in the recent past such as evolution of new organizational forms, current dialogues between actors of the different helices and interest shown by industrial organizations on product/process development, etc, have not been captured. Hence the ground level dynamics in Sri Lanka have not been exposed in the available literature. In this context, the present research will have potential to add to the literature, specially in relation to the Sri Lankan context.

The URI relationships in Sri Lanka are believed to be at evolutionary stages. As such, micro level process related determinants would be of interest in the international context also. Therefore, it is necessary to look into the features of the SL context within well known theoretical concepts such as NSI, Triple helix and mode 2 of knowledge production.

Taking this approach, as the present research deals with the empirical evidence related to Sri Lanka, it is useful to review the evolution of Sri Lanka specific policy measures directed at industrial development and interactions in particular. A review of existing policies in Sri Lanka and some highlights of the Indian context are given in Chapter three.

Chapter three – Sri Lankan context

3.0 Introduction

The outcomes of the major research component connected to this thesis, i.e. the exploration of characteristics of URI relationships in a small developing country, are planned to be implemented in Sri Lanka. Hence, it is necessary to consider the socio-economic, political and technological environment of Sri Lanka, compared to other countries in the region, Newly Industrialised Countries (NICs), and industrialised countries. Hence, chapter three is devoted to this.

3.1 Socio-economic environment

Table 3.1 gives the general socio-economic indicators related to Sri Lanka .

Table 3. 1 Basic socio-economic indicators in 2001

Total population (2001)	19 million
Labour Force	7.0 million
Employment by economic activity	
Agriculture sector	2.1 m
Industry sector	1.4 m
Service sector	2.9 m
Per Capita GDP	826 US$
Unemployment rate	7.9 %
GDP	Rs 1,407 billion
GDP by sector	

Sector	GDP (%)
Agriculture	20.1 %
Service	52.5 %
Industry	27.4 %

Expenditure on general education	2.28 % of GDP
Age specific university education ratio	2.4
Unemployment + underemployment rate of university graduates in S&T disciplines	30 per cent in 2003
Export earning	US $ 5522 m (in 2000)
Export earning by sector	

Sector	US$ m
Agriculture	1005
Industry	4283
Mineral	97
Other	137

3.2 The economy and the industrial performance in Sri Lanka

Since Sri Lanka shifted to a market oriented economy from restricted inward oriented economy in 1977, the national economy has maintained a steady growth with the GDP increasing at an average of 4 to 5 per cent per annum. The industrial policy, and subsequent industrial master plan, have targeted the growth of the private sector by providing an economic environment conducive to the growth of industry through economic and financial incentives and minimum regulatory controls, as one of its strategies for achieving its goal of expansion, diversification and upgrading the industrial base.

The output from private sector industries grew by 2.5 per cent in 2002. Industry plays an increasingly important role in the economy of Sri Lanka, and also in 2002, the output from factory industries, which accounts for 80 per cent of the manufacturing output in Sri Lanka, contributed 10 per cent to overall economic growth. There have been significant changes within this sector as the importance of manufacturing has been emphasized. However, R&D expenditure by the private manufacturing sector in Sri Lanka is less than 10 per cent of the total R&D expenditure of the country (Fernando and Amaradasa 1998). This is one of the lowest expenditures in the world.

The percentage of industrial R&D to the total R&D expenditure for India and Sri Lanka are given in table 3.2. This shows evidence of the lower levels of development of technological capabilities. Hence it is suggested that the marginal increase in industrial production might be due to an increase in the volume of production.

Table 3. 2 Private sector R&D expenditure as a percentage of total R&D expenditure in Sri Lanka & India

Country	Private sector R&D expenditure as a percentage of total R&D expenditure[3]	Year
Sri Lanka	9%	2000
India[4]	11 %	2001

Most of the technologies available to industries in Sri Lanka are outdated or non-competitive. Out of the 75 countries in Asia, Sri Lanka has been ranked at 59th for technology compared to 66th for India, in the Growth Competitiveness Index (GCI) ranking for Asia (James 2002). One of the reasons for poor product quality and lack of competitiveness is the dependence on old machinery used in the production process. Only a limited number of industrial organizations undertake in-house R&D while some industrial ventures such as MNCs use central laboratories located outside the country to meet their R&D requirements. Some of the characteristics of industrial organization are given below: (Ramanathan 1988)

- Weak capacity of managers to assess the economic implications of technology,[5]
- Inability of many organizations to compete with imports in terms of quality and price,
- The private sector appear to be interested only in short-term benefits and not in R&D.

[3] It was noted that the industrialised countries this percentage exceed 50 %

[4] Source – CSIRO, India

[5] The exploitation of external technology requires the creation of some absorptive capacity and an ability to understand an externally sourced technology and apply it internally. To understand this tacit component and to exploit the commercial possibilities, there needs to be a threshold technological capability within the firm. This requires conscious allocation of funds for learning. Aggarwal, A. (2000)"Deregulation, technology imports and in-house R&D efforts :an analysis of the Indian experience." Research Policy **29**: 1081-1093.

3.3 The S&T system in Sri Lanka

Despite limited S&T activities in the private manufacturing industries and non governmental organizations (in limited disciplines such as environment sciences), the S&T system in Sri Lanka functions within the administrative set up of the government institutional structures (Fig 3.1).

Although the organizations in the government set up are vertically linked (at least for administrative & financial purposes), horizontal links seem to be weak. Research collaborations are also found to be non-existing at and operational levels (Amaradasa 1998). There is no indication to show the existence of clearly defined monitoring and evaluation mechanisms of R&D activities. The perception of individuals on national priorities and institutional objectives are the key guiding principles in choice of R&D projects (Silva, Yapa et al. 1996). Conscious coordination of S&T activities between "producers" and "users" seems to be absent.

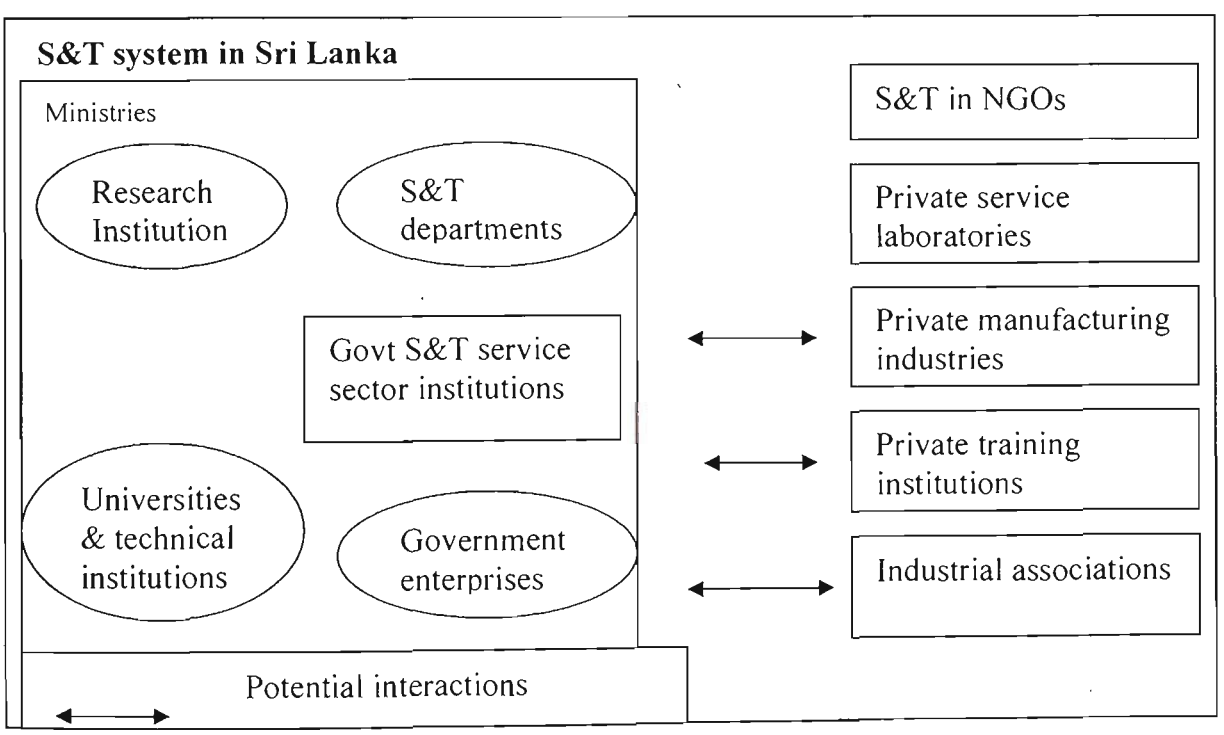


Figure 3. 1 The S&T system in Sri Lanka

One of the most important prerequisites for technological progress is strong R&D support to apply scientific knowledge to economic activities. This includes testing, experimentation and applied research. In Sri Lanka R&D has been basically a state sponsored function where about 65 per cent of the R&D expenditure is borne by a network of national R&D institutions. The university sector accounts for 25 per cent (again 90 per cent of that comes from the state and the almost the rest from foreign donor agencies). The balance of national R&D expenditure comes from the private sector and NGOs (Amaradasa, Pathirage et al, 2003).

The national expenditure on R&D has not passed the level of 0.2 percent of GDP within the last 15-20 years. This ratio is one of the lowest in the world. Table 3.3 shows Gross Expenditure on Research & Development (GERD) as a percentage of GDP for selected countries and regions and significant changes in the composition can be observed.

Table 3. 3 GERD as a % of GDP by principal region/countries 1996/97

Country/Region	% GERD/GDP ratio
United State	2.6
Japan	2.9
OECD Countries	**2.2**
Developed countries	**2.2**
European Union	1.8
Europe	1.7
WORLD	**1.6**
Asia	**1.3**
Newly Industrialized Economies in Asia	1.1
India	**0.7**
South Africa	0.7
Developing Countries	**0.6**
China	0.6
Latin America and the Caribbean	0.5
Africa	0.3
Sri Lanka	**0.2**

Amaradasa, Pathirage et al (2003) show that R&D activities in the year 2000 were more oriented towards experimental development activities (from 7% in 1996 to 25.8% in 2000) than in 1996. The R&D expenditure in Natural Sciences and Engineering & Technologies has shown a significant increase from 22.6% and 11.6% in 1996 to 29.6% and 17.1% respectively in 2000.This suggests that the composition of national R&D activities are shifting towards natural science & engineering technologies.

Simultaneously, the above change in the type of R&D activities can be considered as a reflection of the economic policies of the country towards industrialization and the response of the public sector research institutions to those industrialization policies by shifting their R&D activities at the cost of basic and applied research. The other reason for this change can be due to realisation of the importance of R&D by the industrial sector.

3.4 Industrial R&D and interactions

Industries are involved in R&D activities in two ways, namely in house R&D and contract research (usually done in a university or a research institution). The information from the survey on innovative activities conducted in private industries in 2000 shows a considerable improvement in terms of R&D expenditure. This has resulted in an increase in the percentage of expenditure on R&D, with the total R&D expenditure by the private sector increasing from 1.7% in 1996 to 9 % in 2000 (Fernando and Amaradasa 1998). Private sector organizations seem to have identified the importance of innovative activities, and hence seem to have increased innovative behaviour in terms of incremental changes and experimental development activities (Amaradasa, Pathirage et al 2003).

However, support for research in universities by industries is hardly available in Sri Lanka due to many reasons. Firstly, the culture for industrial support of research in universities is not adequately defined in the Sri Lankan context.

Universities and research institutions define and conduct industrial research according to their own perspectives of industrial problems. As a result, they are very often not applicable in real context. On the other hand, Lall (2001) argues that industries in developing countries, especially those which really require research inputs, lack the understanding on how to define the problem to researchers. Lall (2001) continues to say that whenever these problems are sorted out, the administrative barriers severely de-motivate positive integrations.

Although, contribution of local technological inputs seems to be negligible, there is evidence for service based and education & training based relationships with industries. For example, the Industrial Technology Institute (ITI) earns 46% of their annual operational budget from services, consultancy and contract research (ITI 2002). The academics in universities are involved in informal consultancy services depending on their specialty and field of expertise. Undergraduates in sciences and engineering do engage in vacation studies and mini projects in industries whilst postgraduates are encouraged to work on industry related problems for their degree project. Industry personnel are involved in conducting course units for postgraduate degrees. Whatsoever, it has been noted that industries have only a relatively small number of relationships with technological institutions (including universities) in Sri Lanka except for the garment industry (Wignaraja 1998).

In the recent past, a trend has been noted of changes in many spheres towards relationships to respond the social requirements. For example, University Industry Interaction cells, Engineering design centres and Agro-Business Centre have been established on university premises to work for the needs of the industry. The issue of relationships has been discussed in many formal and informal gatherings. This indicates the changing environment of these relationships.

3.5 University education in Sri Lanka

The University education system in Sri Lanka, a monopoly of the government, consists of 13 universities inclusive of an open university. A regulatory authority set up by the government, the University Grants Commission (UGC) selects students for entry into each university, and sets academic standards and policy with respect to university education in the country. Admission to university education is very competitive. Annually, out of the total who sit for the university entrance qualification examination (General Certificate of Education –Advanced Level), about 50 percent become eligible to enter a university. However, no more than 16 per cent of the students who become eligible are admitted. Of year 1 entrants to schools of any age, no more than 2.4 percent enter a university 13 years later (Central Bank 2002). This extreme competition has adversely affected the expectations of average students.

As a result it is claimed that the existing university education systems in Sri Lanka has not been able to provide the country with a work force ready to face the challenges of a dynamic, market oriented economy (Central Bank 2000). The inabilities to match modern industry skills and trends in economic and industrial development have curtailed jobs and income opportunities for a substantial number of people. Most of the professional courses and programs are directed at employment opportunities for graduates in the government institutions. These opportunities were drastically downsized at present, and it has exacerbated these problems. In other words, the high unemployment and underemployment rate among university graduates -30 percent in 2003- points to a mismatch between supply and demand conditions for graduate employment, reflecting the existence of a supply driven education system with little relevance to labour market conditions, despite the elite nature of higher education system (Pathirage, Dilrukshi et al. 2003). This leaves the challenge for universities to orient the courses to include market demand course units in the curricula.

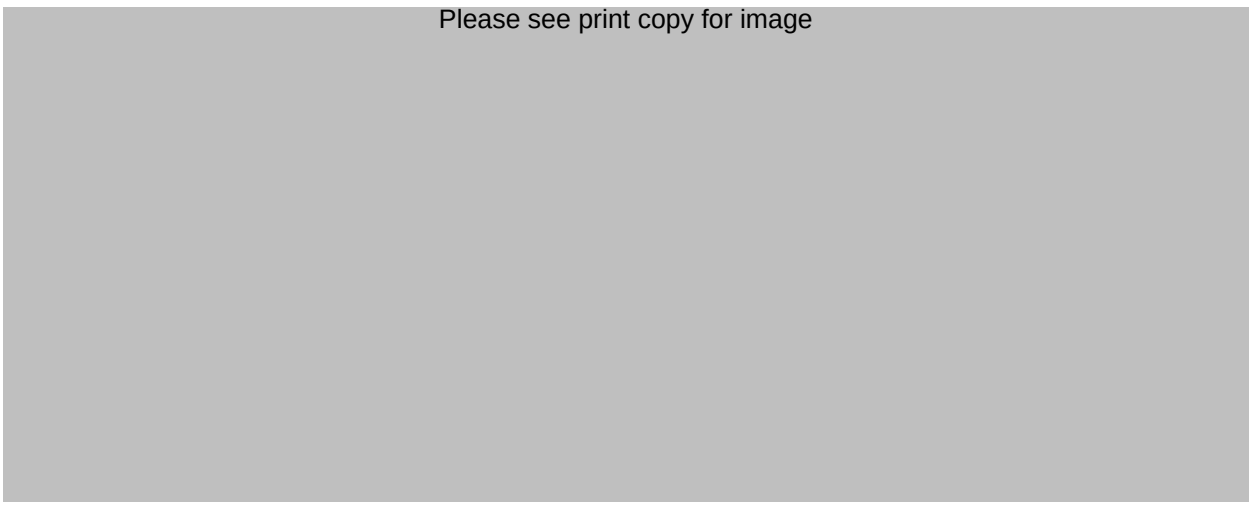
A number of reasons can be cited for the deficiencies in the present tertiary education system. With regard to university education, full time degree courses still remain a highly restricted and centralized public sector monopoly. The transmission of knowledge is mainly by traditional teaching methods and courses. The uniform curricula, syllabi and teaching materials used thus do not cater to present day industrial requirements. Standards and expected services demanded by industry are increasing both locally and abroad. The curriculum in science and engineering is highly structured and inflexible and courses need major revision and updating. While, infrastructure facilities vary from university to university, equipment in laboratories and workshops need to be modernized. Moreover, as prices have played a very minor role in the provision of tertiary public education services, the resort to budgetary financing as a means of funding university education has resulted in restricting opportunities and reducing the quality of the service provided. The intense competition for scarce government resources has led to the under-financing of this sector.

The postgraduate education S&T related areas (except in the academic stream of architecture where almost all the graduates who receive a Bachelor's degree enrol for postgraduate education to become professionally qualified) are still under developed and do not follow a uniform pattern. Out of these courses, adequate research component are built into M.Phil and PhD courses. The focus of these research components are gradually shifting towards industry related problems. This needs aggressive promotion through an adequate incentive system such as fellowships /scholarships for industry oriented projects to compensate the early job seeking behaviour of graduates. The graduates feel that the job opportunities will become worse after a couple of years even though they get higher degree qualification. Hence they tend to take the earliest opportunity for a job. As a result, the enrolment in postgraduate courses both in the sciences and engineering is very low. The output is also affected by the same factors due to dropouts in the middle of the stream (Central Bank 2000). The enrolment for postgraduate courses in Sri Lankan universities and the actual output for selected years are given in the table 3.4. The high level of dropouts calls for the educational

institutions to review the postgraduate courses by incorporating strategies for encouraging the students to conclude the course.

3.6 The R&D infrastructure/institutions

The Government S&T system is spread amongst many ministries, each being responsible for the implementation of the projects and programs within the various departments , corporations or authorities falling within their purview.



Source :UGC web site 19/Dec 2003

In addition to the R&D activities in science and engineering being undertaken in a limited way by the universities, there are 21 research institutions in the country dealing with R&D activities. Many of these institutions (nine in total) deal with agriculture related R&D work including crop based R&D institutions and the R&D institution in the fisheries sector. Other than these two R&D institutions, one on western medicine and the other on traditional medicine, the rest of the institutions have either full or partial responsibility for industrial research. Of them , the ITI and the NERDC directly deal with the industrial partners whereas the NBRO and ACCIMT have partial obligations to their industrial partners.

Inadequate funding and inefficiency in R&D institutions in developing countries are well known factors. Characteristics of the R&D institutions include:

- Negative attitude to work
- Low productivity
- Inadequate incentives for promoting creativity
- Excessive emphasis on control which hinders risk-taking (Ramanathan 1988)

The research leaders forum of the NASTEC has identified that poor administration/management, weak leadership, lack of perspective, long term planning, resistance to change, poor infrastructure facilities, long drawn administrative procedures, lack of monitoring, evaluation & feedback, poor remuneration packages and inadequate interactions between and within institutions as weaknesses of the research institutions in Sri Lanka (NASTEC 2002).

3.7 S&T management infrastructure

Sections 3.3 through 3.5 gave an outline of the S&T infrastructure and the university structure in the country. Alongside these structures, the government has created mediatory organization such as NASTEC, NSF and CARP to deal with policy related issues in S&T policy. The details of functions of each of these organizations are given in the annexure one.

In this respect the NASTEC was established with a view to advise the government on S&T policy related issues and allocation of funds for different S&T activities and to identify and promote research in priority areas likely to be of benefit to Sri Lanka. The members of the commission consisted of eminent scientists in the country, with one of them to lead the group. The NSF plays the role of conducting policy studies in the field of S&T and transferring those findings to NASTEC and decision making authorities as inputs. The NSF also performs a traditional way of supporting research projects using competitive mode. The priorities for research of NSF are heavily fragmented with strings attached to scientific disciplines. Very little attempt has been made to position the organization in changing environments

and to promote multidisciplinary approaches. The Council for Agricultural Research Policy (CARP) on the other hand deals with the agriculture sector only, while keeping relationships with the NASTEC to see its' priorities in research in the national context. CARP also perform their functions based on the needs of the agriculture sector and it's stakeholders. It seems the National Agricultural Research System (NARS) maintained at CARP assist the managerial decision making process at the institutional level as well as the national level. The University Grants Commission (UGC) plays a more or less administrative role. The capability of the UGC to support research in universities is very limited in all aspects due to financial constraints and an absence of organizational capabilities to manage/coordinate research. The role played by the UGC to coordinate foreign donor-funded research projects has isolated objectives depending on the research group and the donor agency. The UGC has recently proposed reforms in higher education sector where more autonomy will rest on individual universities. Also, the reforms seem to be advocating the establishment of new organizational orders within university premises to meet the demand related issues.

This shows that the major institutional structures capable of supporting research in Sri Lanka has almost neglected industry research. This has left industries to look after their own problems. In this context, the options available for industries are to establish in house R&D or to look for complete technologies that can be imported. As the former possess more risk and is costly to maintain, the industries may opt for technology importation or sharing with other firms. Once the technology is imported, the maintenance and adaptation requires in-house capabilities within industries or access to external knowledge for troubleshooting. For this purpose industries may still need to keep relationships with the local S&T base.

3.8 Policy directions and tools to promote relationships in Sri Lanka

Chapter two briefly discussed generic policy interventions that can be used by government, some lessons from the NICs and many from developing countries. It would be useful to examine the existing policy environment and tools in operation

to promote relationships operating in Sri Lanka. Hence, this section is devoted to reviewing major policy statements and implementation tools that are currently practiced in Sri Lanka.

The search for policy directions will cover industrial policies, S&T policies and institutional mechanisms that facilitate relationships. In the absence of well defined innovation policies, I failed to discuss the policy directions to promote innovative culture. However, rather fragmented mechanisms to promote innovative habits are discussed in this section. The institutional mechanisms and policy directions in India are also discussed in this section with a view to bring up the facts at a later stage for comparative purposes.

3.8.1 Industrial policies

Industrial policies are generally targeted at enhancing industrial growth through public/ private enterprises. This can target specific strategies based on the attributes of the economy and factor conditions (Lundvall 1992). Accordingly, the "New industrialization Strategy for Sri Lanka " published in 1995 has enabled the government to focus its efforts by identifying nine thrust areas and technologies for development. These areas includes,

- Electronics and information technology
- Agro-based industries & food processing
- Light engineering and metal working
- Industrial infrastructure
- Tourism infrastructure
- Mining & mineral exploration and processing including ceramics
- Textile fabrics and accessories for the garment industry
- Rubber based industries and footwear
- Gems and jewellery

The main objectives of the " New industrialization Strategy for Sri Lanka" were the:

> " expansion, diversification and upgrading of both the industrial base and the export base; efficient management of physical and manpower resources; employment and income generation in both rural and urban areas; export orientation; regional industrialization and fostering environment friendly and sustainable industrial development. In order to achieve these objectives, the government has offered a range of incentives to encourage both local and foreign investments in specific thrust area. These incentives include tax concessions; tax holidays tariff concessions and duty free imports of machinery, equipment and raw materials. In addition, the Government has introduced several other promotional measures such as National Productivity Decade Program, Advanced Technology Incentive Program and Textile Restructuring Program aimed at enhancing industrial sector productivity and global competitiveness of industrial exports (Central Bank 2000).

In addition to creating a macro economic environment conducive to rapid growth, the policy has outlined strategies to promote FDI to boost capital inflow and access to technology and markets. The BOI outlined the attraction of efficiency seeking over the market seeking and resource seeking as the strategy towards attracting FDI (Interview with Director(Research) of BOI of Sri Lanka).

The policy also envisages encouraging private sector participation in the economic growth through incentives like

- Introduction of non-discriminatory uniform tax regime
- Achieving a uniform import duty rate of 15 percent
- Avoiding multipoint taxation on turnover by introducing GST

The strategy also envisages encouragement of R&D and facilitation for access to technology and demand oriented skills development in order to increase

productivity. Overall the policy aims to develop its industry to ensure higher value addition by upgrading processes to obtain better quality so as to make it capable of competing in the global market.

However, these policy tools have not provided adequate results in terms of technological and economical development. The main problem of these policy directions seems to be a lack of targeting, unclear implementation tools and ignorance of micro level situations such as strengths and weaknesses of SMEs. Hence, the Government has taken initiative to look at the problem in a more comprehensive way with a different approach. This approach was financially and intellectually supported by the government of Japan and hence named as JICA MASTER PLAN.

3.8.2 JICA Master Plan

Although the above measures contributed to open avenues and the development of the industrials sector to some extent, especially the export oriented local institutions, the export structure was still dependent on a few industrial products, particularly textiles and apparel. In order to increase the diversification of industrial export structure with a view to reducing high dependence on a few products and promote industries in a selective and strategic manner, the Government formulated a Master Plan, which is also known as the Rainbow Plan in collaboration with JICA and UNIDO, for industrialization and investment Promotion. The Master Plan covers the ten year period from 2000-2010. The main objective of this plan is a shift from labour intensive industries to knowledge based and technology intensive industries, in the context of free trade regimes, in the coming decades. This plan identified key industrial sectors namely apparel, leather, rubber, plastics, machinery, electric/electronics and information technology as priority industries to be promoted in a selective and strategic manner. The Plan also highlighted the fact that it requires dynamism of the private sector, as well as collaboration with the academic sector and hence mentioned that

the key to this paradigm shift is the "Private-academic-public partnership and collaboration".

The time period of the plan is divided into two stages 2000-2004 and 2005-2010. The first period is designated as the consolidation period, while the second will be the period for accelerated growth of the industries. According to the Master Plan, the manufacturing sector is targeted to grow at 10-11 percent per annum during 2000-2010. As the SMEs account for 90% of the industrial establishments and 70% of employment in the manufacturing sector, the Master Plan has given high priority to develop small and medium scale industries by setting up a new organization known as the Small and Medium Scale Enterprise Development Corporation (SEMEDEC). This organization is expected to provide technical management advice for technological upgrading of SMEs , management and information services, and venture and incubation promotion to support new venture industries and a credit guarantee organizations to facilitate funds flows to SMEs.

The rainbow plan identifies that a shortage of designers and engineers in enterprises, which is one of the major reasons for the low technology level of the manufacturing sector, is partly attributed to the higher education system in Sri Lanka. Hence, the plan proposes an integrated program where the academic will devote itself to "research", and public research institutes to "development" while private enterprises to concentrate "design" and production.

The Ministry of Enterprise Development, Industrial Policy and Investment Promotion has taken on the coordination role of the Master Plan. This has led to the establishment of sectoral committees comprising members from stake holders to formulate and monitor the implementation of policies.

3.8.3 S&T policies

The term S&T in Sri Lanka mainly covers the R&D and S&T services base (including S&T in higher education sector). Compared to the impact of industrial policies, S&T policies seem to be less dynamic potentially due to S&T policies that are comparatively isolated from, and create more pressure on, the economy.

The current ST policy document, named as "The Presidential Task Force on S&T Development" accepted by the Government in 1994 has identified a ten point policy guidelines for the 1990s and recommended 100 specific strategies for coordinating the S&T system encompassing 10 ministries. Details of the policy recommendations are given in the annexure two and the relevant sections from these recommendations will be quoted when and where necessary. The report seems to have identified the weakness of the industrial dynamics to capture local knowledge in relation to technological development. It says that " Industry can generally appear not to concern itself much with the utilization of scientific research for its own development "(anonymous 1991). However, as the implementation of the recommendations were delayed for several years(4 years), and the document itself has received many criticism from the scientific community, the NARESA set up another initiative in 1995 to formulate "An action Plan for development and application of S&T in Sri Lanka". Accordingly, a document was prepared and submitted to the Her Excellency, the President. This document contains (although the implementation of the recommendations is not visible) the following features as recommendations.

- Use S&T as an integral part of the effort to achieve rapid economic development, improved quality of life and poverty alleviation.
- Cultivate and establish a science culture among all sections of the community to enable improvement of productivity and the quality of life.
- Encourage and strengthen achieving greater co-operation in S&T areas.

- Support the development of indigenous technology wherever feasible while selectively enquiring and adapting scientific knowledge and technology from abroad
- Build a national S&T capability
- Identify priority areas of S&T likely to be of benefit to Sri Lanka and to specifically focus & promote R&D in identified areas.
- Establish an ongoing national monitoring system to continuously evaluate, review , plan and modify the S&T system
- Disseminate the benefits of S&T activity as widely as possible within the country, to all sections of the people.

Overall, the recommendations show a protective and passive approach. Closely associated with the above policy elements, the need to upgrade the S&T infrastructure has also been proposed in the report. It has been recognized that maximum benefits at a minimum cost to the state in the short term can usually be achieved by strengthening existing institutions. Also, the need to provide better remuneration, rewards and facilities to improve retention and attraction of S&T personnel has been emphasized. A process for the systematic development and retention of skilled S&T personnel is also considered necessary. The need for the private sector to participate in this process has been recognized. However, in order to achieve these policy goals, the most important implementation tools to manage policy were not identified.

A change of the ministerial port-folio in 1998 resulted in reverting to the policy approach, "Presidential Task Force of 1991". Consequently, the above "Action Plan" was shelved in the libraries and the private collections of interested individuals.

With the acceptance of the above task force report in 1998, the institutions were compelled to restructure to suit the new Act of the Parliament. The significant feature of the change was the creation of a national body, called "NASTEC" to

deal with prioritisation of research and to advise the Government on S&T policy directions. The impact of this change needs a specific evaluation.

Despite these changes, the recommendations of the Task Force 1991 in relation to promoting the industry –institution relationships (given below) have never been effected.

1. The creation of a coordinating committee composed of the chief executive of selected institutions to ensure direction and coordination of efforts
2. The creation of explicit marketing divisions within each institution

3.9 Some features of URI relationships in Sri Lanka

In Sri Lanka, the importance of the URI relationships for technological development have been highlighted in policy documents and action plans as indicated above. Unfortunately, the recommendations and policy directions in those documents do not show any impact on industrial development. The reason could be due to the lack of a proper implementation plan and follow up measures to be taken up by the relevant actors in the system. A lack of understanding of the features of the system to make effective interventions could also be a factor. In other words, it is believed that the Governments have failed to intervene and these systems failed as a result.

3.9.1 URI relationships- previous approaches

The first policy initiative taken in the direction of university industry cooperation reported in 1982, based on a suggestion by UNESCO, lead to the formation of the National Committee for University Interactions in Chemistry. The NCUIIC was established with eight specific objectives :

1. To promote better communication between the universities and industry in the field of chemistry

2. To enable university teachers in chemistry to participate in R&D activities in industry
3. To obtain the services of industry experts for academic programs in universities
4. To assist universities in cooperating with industry in the practical training of students
5. To formulate curricula and academic programs appropriate for the needs of industry
6. To give expert advice to small scale industries
7. To ensure better utilization of physical resources , equipment and libraries available in universities and industrial establishments
8. To promote cooperation between chemists in various countries with a view to sharing experiences in university industry interactions.

The major emphasis of the committee seems to be on education and training based interactions. The committee reported in 1991 that "Sri Lanka has entered the phase where an awareness of the usefulness of fruitful cooperation between university and industry has only just begun to be recognized. " It was emphasized that unlike in western countries, universities in Sri Lanka have not reoriented priorities and programs to address problems in industry and agriculture. It also highlighted that universities should be self critical to identify gaps and forge a balance between

- Academic excellence and relevance
- Generation of knowledge and its consumption
- Material and human development
- Fundamental and oriented research

On the other hand, industry has commented on a lack of practical orientation of curriculum and the lack of problem solving capabilities of graduates. The quality of the graduates who are available for recruitment in industry was expressed as

major concerns. The need for involvement of university graduates and staff in solving industry problems have also been highlighted by the Industry.

3.9.2 Current approaches to promote relationships

The Ministry of Science & Technology of Sri Lanka has made initiatives in 1998 to promote competitiveness of the industry through better Industry – Institute partnerships. The ADB funded project on "Science & Technology Personnel Development "(STPD project) coordinated by the Ministry of Science & Technology has taken steps to promote Industry-Institute[6] partnerships in various ways. The establishment of Industry Consultative Boards (ICB) at universities has been one of the aspects promoted by the project.

The project has noted the normative issues of the system such as absence of pressure or incentives for the academics to sell their "Products". Therefore, the ICBs are encouraged to have a commanding role to facilitate effective monitoring, commitment and incentives.

3.9.3 Industry Consultative Boards (ICBs)

The establishment of ICBs seems to be the most common, comparatively easy and administratively flexible way for universities to get closer to industry perspectives. Many faculties seem to have gained an impetus to promote marketing graduates through industry involvements, and therefore have taken steps to set up ICBs (at different levels). For example, getting industry involved in curriculum revision seems to be the first step that universities are aiming towards. The major emphasis of the setting up of ICBs is to minimize mis-conceptions of the two parties towards each other. Industry participation in curriculum development and academia involvement in problem solving in industry facilitate this and have increased potential for, greater relations in the development of the sector.

[6] Institutes include universities and research institutes

Among various functions towards achieving the above objectives, the execution of a Continuous Professional Development Program for industry personal is a novel initiative that evolved from academic departments for promoting better relationships. This initiative is in accordance with the university reforms initiated by the Ministry of Higher Education.

ICBs proposed to set up at departmental level and faculty level. The proposed composition was ;

- The head of the department (to act as the Chairperson)
- An academic (to act as the coordinator)
- Members from the department
- Industry representatives, and
- Representatives from the relevant chambers

The proposed faculty level ICBs will consist of the Dean of the faculty and representatives from the departmental level ICBs . The faculty level ICBs will focus on the much broader objective to develop the degree programme and enhance the profile of graduates to suit industry needs. The possibility of the development of the commercial arm in the faculty is suggested to overcome the bureaucratic nature of the existing system. Among the functions of faculty level ICBs, tracer studies to review the demand for graduates in different disciplines and publicizing the facilities and capabilities of the faculty have been proposed in addition to coordinating recommendations from departmental level ICBs.

The other aspect of the STPD project was to establish University Industry Interaction Cells in Engineering & Technology based faculties in the Universities. Following this endeavour, the UOM has established University-Industry Interaction Cell (UIIC) with a view to market the expertise and research programs of the faculty to the industry. The UIIC publicizes available resources and capabilities.

The other mechanisms proposed by the STPD project are

- Exchange of persons between university and industry
- Supporting industry related postgraduate research projects
- Facilitating and supporting collaborative research
- Support continuous interactions such as industrial visits and through information systems

3.9.4 New forms of organizations

Despite the pending approval for the university reforms by the Parliament of Sri Lanka, many universities have taken steps to establish new organisational orders to meet the demands of the contemporary environment. Engineering design centres at the engineering based faculties, Agro-business Centre at the agriculture faculty in UOP, BI at the Agriculture Faculty in Ruhuna are few of those. Apart from government research organisations also formed new organisational orders to respond to the much expected function of outreaching to industrial customers. The details of these organisations are discussed on the chapter nine.

3.10 Summary of Sri Lankan context

The major features of the Sri Lanka context is low technological advancement, limited capabilities, and under developed policy initiatives and implementation tools. However, the new initiatives in the recent past seem to picking up the momentum to deal with interactive approaches, probably for mutual benefits. The study expects to investigate the reality of the new approaches and propose policy recommendations to promote these approaches.

3.11 Indian context

> "India is becoming increasingly, entangled in a double bond situation, on the one hand responding to market forces under globalisation and on

the other hand sustaining research activities directed to the view of Science as public good" (Krishna 2001).

Although India is a large developing country which has sophisticated S&T infrastructure, vast human resources of scientists and engineers and better organised S&T decision making structure, university-industry-research relationships are still not adequately developed (Alam, Jayakumar et al. 2003). However, new economic policies introduced in early 1990s and schemes to promote innovations (see table 10.1) have potential to improve industrial growth and facilitate better URI relationships. Some of the important features of the Indian context obtained from literature and personal contacts with Indian scientists and S&T managers, are described below.

3.11.1 Indian S&T structure

India has a reputation for well developed S&T infrastructure and human resources through appropriate policy mechanisms developed during the immediate post independence period. The protected regime that aimed at industrial self-reliance through the process of import substitution in major branches of industry encouraged Indian firms and government research organizations and universities to develop technologies required for the needs of the country (Bhagavan 1988). As a result a substantial technological capability has been developed in India that helped facilitate a fast growth rate during the de-regulated regime. The available literature, although lacking, provides evidence for such achievements in technological developments (Narayan 1998; Krishna 2001). The present system of S&T in India is given in Figure 3.2.

The existing institutional setting and the volume of activities are dominated by few selected departments run by the central government. Out of this the Department of Space, Department of S&T and Department of Atomic energy consume 80% of financial allocations proposed in the 10th Plan 2002-2007. With

Source : Mohan, S. and A. Jain,(2000)

Fig. 3.2: Indian Science & Technology : Organizational framework and planning process

regard to expenditure, the state departments and agencies consume 73% of the total R&D expenditure while private sector industry consumes only 11%. (see table 3.2) However, the remarkable feature of the Indian S&T system seems to be the well established institutional and coordination mechanisms, which are immune to the political party interests and interests of individuals.

S&T in India, namely the Cabinet Committee on S&T, Science Advisory Committee to the Cabinet and Principal Scientific Adviser's Office - which are represented by the leading organizational stewards - seem to be very strong in performing and adhering to the national policies.

No literature was available until the recent past to propose the contribution of the collaborations of firms with Universities and government research institutions to yield meaningful results. Sikka (1998) proposes the need of a comprehensive industrial research policy, based on the utilization of expertise of in-house R&D centres of industry, in conjunction with the capabilities and capacities of national laboratories and technological institutes towards the rapid growth of the industrial sector.

Alam and Langrish (1984) reports that some of the problems responsible for the existing failures of licensees of the National Research & Development Council (NRDC) to exploit the technology commercially were: imperfect technology; difficulty in procuring raw material; bureaucracy in the government institution; competitors importing technology; and lack of cooperation from research laboratories. Although these factors blur the URI collaborations in India, many attempts have
been made to promote collaborations by introducing structural changes and incentive mechanisms especially in the recent past.

The Indian S&T system seems to going through a rapid learning process energized by liberalized economic policies. Various tax incentives coupled with the evolution of new funding and facilitating mechanisms targeting specific sectors seem to be dynamic enough for capturing the much delayed economic and industrial growth. The details of funding mechanisms are indicated in table 10.1 and the existing incentive schemes are given in annexure seven.

In addition, organizational structures facilitate industrial development through various mechanisms and funding arrangements. A description of the available funding arrangements are given in the table 10.1. Most of these funding arrangements are quite new and therefore, it is too early to comment on their mechanism.

3.11.2 URI relationships in India

It has been reported that, universities /institutions interact with industry mainly for training of students and lecturers by industry personal. With globalisation and liberalization of the economy, industries and institutes have been brought together for technology development. The Government has also been funding projects on mission mode for technology development, with industry sharing part of the funding and also commercialising the technology. Government funding agencies, such as the DST, also insist on industry participation in projects taken up by universities and institutions. The S&T policy 2003 also encourages closer interaction and several incentives have been proposed to promote such interactions (Alam, Jayakumar et al. 2003)

"Industry and scientific R&D

Every effort will be made to achieve synergy between industry and scientific research. Autonomous Technology Transfer Organization will be created as associate organization of universities and national laboratories to facilitate transfer of the know-how generated to industry. Increased encouragement will be given, and flexible mechanisms will be evolved to help, scientists and technologists to

transfer the know-how generated by them to the industry and be a partner in receiving the financial returns. Industry will be encouraged to financially adopt or support educational and research institutions, fund courses of interest to them, create professional chairs, etc., to help direct S&T endeavours towards tangible industrial goals. There has to be increased investments by industry in R&D in its own interest to achieve global competitiveness to be efficient and relevant. Efforts by industry to carry out R&D, either in-house or through outsourcing, will be supported by fiscal and other measures. To increase their investment in R&D, innovative mechanisms will be evolved. "

It seems the Government encourages partnerships at every stage. Various mechanisms of supporting and promoting U-I-R relationships in India are given below.

1. CSIR has launched the New India Millennium Technology Initiative under which 45 private partners and 115 research and academic institutions are working together.
2. Sixteenth national conference on in house R&D in industry jointly organized by DSIR and FICCI.
3. National Innovation Fund (NIF) was set up by DST to recognize, respect and reward the unaided innovators and outstanding traditional knowledge experts at the grassroots level. NIF enables the grassroot innovators to build linkages with formal science, technology and design expertise mobilize venture capital support to help convert innovations into enterprise and pursue intellectual property rights protection.
4. Established PATSER programme aimed at technological self reliance with the following objectives;
    - Supporting industry for technology development and absorption of foreign technology.
    - Building indigenous capabilities for development and commercialisation of contemporary products and processes of high impact

- Involvement of national research organizations in joint projects with industry

5. Home grown technology programme to provide financial assistance in the form of soft loans to innovative industrial units and research laboratories to scale up their technologies to pilot/semi commercial scale.
6. Technology Development Board aimed at accelerating the development and commercialisation of indigenous technologies or adapting imported technology to wider domestic applications
7. National Millennium India Technology Leadership Initiative aimed to support innovation centred S&T developments as a vehicle to attain for the country a position of global leadership in some selected niche areas
8. A 600 sq km belt near Hyderabad has been cleared as Genome valley where biotech parks are being established.
9. Set up Bio tech development fund with an initial corpus of Rs 50 cores
10. Biotechnology Board has been set-up as a policy making body
11. Three biotechnology parks have been planned at Pune, Jalna and Akola.
12. Associations of state BT parks is proposed to avoid duplications

This shows that the URI partnerships seem to be still driven by the interests of the Government through its various mechanisms and facilities. Government has taken several promotional steps to encourage industry to establish partnerships. Except for few selected industrial sectors, the economic viability of technologies transferred by research labs are not adequately analyzed. India seems to be selecting the resources and the capabilities to the process of policy interventions. For example BT, IT & PT have been selected for special consideration of interventions. For example, the National Biotechnology Board of India which was established in 1983, and became the Department of Biotech in 1986, established around 200 groups located at academic, research institute and industrial in-house R&D units working on various aspects of BT. Around 20 patents (2002) have been filed in and outside India. Four to five products based on indigenous R&D have reached Indian markets with varying degrees of success. DBT has concentrated on infrastructure and manpower development by devising various

new schemes. The department has also strived hard in TT of Indian and foreign sources. Funding for initial production, infrastructure and validation exercise have come through in deserving cases from DBT and Biotech consortium of India Ltd. In the recent years, financial companies have come forward to support venture companies in Biotechnology. Guidelines for regulation have also been laid down. Specific areas were identified by CSIR based on the capabilities of the laboratories.

Industry has become aware of the impending competition they have to face with the possible arrival of multinationals. A survey carried out by CSIR revealed that the BT industries in India still expect help from CSIR laboratories. There was a strong demand for information about the activities of CSIR laboratories and the availability of expertise in different areas.

Palani reports a case study on U-I-R linkages program at BITS, based on their 25 years of experience, where the cultural differences between university and industry prevented the desired results from U-I linkages. Universities have been unable to integrate their programs with the development activities of industry and industry never looked at this arrangement as part of their overall development strategy. BIT has three major programs to promote U-I linkages such as Practice School Program (Industrial training), Off campus higher degree programs and Technology Innovation centres.

Based on the experience of the BITS, the author of the report has noticed that the normally defined functions of the university sector, namely, the creation, preservation and dissemination of knowledge, are no longer the preserve of the university system alone. New technologies are being created in industry and university curriculum development cannot ignore knowledge created outside the university system.

The author also emphasizes that institutionalised mechanisms in universities need to focus on

1. Restructuring of education by introducing a flexible course structure
2. Constant upgrading curriculum
3. Linking the ongoing projects in industries with the academic requirements
4. Commitment from the faculty
5. Identifying and monitoring projects which are mutually beneficial to the university and industry.

It was also noted that CSIR from the beginning has been strongly promoting public research collaboration with Indian industry (Krishna 1993). It is reported that, in the present context, chemical industries and BT related industries have close cooperation with the university departments. A survey conducted in 1996 under the sponsorship of the UNESCO "Strategies for University Industry Corporative program in Science, Technology, and Engineering in India" revealed the level of corporation at the time the study was conducted. The major findings of the survey were,

- one hundred per cent premier and engineering institutes and 80 per cent of universities had policy for seeking out industries
- 100 per cent premier institutes, 73 per cent engineering institutes and 45 per cent of universities have collaborations with industry
- 100 per cent premier institutes, 54 percent engineering institutes and 13 per cent of universities have increased in activity in terms of collaborations
- 100 per cent premier institutes, 94 per cent engineering institutes and 13 per cent of universities have industry liaison units.

Deepak (2002) suggests that though the I – U – G relationships do exist in India, concrete results in the form of economic development still could not be seen. Further, he believes that although effective government intervention by means of correct policy decisions would boost interactions (which he names as "Triple helix model of Innovation in Indian context"), care should be taken about realities such as cultural, institutional, organizational environment for Science, Technology and Innovation.

Deepak (2002), in his study on the relevance of Triple Helix in the context of Biotechnology in the Delhi region concludes that in the present context of the Delhi region, with respect to BT, bilateral linkages and partnerships mostly between government and public sector research institutions including universities seems to be more relevant and meaningful than tri-parties relationships. Government is the main source of financial support for various research projects which are being carried out in public research institutions including universities. Deepak has observed that the linkages between CSIR and University laboratories are also minimal. Also, it was revealed that the institutions are yet to institutionalise organizational changes (Patent related legal units, technology transfer units, etc). He observes that organization changes are needed in the universities to encourage partnership with industry, to deal with patenting regimes, to commercialise research and to catalyse spin off companies. He proposes that there is a need to incorporate new norms and regulations in the university constitution to encourage triple helix based partnerships

Chapter four- Research framework

4.0 Introduction

The literature review in chapter two explained the features of the URI relationships that can be seen in developed and developing countries, leading to models of knowledge production & models explaining URI relationships and the importance of policy interventions to promote relationships. It was argued that most policy interventions deal with financial assistance and incentives, but this may have different impacts depending on country specific conditions. Hence, it is necessary to understand properly the issues in specific cases (countries) before formulating policy responses (Lundvall 1992). It was also argued that micro level issues are not adequately covered in the literature and hence, the present research focus is more on micro level issues. Chapter two also discussed the available policy statements, instruments, and the role of policy implementation organizations to provide evidence and lessons from newly industrialized and large developing countries and argued that these countries focus more on skill development agendas.

In other words, chapter two emphasized that,

1. Government interventions shape and facilitate the URI interactions.
2. The relationships between industries and universities & research institutions are natural phenomena that exist in any S&T system and sub-systems, throughout the world. However, the type of relationships, intensity and the impact vary in different localities, sectors and in different political environments.
3. The taxonomy of relationships is universal in broader context, but their nature vary according to the social, cultural, economical, technological and political contexts of different countries.

Chapter three discussed the present context of URI relationships in Sri Lanka. Accordingly, these two chapters lay down the foundation for research design. The questions raised in the thesis objectives and chapter two are "What are the existing features of the relationships in Sri Lanka?", "Why do such features exist?", "What are the weaknesses/strengths in the system?" and "What policy instruments exist and/or needed in the future?".

The purpose of the present chapter is to develop the research design to answer those questions. In this context, I would initially reiterate the major characteristics identified in the literature review and discuss how those characteristics shape our research design.

According to the literature review in chapter two, the major characteristics of relationships such as type of relationships, motivation, barriers, management of relationships (coordination & communication), funding, and actual benefits gained out of relationships are considered for investigation in this study. These characteristics, seems to be comprehensive and no other characteristics could be identified at this stage of research design. The following section describes the characteristics of relationships that were initially selected for exploration.

4.1 Characteristics of relationships used for the investigations

Chapter two identified different types of relationships available in the literature of URI relationships. These types vary from personal (informal) relationships to more structured mechanisms supported by the Government. Based on these literature, the types of relationships were selected for inquiry. (see table 4.1 for details).

Similarly, the factors connected to motivation of actors, barriers to initiate a relationship, barriers to continue existing relationships, management & coordination mechanisms that can be seen in developed countries, and actual benefits proposes in the literature are selected for investigation in the Sri Lanka

context. (see table 4.1 for details). However, the mechanism of funding the linkage programs are designed based on my experience in the field. The common funding mechanisms proposed here are:

- Institutional funds
- Joint venture
- Government funds as research grants
- Funding by Industry
- Funding for research students
- Foreign donor agencies
- Personnel

As industry may have access to government funds through several schemes to cover certain financial requirements, despite an absence of structured mechanisms, an additional factor "Partial funding by industry and the remainder from Government" was also included for industrialists.

As argued earlier, structural mechanisms to promote relationships are lacking in small developing countries. Hence, my curiosity captured the issue on how the relationships are initiated in Sri Lanka. I therefore decided to include the question on "How relationships were initiated" with possible options such as personal, family or previous work relationships, through groups of interested persons, inter-mediate organizations and /or the directions from the Government/ organizational policies. Accordingly, based on the literature review and issues in the SL context, the major characteristics for base line explorations was selected for analytical purposes which help to break up and understand the characteristics.

In reality, a relationship between two actors may not limit to a pure version of one type of relationship. For example, an academic may be involved in a consultation activity with an industry while doing short training programme(s) for industry personnel. He may have a research contract with another industry also. Hence the above characteristics will only help to look at and understand the relationships analytically and may not permit evaluation qualitatively.

As the factors connected to different characteristics can vary according to specific situations, it was decided to leave open space to indicate the more uncommon characteristics in the exploratory questionnaire. Hence, the characteristics mentioned in this section do not mean that the research design limits only to those characteristics but contain ability to capture unforeseen characteristics also.

Having stated the general features of the characteristics that can be expected in the URI relationships in Sri Lanka, it is now needed to specify the assumptions, scope and limitations of the present research. The research problem is built in the context of the innovation debate. As the issue is much broader to investigate under a PhD program, it has become inevitable to narrow down the research to specific boundaries without damaging the representation of the major issues of the problem under consideration. Accordingly, it has become necessary to lay down assumptions, define the boundaries, design attributes, and then formulate research objectives & hypothesis.

4.2 Assumptions

Many pretend to argue that URI relationships do exist in developed countries but not in many developing countries, especially small developing countries. The basis for such arguments seem to be in financial terms such as high expenditure in industrial R&D and existence of a technologically advanced industrial base where the major benefit is access to leading edge research in developed countries. This argument seems to have ignored many facts in developing countries such as,

1. Incremental innovations in industrial sectors in which the actual expenditure on those related activities are not recorded as R&D expenditure
2. Secondly, the international collaborations and joint ventures in which local firms have access to advance technologies abroad for specific components of the production line.

3. Industrialists have access to foreign laboratories and services for testing services and technological know how through personal contacts and widely spread communication facilities. In other words, the argument of inadequacy of technologically advanced industrial base has become less imperative in the context of advancement of communication and transport facilities.
4. In relation to 2 & 3 above, what industry needs are close relationships with the scientific community which offers better access to knowledge not only in terms of utility content but also in terms of understanding trends in the international arena.

The ability to tap such sources, and convert them into the practical process, help firms achieve competitive advantage over other local firms and international firms. These reasons justify the existence of some form of URI relationships in any country whether small or large and whether developed or developing.

Hence, the very first assumption in this category is that universities, Government research organizations and industry are involved in different types of informal and formal relationships even in small developing countries. Within this assumption it is also assumed that actors involved in these relationships are motivated to receive economic, social and other personnel benefits by being involved in these linkages. However, they face barriers to initiate new relationships and continue the existing relationships. The existing relationships are funded through various mechanisms and those are coordinated using different techniques. The actors communicate to each other in different forms.

4.3 Scope and design attributes

The research problem addresses relationships in the Sri Lanka context. Although it is difficult to generalize the findings of a single country to other developing countries, there can be some useful lessons for other developing countries which

would arise from this research. Hence it is expected that the results can be generalized for any other small developing country which possess similar economical and technological attributes, despite the potential existence of cultural and political differences. Arguments on technological attributes suggest generalization of research findings to other developing countries. For example, developing countries are considered as assemblers or imitators of technology and conduct adaptive R&D to suit for local conditions and material (Niosi, Saviotti et al. 1993). On the other hand, developing countries lack the levels of capabilities required for advanced research and advanced industrial activities. Hence, the benefits of the relationships focus on sharing capabilities for mutual benefit by improving existing technological capabilities. In this context, universities and research institutes (in other words S&T base of the country) play the major role in terms of input related to the intellectual resources while the industrial sector plays the role of conducting technological advancement. Further, Government is supposed to provide financial inputs through various mechanisms. Despite different levels of advancement of the S&T bases such as well developed infrastructure, and Government initiatives to promote industrial development such as funding schemes, many of the factors related to technological advancement are similar for many developing countries. Hence, I argue that the out come of the research, i.e. recommendation on policy initiatives, are transferable to any other developing country which shows similar (limited) technological capabilities. On the other hand the methodology used in the research to explore relationships, identify important issues and recommend policy responses are transferable to any other developing country.

The data collection was limited to the three institutional frameworks namely university, industry and research institutes. In this sense industry mainly consisted of private sector manufacturing organizations. In addition, only five industrial sectors (Food sector, Rubber & polymer sector, Fisheries, Information technology and Apparel & textile) were selected in order to narrow down the study. These were selected based on economic indicators, as they are comparatively stronger sectors in terms of contribution to the Gross Domestic

Production (GDP) of Sri Lanka. This tends to assume that industrial bases and S&T base is comparatively stronger in the selected sectors and hence the relationships among the actors are comparatively stronger than other sectors.

Design attributes consisted of definitions used in the research, characteristics of the relationships concerned, approaches of data collection and the theoretical framework used in data analysis.

4.4 Definitions

Relationships /linkages : The URI relationships include any type of contacts between individuals or institutions. These contacts include wide variations from personal contacts (informal) to highly organized collaborative research programmes.

Actors : The term "Actors" is used to denote individuals dealing with relationships

Agents : The term "Agents" is used to denote the type of actors dealing with relationships (example: industrialists, academia, researchers)

Sites : The term "Site" is used to denote organizational structures such as universities, industries and research institutions.

Universities: Universities functioning under the University Grants Commission are considered as Universities. However, due to the prevailing situation in the country, three universities which are situated in the war zone areas have not been included leaving ten universities for inclusion in the study.(see sample selection in chapter five)

Research Institutions : Institutions which are established under acts of the Parliament to carry out specific research and development activities, are considered as Research Institutes[7].

[7] These research institutions are administered and funded by the government

Industries: Public and private sector manufacturing and service enterprises including non-profit organizations in the country are considered as industries (Turpin, Aylward et al 1999). However, only private sector manufacturing industries are considered for the present study.

4.5 Theoretical framework

The research is designed within the theoretical framework of National Systems of Innovations (NSI) and models related to University Industry Research relationships. As reviewed in the chapter two, the theoretical framework also takes into account the considered interactive model such as mode 2 of knowledge production and Triple helix model. Although linear model of innovation is considered as obsolete, I wish to reiterate the importance of the linear model with some modifications.

The research will not attempt to test or validate any of the above models in a small developing country context, but use these models/concepts to elaborate the features of URI relationships in the Sri Lanka context.

Finally, different policy initiatives in developed and large developing countries such as Australia and India will be used as guides to propose policy responses to match the conditions in Sri Lanka identified through the empirical evidence.

4.6 Research problems and hypothesis

The research problems and hypothetical contexts based on the above arguments are given below.

- what are the characteristics of formal and informal linkages among universities, government research institutes and industries in Sri Lanka.
- It is hypothesized that the characteristics of these relationships are different in small developing countries than those characteristics of relationships in developed and large developing countries. The hypothesis

is not intended to argue about the existence of relationships, but rather to determine the significance of different characteristics in the present context.

- What are the reasons for the availability of existing characteristics and non-availability of characteristics found in developed countries and large developing countries.
- It is hypothesized that the current framework, procedural and behavioural setting affect the formation and sustaining of the relationships. Also, the existing systems and procedures do not support interactions and need new forms of organizations and procedures to meet the current demands.
- It is also believed that some features of Triple helix model and mode 2 of knowledge production are reflected in the developing countries context. In this context, the research problem focuses on finding existing measures that foster interactions and how the different spheres react to changing social expectations.
- In this context it is hypothesized that the existing S&T policy environment, traditional settings and practices do not adequately support the emergence of interactions. In other words, existing government interventions in Sri Lanka do little to facilitate interactions.

With these research questions and hypothesis it is expected to identify the process that can change the outlook and features of interactions using different settings and identify policy interventions to be implemented in those settings for interaction to happen.

Deriving from the above research problems it is imperative to investigate and understand the underlying issues connected to interactions in developing countries. Therefore the present study was designed in such a way to understand properly the current relationships, new initiatives, trends and constraints and expectations connected to the actors and shareholders of the URI interactions.

Hence the steps taken in the research are given below,

1. Explore and identify main characteristics of the existing linkages in Sri Lanka.
2. Identify the connections among the characteristics.
3. Explore explanation for the existence of such characteristics
4. Identify features of theoretical models for Sri Lanka
5. Obtain perception and experience of the decision makers on relationships and capture their views on relationships and policy framework
6. Use views of the decision makers to evaluate the findings and improve reliability of the above findings with the decision makers.
7. Reflect and refine the theoretical framework of the research using empirical evidence
8. Explore the evolution of new forms of organization to respond to the new expectations and comparison with the theoretical model.
9. Identify and recommend conducive country specific policy interventions that support to enhance technological development through URI collaborations.

With these research problems, objectives and research design in mind the data collection process was planned and conducted. The methods used in the data collection process and the reasons for using the specific methods are given in chapter five .

Table 4. 1 Characteristics of relationships selected for the study

Issues for investigation	Dimensions		
	Industry	University	Research institutions
Types of linkages	Student projects Consultations (informal) Interest groups/Study committees Information /equipment sharing Consulting agreements Industry committees/Advisory boards Seminars/workshops and short training courses Industry sabbaticals/fellowships Contract research grants Joint R&D arrangements Incubator facilities Technology licensing programs Endowed chairs and professorships Extension services Science/Technology Parks and centres Industry - Institute Collaborative Research Centres		
Motivation	To obtain funds to continue research/product development To assist industrial product/process development Develop the image of the institute Support Student's projects To keep the relationships on for mutual benefits (not specified) Student Recruitment To involve in application oriented research Laboratory development Development of skills of the staff To solve technical problems[8] To take advantage to access new knowledge[8] To keep the company updated with new knowledge[8]		

[8] For industries only

Co-ordination & management	Administered by the institute Licensing office / contact office Commercial /service arm Independent project office Managed by Industry Assistance by the faculty Managed by individual researchers	
Funding	Partial funding by industry & rest from Government Joint venture Government funds as research grants Funding by Industry Funding research students Foreign donor agencies Personnel	Institutional funds Joint venture Government funds as research grants Funding by Industry Funding for research students Foreign donor agencies Personnel
Barriers to initiate relationships	Difficulty in making appropriate contacts Time commitment to find a suitable partner Lack of a reward & incentive system Lack of information on research capabilities	
Barriers to continue relationships	Lack of research orientation of the industry Dissimilar motives. Absorptive capacity of the industry Bureaucracy of the research institute. Lack of communication	
Actual Benefits	Commercialisation of research results New recruitments Upgrading curriculum to suit industry Solving technical problems Product/process development Increasing profits of the firm	Funds for research Commercialisation of research results Solving technical problems Financial benefits to individuals Product/process development Upgrading laboratory facilities Jobs/training for students

Chapter five – Methodology

5.0 Introduction

The research design given in the chapter four calls for methodologies to explore the existing URI relationships, to find reasons for the existence of such relationships and to develop a conceptual framework for recommending policy initiatives for Sri Lanka. Accordingly, this chapter will describe the methods used to collect empirical evidence to achieve the research objectives set out in chapter four. This chapter will explain the steps taken by the researcher to achieve the objectives while justifying the specific methods used. Also, the steps taken in relation to data analysis and the analysis framework are presented at the end of the chapter with a view to lead into the data analysis in the proceeding chapters.

The methodology consists of four steps, such as: exploratory questionnaire survey; follow up interviews with the respondents to the questionnaire survey; interviews with decision-makers; and mini-scale case studies on new forms of organizations evolved within universities, research institutions and industrial organizations. The analytical framework was designed according to the data generated at each of the four steps given above. For example, the questionnaire survey dealt with quantitative statistical methods while the interview data dealt with qualitative methods used in the grounded theory approaches.

5.1 Exploratory survey

The exploration of the existing URI relationships, the first research objective, needed a wide coverage within a limited time and cost. As the URI relationships in Sri Lanka are unknown in the literature and the researcher had only a limited knowledge of what is happening in relationships based on experience as a research manager, the research data collection process was planned to commence with a postal questionnaire survey. The questionnaire survey method was used as it produces quick results, is convenient, less expensive and it promises wider coverage (Sarantakos 1993). Alternative methods such as using secondary sources

(e.g. Annual reports of institutions & universities etc.) do not provide adequate coverage, current context and also lack the consistency of the type of information needed for exploration. Hence, such methods were noted as inappropriate for the present exploratory survey.

In this exploratory survey, a self administered mailed questionnaire was used to collect baseline data. The purpose of the survey was to understand the types of relationships and the general characteristics of URI relationships in Sri Lanka. In this context, the following issues related to questionnaire type surveys were taken into consideration.

- Adequacy of the questions while maintaining the brevity,
- More convenient way to respond (ranking method),
- Clarity of terms used,
- Instructions to respond,
- Assurance of confidentiality,
- Facilitation of returning the responses,
- Provision of adequate time frame to respond,
- Validation of the questions through pilot test,
- Formulating coordination mechanisms,
- Sending reminders

The major characteristics that were mentioned in the preceeding chapter such as types of linkages, motivation factors, coordination and management, communication practices, how the funds are allocated, barriers to initiate and barriers to continue relationships and the actual benefits gained by the respondents were included in the questionnaire. Two open-ended questions were also included for two purposes. The first was to obtain the opinion of the respondents on the adequacy of existing legislative and structural mechanisms that promote linkages and changes proposed to existing mechanisms. The second was to use such information as a guide for follow up interviews to facilitate an in-depth investigation.

5.1.1 The questionnaire

A set of questionnaires which consisted of four sections (Section A for the general information, Section B for the characteristics of the relationships, Section C for the open ended questions on policies to promote relationships and Section D for the concluding remarks and customary aspects) was designed to gather different sets of information from respondents from universities, research institutes and industries, yet maintained the same question items in each questionnaire[9]. The questions in Section B were organized in a two-dimensional format. Each question was backed up with several choices and each choice was stretched to rank (point scale ranking such as 5- very high, 4- high, 3- indifferent, 2- low, 1- very low, 0- not relevant) according to the importance or level of relevance. A choice "Other (Please specify) was included in all questions to capture unforeseen choices which can be significant to the respondent's point of view. A set of instructions, explanation about the research study and a letter from the sponsor indicating the importance of the study to the sponsor and assurance of confidentiality of the data accompanied the questionnaire. (A sample set of copies of the questionnaire, instruction sheet and a copy of the letter from the sponsor are given in Appendix three)

5.1.2 Sample selection

The sample selection process was undertaken in different filtering stages. The first level filtering selected universities, industries and research institutes. Universities, industries and research institutes located in the war zone area[10] were not included in the sample, based on the assumption that researchers in those organizations are not in a position to involve in any useful collaborative work.

[9] Modifications in vocabulary and minor changes were undertaken to match the questionnaires according to the organization. Otherwise the questionnaire maintained the same standard.
[10] At the time of the research two out of nine geographical provinces were affected by the civil war in the country

5.1.2.1 Selection of researchers and academics

The database on S&T personnel available at the National Science Foundation of Sri Lanka (NSFSL), which consisted of details of scientists and engineers in the universities and research institutes, was used as the starting point. According to my knowledge, this database is the single most comprehensive source of information about researchers and academia covering all sectors and universities & research institutions in the country. Hence, availability of information at hand without any cost and availability of information at a single place were the criteria for selecting this database as a source of information. Apart from the above first level filtering, an additional filtering level was applied to select the sample. The researchers and academia with specialist, research interest or attachment to an institutional department /division connected to one of the selected economic sectors (See Chapter four for the selection of the economic sectors) was taken as a second filtering process to select the sample. Consequently, 235 researchers (including academia) in 14 research institutions and 24 university faculties were taken as the sample for sending the above questionnaire.

5.1.2.2 Selection of industrialists

In response to the inquiry made with the Chamber of Commerce of Sri Lanka about the source of information about industries and industrialists, they recommended, the "Kompass Directory" which provides a comprehensive listing of industries operated in Sri Lanka. Hence, it was used as the primary source to select industries. The directory provides information on the name of the industry, address, CEO, and the major functions of the industry (trade, training, manufacturing, export.. etc) . The selection was done using three filtering stages. Firstly, the industries were filtered according to the economic sectors the study was concerned with. Secondly, industries which are involved in trade activities only were omitted. The 93 industries were finally selected according to a stratified random sample basis. Postal questionnaires were sent to managers in those selected industries. It was made optional for either the manager or a scientist in the industry to fill the questionnaire.

5.1.3 Validation of the questionnaire

The survey questionnaire was validated through a pilot survey of eight individuals from the sample. This sample was selected based on personal contacts. They were not contacted again for the major survey. However, responses from the pilot survey were also included in the data set with the concurrence of the respondents, as there were no major changes made in the final survey questionnaire rather than few typological errors and clarifications.

Having modified the questionnaire for typographical and minor modification to enhance the understanding of the items, it was sent to the individuals in the selected sample together with the instruction sheet, letter of confidentiality, and return post stamped envelope to return the filled questionnaire by post. The first round of the mail questionnaire received around 15 % of responses from all three types of respondents. Contacts were made through email and over the telephone with a view to obtain better response rate. While making these contacts, it was noted that some individuals of the sample were not available in the country.

The second round of mailing was carried out after a lapse of one month from sending the first questionnaire. The second round received more responses. The responded questionnaires were organized in a way to facilitate the data entry for analysis.

The response rate is given below.

Table 5. 1 Response rate for the postal questionnaire survey by type of respondents

	Number of questionnaires posted	Number of responses	Response rate
Academia	112	24	21%
Researchers	123	26	21%
Industrialists	93	39	42%

5.1.4 Preparation for analysis

A worksheet in MS-Excel was created to input data from the responded questionnaires. Three major worksheets were created, one for academics, one for researchers from the public sector research institutions and the other for industrialists.

These spread sheets were analysed to see the important issues for each characteristic. The same set of data was converted into SPSS worksheets for statistical analysis such as correlation among selected issues. The methodology used for data analysis is given in the sections 5.6 (Framework of analysis) and 5.7(Details of process) respectively.

The responses for open-ended questions related to policy and legislative issues were listed against the respondents. These responses and the survey findings are taken as the key to the next stage of data collection, i.e. interviews.

The questionnaire survey did not allow the opportunity to collect additional information that explains the surrounding environment. Neuman (2000) suggest that the questions requiring many contingency questions and complex questions are answered inadequately in mail questionnaires. Also, due to lack of supervision at the point of data gathering, partial responses are quite possible. Therefore, it was planned to conduct a follow up series of interviews with the respondents (named type A respondents) .The process adopted in interview data collection is given in the next section

5.2 Interviews (researchers, academia and industrialists)

As stated above , the interviews with respondents were conducted with a view to

- Obtain more qualitative information and clarification (if any), from the respondents based on their responses to the questionnaire.
- Gather information for case studies, if available.

- Gather information based on their experience on policymaking process.
- Gather any other related information connected to the relationships based on their experience.
- Follow up the suggestions coming out of the survey analysis[11].

The interviews were planned according to the following procedures,

- Interview at least two people from each selected economic sector representing each type of organization (i.e. University, Research Institute and Industry)
- The duration of each interview should not exceed 75 minutes.
- Interviews should not be recorded in magnetic media as some respondents were concerned about the voice recording process. Hence it was assumed that they may not provide more precise information if recorded in magnetic media.
- Not more than two interviews should be conducted in a day.
- Interviews should be semi-structured where the responses for the questionnaire are taken as guiding questions. However, the following questions are formulated as framework questions for interviews
    - how each actor viewed those linkage mechanisms and partners ,
    - whether relationships are useful,
    - how linkages can be improved (e.g. by supporting PhD programs and developing guidelines on IPR)
    - what are the preferred linkage mechanisms and reasons

[11] By doing so it was expected to achieve the research objectives on "What are the reasons for the existence of the available linkages".

During the interviews with respondents, it was possible to identify some key individuals (subjective to the opinion of respondents who were interviewed) who could be included in the sample for interviews. Hence, those key individuals were interviewed (snow ball sample) by persuading them to be involved in the study. (List is given in annexure four). Select other informal and formal interviews were conducted outside of the sample frame, sometimes at unexpected locations, which the researcher felt important to describe the situation of URI relationships in Sri Lanka. The list of interviews made outside the sample frames are also given in Appendix four (in italic letters).

Notes were taken down on the interviews and subsequently, gone through again on the same day, to make sure that the points noted are clear & visible for future references. These interview notes together with other material were stored for qualitative analysis at a later stage. Notes on the interviews were analysed qualitatively using grounded theory approaches. The process adapted in analysis of interview data is described in 5.6 (framework of analysis) and 5.8 (details of process).

The responses for the interviews and this analysis are bound to subjective influences such as personal biases, which are common in most qualitative approaches. On the other hand it was important to cross-examine the claims made by the type A respondents on the issues which are beyond the control of the type A respondents. Hence, it was decided to conduct a series of interviews with a theoretical sample of managers and decision makers in government organizations, universities and representatives of industrial organizations. As stated, the information gathered in this process is used to cross-examine the opinion of the type A respondents and to triangulate the findings.

5.3 Interviews with managers and decision makers

Having gained experience and insight into the issues governing URI relationships in Sri Lanka, by conducting the survey and interviews with researchers, academia and industrialists, the interviews with the managers and decision makers were conducted to validate the findings and obtain their opinion on relationships and technological innovations. This group of the respondents consisted of Deans of Faculties and Vice Chancellors in universities, officers in charge of university based units, Heads of government organizations, Secretaries and Advisors of the Ministries and chief officers in industrial associations. A theoretical sample was selected to conduct interviews. The list of interviews made is given in appendix four. Each person was contacted over the phone for appointments followed by a letter. As these officials are usually busy attending official activities, it was planned to limit the interviews for 45 –60 minutes. Also, punctuality was maintained as a

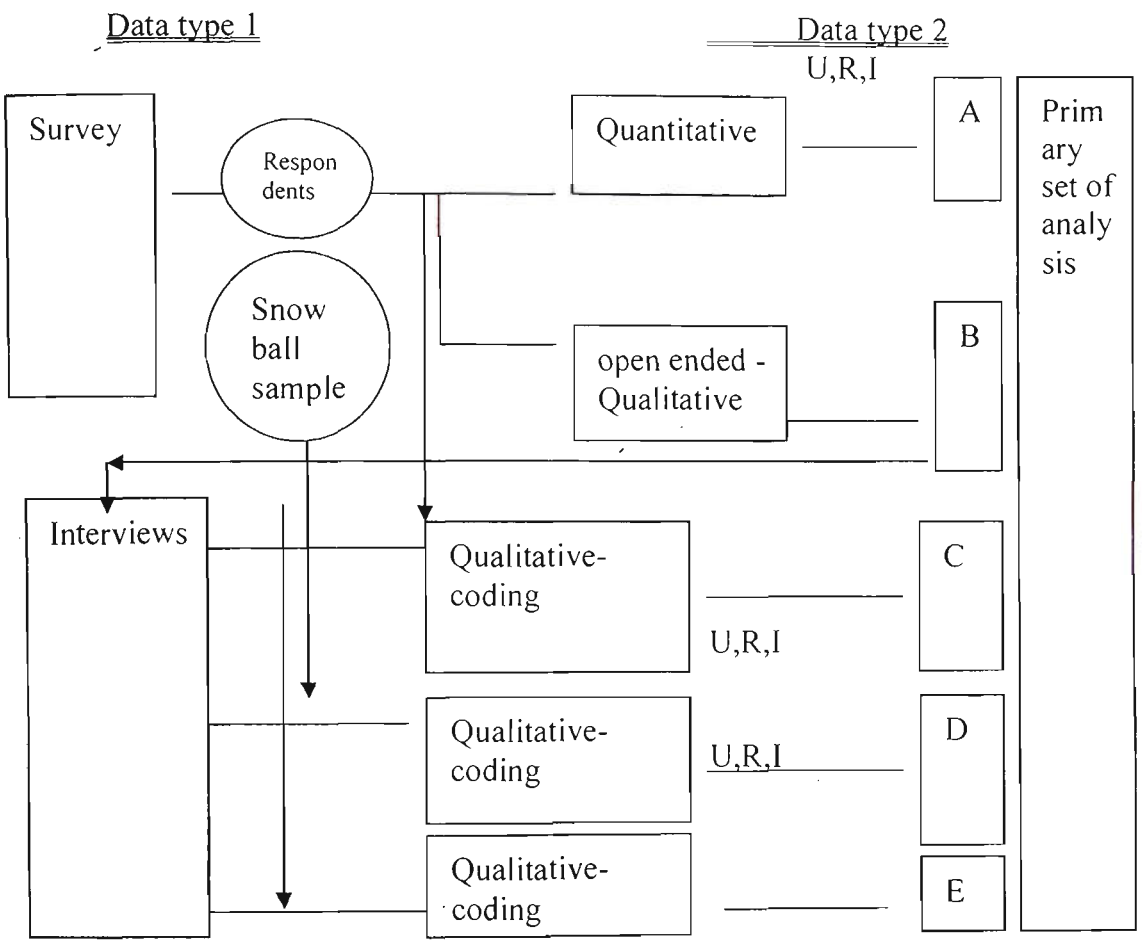
high priority. The discussions were recorded in magnetic media using a micro-cassette recorder. Except for two, all interviews were conducted in English. In addition, a couple of informal interviews were also made, as and when the I felt (subjective) that the respondent would provide useful input into the study. The interviews were transcribed into word documents for coding and clustering process, which is described the section 5.6 (Framework of analysis) and 5.8.

5.4 Case studies

Finally, it is required to examine the new findings. In this context, it was decided to take an example to which the theoretical framework is applied. For this purpose, the information gathered in the interviews of type A respondents enabled me to identify theoretical samples of new forms evolved in the URI system to analyse the findings. Based on the analysis of the notes of the first set of interviews, it was decided to focus the case studies on one or two of the categories where it would be possible to compare the similar categories in a large developing country such as India. Hence, the new structural arrangements in the university, industry and research institutions were selected as case studies. Accordingly four new forms were selected for investigation. Interviews were conducted with the persons in charge of these new organizations to gather information. The findings of this stage of research is used to analyse how new forms of organizations operate within structural boundaries while facing micro-level process related constraints which are faced by universities, research institutes and industries. A similar case in the Indian context is also used for comparative analysis. The data related to the Indian case study was collected through a face to face interview with the person in-charge of the new form of organization, secondary sources of information provided by the interviewee, supplementary interviews with selected academics and research personnel in Indian organizations and sources of information collected from those organizations. The details of the findings are given in the chapter nine.

5.5 Framework of analysis

The data analysis consisted of quantitative and qualitative analysis. The research data consisted of data from responses for the survey and interview notes. The data analysis process is summarized in figure 5.1.



A – responses to the structured questions of the Questionnaire survey

B - Responses to the open ended questions of the Questionnaire Survey

C- Interviews with respondents

D - Snow ball sample

E- Decision makers

Figure 5. 1 The process of data generation and analysis

The data set A, which is the outcome of the questionnaire survey, is mainly used for quantitative analysis to identify the main characteristics of relationships &

possible descriptions. Data set B is used as a feed back for interviews. The preliminary analysis in data set C & D, which is the outcome of the interviews with the respondents, and the snow ball sample is used for qualitative analysis. These data sets were used to create a list of codes, matrices and diagrams for analysis and interpretations. The data set E which is the out come of the interviews with the decision-makers is used to triangulate the findings of the data sets A,C & D. Also, these data sets (secondary data) were used to develop the conceptual and contextual framework for the research outcome.

Table 5. 2 Sample Sizes for different data sets according to the type of respondents

Data set	Industrialists	Academia	Researchers	Other	Total
A	39	24	26	-	99
B	39	24	26		99
C	11	11	9	-	31
D	3	3	5	9[12]	20
E	3	7	7	3	20

Finally, case studies were used to justify the arguments adopted in the development of the contextual framework.

5.6 Analysis of responses to the structured questions of questionnaire survey

The data set A represents the raw data coming from the responses to the structured questions of the questionnaire survey (i.e. Section two of the questionnaire). This data set was sub divided in to three groups according to the type of respondents such as industrialists, academia and researchers. These raw data were entered into three SPSS worksheets for the purpose of analysis.

The responses for the questionnaire were analysed quantitatively with a view to bring out the major types of relationships and issues related to the different

[12] These respondents in the snow ball sample were interviewed to get additional information on specific issues and not included in the coding process. (example; IN26 for functions of Industry Facilitation Forum and IN53 for activities of Board of Investment)

characteristics such as motivation, barriers, funding, management, communication and benefits. The average rank or percentage of responses with higher ranking (e.g rank of 3,4 or 5) for each factor within a characteristic and the variance were tabulated. These figures were used as the main criteria for selection of the important factor(s) that contribute to the particular characteristic. The findings are described in the Chapter six.

5.7 The analysis of interview data

Interview data consisted of three major categories. The first category is data from respondents for the questionnaire survey who are practically involved in some kind of linkages. This is represented in the Data set C of the above diagram. This group is sub divided into industrialists, academia and researchers. Secondly a set of data comes from the snowball sample. This group may or may not be involved in linkages or fall in any of the sub divisions but were either perceived or recommended by the respondents of the previous interviewees as a source of information. This set of raw data is represented in the Data set D of the above diagram. The third group consisted of a set of persons who make a significant contribution to decision making processes. This group consisted of senior officials from Ministry, High level university officials (e.g. VCs and Deans of faculties) and Senior officials in industrial associations and related organizations. This set of raw data is represented in data set E of the above diagram.

5.7.1 Analysis process for data sets C & D- Coding

Interviews were numbered IN01, IN02 and so on. The set of notes were given the interview number as a reference number. Coding is regarded as an analytical tool to organise qualitative data that allow the analysis to spot quickly, pull out, then cluster all the segments relating to the particular question, hypothesis, concept, or theme (Miles and Huberman 1984). The interview notes were coded subjectively and manually while reading through them. These open codes represents segment(s) of words, sentences and paragraphs from those interview notes. Codes and notes

were entered on a hard copy of the interview notes. The codes were entered in to a MS-Excel worksheet with each code having a reference to the interview number.

5.7.2 Bias

The coding process is highly subjective depending upon the experience and knowledge of the researcher and hence the codes are naturally subject to personal bias. The researcher's preoccupied perception (own bias) on certain issues can be regarded as one of the disadvantages that may occur even without notice of the researcher (Glaser 1998). However, in the present context, personal bias, in this context, is taken as more advantageous rather than as a disadvantage. My experience in dealing with the actors of the URI spheres provided an advantage in understanding the issues emanating from the interviews. Also, the position held by the researcher, his awareness of the system and the official relationships with individuals prevailing during the time of the interviews provided an easy environment for the interviewees to talk more openly and without making any attempt to hide information. However, constant comparison with related codes enabled me to minimize this disadvantage.

The codes were grouped according to clusters.

> "Clustering is a general name given to the process of using and/or forming categories, and the iterative sorting of things. Clustering can be used to understand a phenomenon better by grouping, then conceptualising objects that have similar patterns or characteristics" (Miles and Huberman 1984).

The occurrences of each code was counted and noted against the type of respondent. Double counting on the same code by one respondent was omitted using interview numbers against the issue and subsequent crosschecking. The counting was practiced to investigate the issues, which matters more often than the other issues. In addition, counting helps to be self conscious about the important issues, to keep analytically honest and to protect against possible bias (Miles and

Huberman 1984). Accordingly it was observed that the codes can be grouped around ten clusters (Figure 5.2)

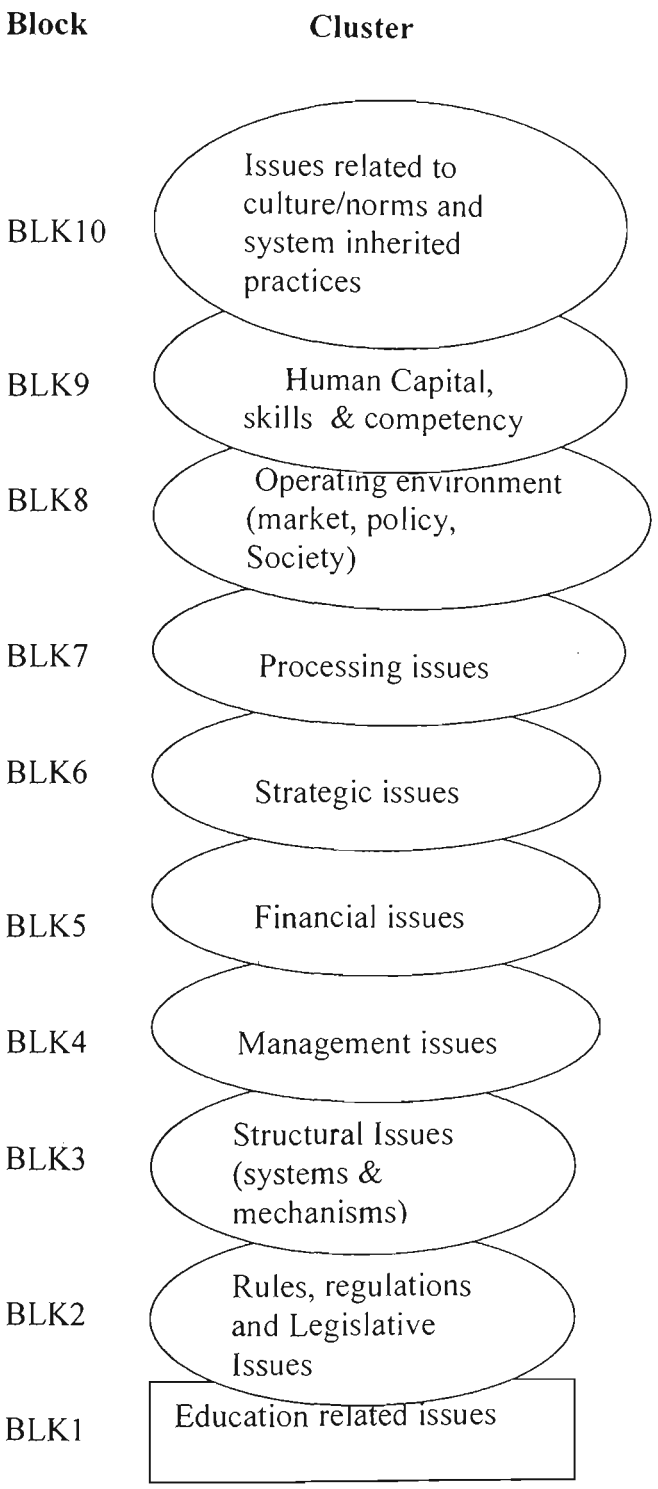


Figure 5. 2 Ten blocks (Clusters) evolved from the clustering open codes

These clusters represented an overlapping nature in one hand and highlighted the possibility of regrouping to form more consolidated clusters. Accordingly it was observed that the codes can be re-clustered around two major themes representing Structural/Framework issues, Procedural issues and behavioural issues. As the framework issues are generally outside the direct control of the type of respondents, it was decided to analyse those issues separately from the rest of the issues.

5.8 Analysis related to framework issues

The counting against clusters related to framework conditions were extracted and the relevant frequencies are noted against each type of respondents. As mentioned earlier the counting assists to investigate the issues, which matter often more than the other issues. The details of this analysis related to clusters of framework conditions are discussed in chapter seven. The interview data from the interviews with decision makers (data set E) and findings from chapter six are used to triangulate the findings of the framework conditions.

5.9 Analysis related to micro level issues

The analysis related to micro level issues begin with coding of the interview notes with respondents and with the persons in the snowball sample. The codes derived for the analysis of framework conditions were revisited and carefully compared for indications on framework issues. The issue of bias is again minimized using constant comparing process. However, in this instance the codes were listed in such a way as to help comparisons among different sites.

These open codes were brought into a list according to type of respondent (TOR), his/her attachment to a site, target group (TG) of the code and the contextual category of the code that it falls into. The contextual category is derived based on the intention of the comment made by the interviewee. Three intentions were identified such as expected status (EP), existing status (EN) and some action taken (AT) to reach the expected status. Accordingly 344 open codes were prepared. It was noted that these codes can be clustered as they show commonalities. Based on

these coding, a code list (indexed by clusters) was prepared. Accordingly it was possible to develop 19 clusters. These clusters include clusters related to framework conditions also. The clusters developed accordingly are given below.

Table 5.3 List of clusters based on the open codes

A. Access to Know how
B. Central facilities
C. Coordination
D. External influence
E. Functional Failure
F. Funding
G. Incentives
H. Industry dynamics
I. Characteristics of local market
J. Modernization
K. Opportunity
L. Orientation
M. Perception
N. Policy culture
O. Research
P. Responsiveness
Q. Social dynamics
R. Systemic failure
S. Tech culture

As the framework issues are discussed in the chapter seven, and it was found that the comments related to those interview notes do not add new observations, those clusters are omitted from the analysis of micro level issues. Hence, the omitted clusters are

- Central facilities (B)
- Coordination (C)
- Funding (F)
- Incentives (G)

In addition, it was noted that a segment of codes under the policy culture also deals with the framework issues. Those segments are purposely omitted in the section dealing with micro level issues. Consequently, the code lists indexed by cluster

(annexure five) related to the remaining clusters (Table 5. 4) were used for the following analytical purposes.

1. To prepare memos related to each of the clusters.
2. To see the importance of these clusters for each site.
3. To prepare a site by type of respondents (agent) diagrams

Table 5.4 Clusters and notation of clusters related micro-level conditions

Access to know how	A
External influence	D
Functional failure	E
Industry dynamics	H
Characteristics of local market	I
Modernization	J
Opportunity	K
Orientation	L
Perception	M
Policy culture	N
Research	O
Responsiveness	P
Social dynamics	Q
Systemic failure	R
Tech culture	S

5.9.1 Memos

The issues related to micro level conditions are more interrelated and need to be observed for interconnectedness. In this context, memos can be used as an analytical device to integrate data and demonstrate connectedness with each other and with a general concept or category. Such memos are central to the process of data collection and analysis in qualitative research, and are used to link empirical data to abstract concepts (Neuman 2000). Hence, in this context, memoing has been used over counting, as the main analytical device in the process of developing

the conceptual frame work. The memos were taken as the part of the thesis to describe the clusters connected to constructing the conceptual framework.

5.9.2 Site by type of respondent (agent) matrices

"Matrix form is considered as a creative, yet systematic –task that furthers [your] understanding of the substance and meaning of data" (Miles and Huberman 1984). Accordingly, site by type of respondent (agent) matrices were prepared using the TOR and TG for better understanding of the micro level conditions. The details of the memos and matrices are presented in chapter eight

5.10 Triangulation

The properties of the clusters were compared with the findings and suggestion in the chapter six (based on questionnaire survey) for accordance and disagreements. Also, the interview notes and the code list based on the interviews with decision makers were used as a measure of triangulation of the findings from the interviews with respondents.

5.11 Presentation of analysis

The analysis and the results of the data set A are described in the chapter six. Chapter seven (framework conditions) and eight (micro level conditions) will be dealt with the qualitative analysis based on the data sets C&D. The outcome of analysis is comprehensively discussed in these chapters.

Chapter six- Characteristics of existing relationships

6.0 Introduction

Chapter six deals with the research question on what are the characteristics of relationships that can be seen in the Sri Lanka context. As indicated in the chapter two, the type of relationships, motivation, coordination of relationships, communication between partners, funding sources and the barriers to initiate and continue relationships are selected as the major characteristics. The survey process was discussed in chapter five. In this chapter, the attributes of the characteristics of URI relationships in Sri Lanka are identified through the analysis of the survey questionnaire using quantitative techniques. A summary of findings was prepared and presented at the end of the chapter with a view to compare the findings with the qualitative analysis that will follow this chapter.

The questionnaire survey was conducted for researchers, academia and industrialists. (Details of the method are given in the chapter five). The overall response rate of 27 per cent was obtained (see Table 5.1). The data sets (three sets - one set for each group of respondents such as industrialists, academia and researchers) from section two of the questionnaire responses were entered into three SPSS worksheets for the purpose of analysis. Responses for the section three of the questionnaire were listed according to the type of respondents to use as a guide for follow up interviews.

The following analysis will deal with the section two of the questionnaire. The responses for the questionnaire were analyzed quantitatively with a view to bring out the major types of relationships and issues related to the different characteristics such as motivation, barriers, funding, management, communication and benefits.

The average rank or percentage of responses with higher ranking (e.g rank of 3,4 or 5) for each factor within a characteristic and the variance were tabulated. These

figures were used as the main criteria for selection of the important factor(s) that contribute to a particular characteristic. The findings are described in the following sections with the help of the tabulations prepared for each characteristic.

6.1 Types of relationships

The number of respondents with more than average rank (average of 0,1 to 5 is 2.5) are used as the criteria for the analysis of the type of relationship. The percentage of the respondents who have given a rank of 3,4 or 5 for each type of relationship is given in the table 6.1.

Table 6. 1 Percentages of involvement[13] of respondents in different types of relationships according to type of respondents

Type of Linkages	Industrialists (n=37)	Academia (n=24)	Researchers (n=26)
Student projects	38	70	55
Consultations (informal)	34	70	68
Interest groups/Study committees	19	55	48
Information /equipment sharing	21	32	36
Consulting agreements	18	33	11
Industry committees/Advisory boards	28	38	45
Seminars/workshops and short training courses	68	59	60
Industry sabbaticals/fellowships	19	23	11
Contract research grants	16	18	25
Joint R&D arrangements	19	27	38
Incubator facilities	6	10	11
Technology licensing programs	6	0	5
Endowed chairs and professorships	9	0	0
Extension services	6	35	70
Science/Technology Parks and Centres	8	14	18
Industry - Institute Collaborative Research Centres	38	14	32

[13] Rank of 3,4, or 5 by the respondent for each factor is taken as the involvement

It can be seen that the academia was more involved in student projects, consultation (informal) activities and seminars/workshops/training (SWT) programmes. The researchers in research institutes are highly involved in extension services, consultancy (informal), SWT programmes, student projects and interest group/study committees.

All these linkages are generally short-term and considered as low-level activities in terms of technological capability development. This situation can be used by moderators, such as intermediate organizations/agencies, which facilitate relationships, as the basis for promoting negotiations among actors for more productive relationships.

On the contrary, the industry seems to be weakly involved in the relationships (at least in their perspective) other than relationships through SWT programmes, while students' projects and informal consultancies have received an encouraging percentage. The reason for the industrialists to indicate a lower percentage in students projects and informal consultancy work compared to the counter part respondents may be due to the yardstick used by the industrialists to indicate the level of rank (very low to very high). The other possibility can be due to a type one error, i.e. sample selection. A striking feature was that although the technology licensing, contract research, joint R&D arrangements, consultancy agreements and industry sabbatical/fellowships were reported as having a very low profile, the existence of such relationships is an encouraging feature in the context of a small developing country.

The analysis also came across some unexpected features. For example, it seems few industrialists and researchers are involved in more structured types of relationships such as incubator facilities technology licensing programmes, S&T parks/centres and collaborative research centres. Although the concept of technology incubation is new to Sri Lanka and there is no government sponsorship on collaborative research centres, the level of ranking, even at the lower level, seems to be unfamiliar. Hence, it was decided to revisit the data and identify the

characteristics of the respondents for such responses. The number of persons who have given ranks higher than three for more structural arrangements for relationships are given below (Table 6.2).

Table 6. 2 Number of persons involved in more structured relationships by type of respondents

Type of Linkages	Industrialists	Academia	Researchers
A. Contract research grants	5	4	5
B. Joint R&D arrangements	6	6	8
C. Incubator facilities	2	2	2
D. Technology licensing programs	2	0	1
E. Endowed chairs and professorships	3	0	0
F. Science/Technology Parks and centres	2	3	3
G. Industry - Institute Collaborative Research Centres	2	3	6

The most interesting feature of these respondents is that almost all in the types of linkages C,F & G have indicated a higher rank for foreign sources of funds. This suggests that the respective respondents have relationships with foreign organizations dealing with incubators, S&T parks and research centres. Further inquiry into this aspect revealed that two out of three respondents from industrialists are from state run enterprises while the other person has strong personal relationships with a foreign company operating in Sri Lanka. The company provides back up support for this particular individual by providing all the technical support to develop his products. This implies that there is a market for such structural arrangements and the policy makers may need to take a note of market signals for potential policy initiatives.

6.2 Motivation

The average rank obtained by each of the factors connected to motivation by each type of respondent is used as the criteria for the analysis. The factors, which are not relevant to the type of respondents, are indicated as "na"(not applicable).

When the reason for involvement in linkages was analyzed, academia and researchers showed a comparatively higher ranking for "To be involved in application oriented research" followed by "To assist industrial product/process development and development of the image of the institution"(table 6.3).

Table 6. 3 Average rank and variance of different attributes of motivations according to type of respondents

Reason for involvement in relationships	Industrialists (n=39)		Academia (n=24)		Researchers (n=26)	
	Avg rank	variance	Avg rank	Variance	Avg rank	Variance
To obtain funds to continue research[14] /product development[15]	1.3	2.0	2.6	3.5	2.0	2.6
To assist industrial product/process development	na	na	3.6	1.8	4.0	1.3
To solve technical problems	2.7	3.0	na	na	na	Na
Develop the image of the institute	na	na	3.5	1.7	3.7	1.3
Student's projects	Na	na	4.0	1.4	2.2	2.2
To keep the relationships on for mutual benefits (not specified)	2.6	2.1	3.2	2.4	2.5	1.2
Student Recruitment	2.3[1]	2.6	2.6	2.9	1.7	2.7
To be involved in application oriented research	na	na	3.7	2.2	3.9	1.4
Laboratory development	na	na	3.0	1.7	2.4	2.6
Development of skills of the staff	na	na	3 .3	1.0	3.0	2.2
To take advantage to access to new knowledge	2.9	2.9	na	na	na	na
To keep the company updated with new knowledge	2.8	2.4	na	na	na	na

1 Support for better recruitment in the future

Surprisingly, the motivation for research funding, student recruitments and laboratory equipment were at the lower end of the ranking order. However, industrialists demonstrated that they were more interested in "To access new

[14] For university & research institutions
[15] for industry only

knowledge and to keep the company updated with new knowledge". Industrialists consider student recruitment as the least motivating factor.

In this context, it is needed to explore the underlying reasons for some of the findings. For example, the low interest of industrialists to get involved in "to solve technical problems" may be due to the lack of capability of the industry to be involved in research or the lack of credibility of research in universities and research institutes. It may also be due to the fact that industrialists in developing countries have short term, profit oriented objectives, which prevent them from foreseeing the future threats to the industry or even when they see those threats, being unable to take the risk of being involved in research.

6.3 How the relationships are initiated

As in section 6.2, the average rank obtained by each factor is used as the selection criteria of the important factor. Interestingly, the data shows that all the types of respondents have ranked high for the personal relationships and previous work relationships (Table 6.4). These two factors are person-embodied features. Hence, as seen in the international literature (e.g. OECD, 2002), the personal relationships also seem to take an important role in Sri Lanka. The researchers and academia have been listed "initiatives from the institution" in the lower ranking order. This shows evidence for lack of institutional mechanisms for promoting relationships. On the other hand, academia have given a higher rank for "Personal interest to from (technical) relationship". This indicates the responsiveness of individuals to the industrial relationships.

Table 6. 4 Average rank and variance of different attributes of "how the relationships were initiated" by type of respondents

How those linkages were initiated	Industrialists		Academia		Researchers	
	Avg rank	Variance	Avg rank	Variance	Avg rank	Variance
Previous work relationships	2.4	2.4	3.8	1.3	3.5	1.3
Personal relationships	2.6	2.5	4.2	1.2	3.7	1.2
Initiatives of the Institute	1.2	1.1	1.6	2.2	2.8	1.9
Family relationships	0.4	2.4	1.4	2.2	0.9	1.5
Relationships formed by third party	1.4	1.4	2.1	3.3	2.2	1.7
Personal interest to form (technical) relationship	2.4	2.5	3.4	2.7	2.5	2.0
Invitation by the partner	1.6	1.9	2.6	2.9	2.8	2.2
Other (Please Specify)- IIP programs	-	-	-	-	3.5	

6.4 Management & coordination

The analysis of factors related to management & coordination of relationships (based on the criteria of average rank), shows that the most of the relationships are managed by the individuals. Also, the research institutes seem to have considerable involvement in managing relationships (Table 6.5). None of the other factors seem to have achieved a reasonable level of average rank. This indicates the lack of organized management practices for handling URI relationships.

6.5 Communication among partners

Communication patterns also seem to fall in line with the above findings. The individuals seem to be communicating with counterparts through informal meetings (Table 6.6). However, higher average rank given by the researchers for "Official correspondence" shows that they are considerably involved in official communications with the industry. In contrast, average rank for "Official correspondence" by academia is at the lower end.

Table 6. 5 Average rank and variance of different attributes of how the relationships were managed/coordinated by type of respondents

How do you Coordinate/manage those linkages	Industrialists		Academia		Research	
	AVG rank	Variance	Avg rank	Variance	Avg rank	Variance
Administered by the institute[16]	na	Na	1.4	3.4	3.0	2.8
Licensing office / contact office	1.3	1.2	0.6	1.6	1.4	1.9
Commercial /service arm	1.0	2.1	0.7	2.0	2.0	1.8
Independent project office	1.0	3.1	1.0	3.0	1.8	2.3
Managed by Industry	1.7	3.6	1.6	2.6	2.3	0.9
Assistance by the faculty[17]	na	Na	1.7	2.4	na	na
Managed by individual researchers	2.0	2.5	3.7	2.5	3.0	2.0

Table 6. 6 Average rank and variance for different attributes of communication used by type of respondents

How do you communicate with your partners in the industry	Industrialists		Academia		Research	
	Avg rank	Variance	Avg rank	Variance	Avg rank	Variance
Regular meetings with industry and researchers	1.3	2.1	2.3	3.6	2.8	2.1
Official correspondence	2.5	2.9	2.5	2.6	3.4	0.9
Visits to sites by researchers	2.2	1.9	3.0	1.3	2.9	1.4
Informal talks/meetings	2.6	2.1	3.5	1.2	2.9	0.6
Manage personally	2.0	2.0	3.1	2.9	2.4	1.8
Assistance from students	1.5	3.2	2.5	2.8	2.2	1.4

On the other hand industrialists have ranked the "official correspondence" and "Informal talks/meetings " as the highest, indicating that those two methods are the most prevalent channels of communication. As the nature of the official correspondence is obviously coupled with the bureaucracy of the institutions, specially in the context of developing countries, it can be expected that bureaucracy is a problem with existing relationships.

[16] Not relevant to industries
[17] For universities only

6.6 Funding

The researchers have given a higher average rank for institutional funding for industry interactions. This suggests that the researchers receive funds from their organizations to support industry oriented research (Table 6.7). In contrast academia seems to have no major support for funding research directed towards industrial matters except one academia who appears to be using his own (personal) funds for relationships with industry. Again other factors have a reasonable average rank by any of the type of respondents. This implies that except for research institutions where the institutional funding is available for promoting industrial relationships, there is no other funding mechanism available in Sri Lanka to support URI relationships.

It is noted that the open ended option ("Other") shows a higher average rank for academia. The investigation into raw data revealed that the response is related to an academic who has indicated " personal funds " as a source of funds (one on rank 4 and the other on rank 3). This implies that certain academics are committed to maintain URI relationships using their own funds, for some reasons which are not disclosed to the public.

Table 6. 7 Average rank and variance of different attributes of "how the relationships were funded " by type of respondents

Source of funds	Industrialists		Academia		Researches	
	Avg rank	variance	Avg rank	Variance	Avg rank	Variance
Funds from the univ/ Research institution	0.5	1.2	1.3	2.2	3.2	2.8
Funds from the industry	2.0	3.3	2.4	3.1	1.7	1.7
Third party grants	1.0	2.6	2.4	4.8	1.7	2.0
Direct Government funds	1.0	2.7	1.7	3.3	1.6	2.5
Foreign Funds	1.4	4.0	1.6	3.2	1.6	2.1
Other (own funds)	NA		5.00(n=1)			

6.7 Barriers

The barriers for initiating a relationship shows a more homogeneous pattern among all three types of respondents. However, the lack of information on research capabilities is noted as the most significant barrier (Table 6.8). From these results, it can be seen that the information on research capabilities plays a major role in initiating linkages. In this context, the government has a role to improve information systems to facilitate fast, accurate, reliable and customer oriented information exchange.

Once such an efficient system is available, barriers such as "difficulty in making appropriate contacts" and " time commitment to find a suitable partner" can be expected to disappear as better communication counteracts those barriers. However, the lack of rewards and an incentive system, which were ranked at a higher order needs the attention of decision makers and has to be worked out carefully, as any approach to reduce the magnitude of the problem will have multidimensional and multifaceted effects. Therefore, it is necessary to consider case specific approaches rather than general public policy direction for rewards and incentives.

Table 6. 8 Average ranks and variance for different attributes of "barriers to initiate relationships" by type of respondents

Barriers to initiate a linkage	Industrialists		Academia		Researchers	
	Avg rank	Variance	Avg rank	Variance	Avg rank	Variance
Difficulty in making appropriate contacts	2.5	3.3	3.0	3.2	2.8	1.7
Time commitment to find a suitable partner	2.0	2.8	3.5	3.1	2.6	1.9
Lack of a reward & incentive system	3.2	3.0	3.4	3.2	3.2	1.5
Lack of information on research capabilities	3.2	3.4	3.8	2.4	3.3	2.0

Both the researchers and academia feel that the lack of research orientation of the industries as the main barrier for the continuation of existing linkages (Table 6.9). On the other hand, the lack of rewards/incentives and the lack of information are considered as major barriers for initiating relationships. This suggests that continuous efforts to bring the two groups into a common forum and the development of a reliable information system would help in overcoming the latter issue. However, the incentive systems have to be worked out by institutional level or national level based on the performances to motivate the continuation of existing relationships.

Table 6. 9 Average ranks and variance for different attributes of "barriers to continue existing relationships" by type of respondents

Barriers to continue already established linkages more effectively	Industrialists		Academia		Researchers	
	Avg rank	variance	Avg rank	variance	Avg rank	variance
Lack of research orientation of the industry	2.7	2.7	4.1	2.0	3.3	1.8
Dissimilar motives	2.4	2.2	3.5	2.0	2.9	1.4
Absorptive capacity of the industry	2.6	2.5	3.1	2.0	3.0	0.9
Bureaucracy of the research institute	2.8	2.0	3.4	2.9	2.7	2.4
Lack of communication	2.8	2.6	3.1	2.1	3.2	1.1
Industry restriction[18]	2.6	2.6				

Also, the lack of research orientation of industry has been ranked as the most significant barrier by academics and researchers. However, from the point of view of industrialists the lack of communication with counterparts and bureaucracy of research institutes/universities are regarded as the major barriers. In contrast, the academia do not agree with the others in considering the lack of communication as a major barrier for continuing existing linkages. But researchers agree with the academia in ranking "bureaucracy of institutions" at a lower rank in the order. In contrast, industrialists have ranked the bureaucracy of the universities and research institutes as a major barrier. This leads to the relationships that the industry

[18] For industry only

personnel have with universities and research institutions being dealt with at an informal and personal level. By doing so, the universities and research institutions are losing in two directions. In one way, the possible income from consultancies through official channels will not be available for the institution. In addition, a proper system will enhance the power (and the reputation) of the institution in terms of capabilities. Also, the institution will be in a position to attract many more assignments both nationally and internationally.

6.8 Actual benefits and their relationship with type of linkages

The analysis of actual benefits for the three types of respondents shows that the researchers and industrialists have given higher average rank for " Product process development" and " Solving technical problems" where as academia has given an higher average rank to jobs for students compared to other benefits (Table 6.10). This shows that the desired benefits are in agreement between researchers and industrialists. This issue can be taken as an opportunity for policy makers to promote relationships between research institutes and the industry. On the other hand the industrialist have given a lower rank to the "upgrading curriculum to suit the industry needs" as a benefit. Probably, the industrialist does not see that as a benefit from the relationship with the universities as universities do not cater to the requirement of the industry. In this context, the findings are a useful input for the university authorities to review the applicability and suitability of the curricula. It was noted that several initiatives are taking place in the university spheres to address this issue in the current context. It is further noticed that the open-ended option ("Other ") shows a higher average rank for researchers. The raw data revealed that the response is related to two researchers opinions on " professional development" as a benefit (one on rank 4 and the other on rank 3). This implies that the policy makers in the research institute spheres may consider recognition of URI relationships as a measure of professional development.

Table 6. 10 Average ranks and variance for different attributes for "Actual benefits from relationships" by type of respondents

Actual benefits that you have gained through linkages	Industrialists		Academia		Researches	
	Avg rank	variance	Avg rank	Variance	Avg rank	Variance
Product/process development	2.2	2.3	2.7	2.5	3.4	2.7
Funds for research	na	na	1.7	3.4	1.6	1.9
Commercialization of research results	1.7	3.2	1.6	2.5	2.8	2.8
Jobs for students/ new recruitments[19]	1.8	2.8	3.5	1.5	1.7	1.9
Upgrading curriculum to suit industry issues[5]	1.8	2.6	na	na	na	na
Financial benefits to individuals/ increasing profits for firm	1.0	1.9	2.0	3.1	1.2	2.6
Upgrading lab facilities	na	na	3.1	1.5	1.4	1.9
Solving technical problem	2.2	2.3	3.1	0.8	3.3	1.8
Other- Professional development	-		-		3.5(n=2)	1.2

6.9 The graphical representation of characteristics

The graphical representation of the influence of above characteristics on URI relationships can be presented as follows.

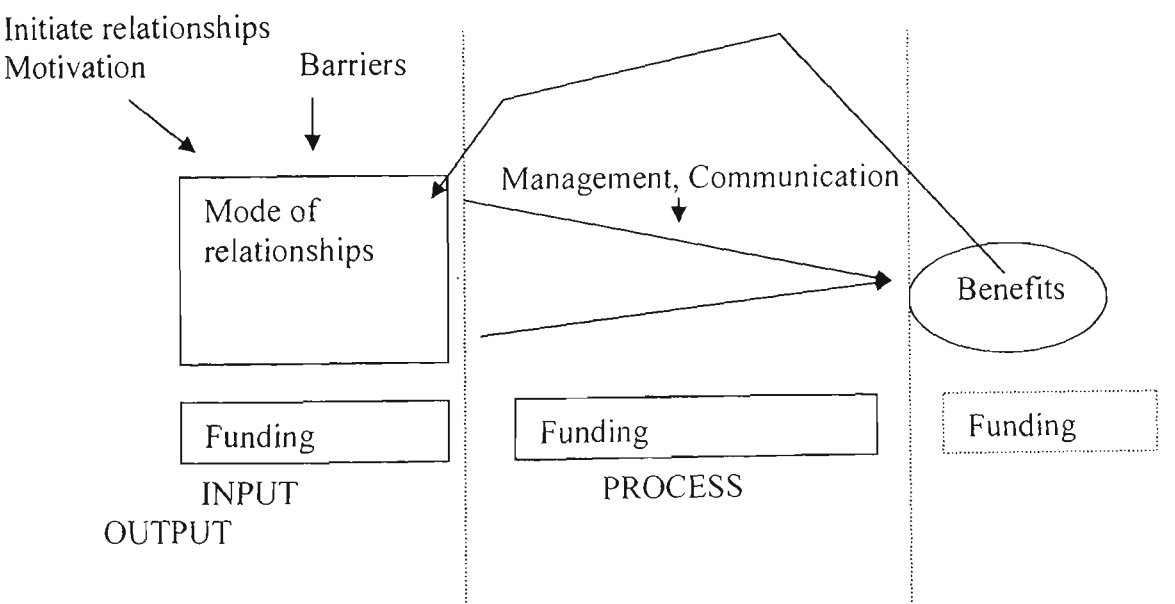


Figure 6. 1 Graphical representation of relationships

[19] For industry

The relationships can be categorized into three major sections such as input, output and processing. Funding is considered as a bottom line issue although the type of funding can vary according to the stage of relationship.

With respect to inputs and the availability of funding, the barriers to initiate relationships and the motivation to initiate relationships would depend on the type of relationship that it is going to occur. For example, dissimilar culture (barrier) and lack of funds combined with desire to find jobs for students would lead the universities to have student based relationships. In turn if the industry wishes to improve the production process, student based project would not be adequate. Hence, industry may select short-term consultation to academia or researchers. If funding is available and the desire is for major product development, it may turn to contract research or joint venture relationship.

With respect to the process, again funds are required to manage and coordinate relationships effectively. Apart from that, the management style, and the continuous interactions will decide the effectiveness of relationships. Due to unavoidable cultural differences between industry and universities & research institutions, the lack of communication can easily retard the effectiveness and the life-span of the relationship. Thirdly, actual benefits are measured by the actors involved in relationships to decide whether to continue the existing relationships. This means that the actual benefit will act as an input to decide the proceeding type of relationships. For example, useful student project may motivate the industry to invite the academia to involve in new product/process development activity.

The above model helps to understand the process of URI relationships. In this line we tried to investigate the input output relationship of existing URI relationships in Sri Lanka. For this purpose, correlation between the type of relationship and the actual benefit was tested.

6.10 Correlation between type of relationship and the actual benefit

In this regard, the correlations between the type of relationships and the actual benefits gained were tested. The Spearman's correlation coefficient with level of significance at less than 0.005 was considered as significant correlations. Accordingly, the following types of relationships and actual benefits are found highly correlated. (Details of the correlation coefficients and the approximate significance are given in the annexure seven).

The industrialists show that the relationships based on student projects have correlation with upgrading curriculum to suit industry issues (Table 6.11). Also, it shows that the informal consultations have significant correlation with "solving technical problems". In addition, industrialists show that relationships through "Seminars /workshops and short training courses" have correlations with upgrading curriculum to suit industry issues". Furthermore, they seem to believe that "Industry sabbatical/Fellowships" has correlation with the commercialization of research.

With respect to the academia, it seems the "students projects" are strongly correlated with "Solving technical problems". In addition, it shows that relationships through "Seminars /workshops and short training courses" have strong relationships with "solving technical problems" and "product/process development". With respect to researchers, it seems that relationships through "Seminars /workshops and short training courses" have strong relationship with "commercialization of research results" and "product/process development". Furthermore, the test shows that "Joint R&D work" has significantly strong relationships with "commercialization of research results".

Table 6. 11 Benefits out of different types of relationships for different types of respondents

Industry		Academia		Researcher	
Type of relationship	**Benefits**	**Type of relationship**	**Benefits**	**Type of relationship**	**Benefits**
Students projects	Upgrading curriculum to suit industry issues	Students projects	Solving technical problems	Seminars, workshops and Training programs	Commercialization of research results
Consultation (informal)	Solving technical problems				
Interest groups/ study committees	Commercialization of research results				Product/process development
	Upgrading curriculum to suit industry issues				
Information/ equipment sharing	Commercialization of research results	Seminars, workshops and Training programs	Product/process development		
	Upgrading curriculum to suit industry issues		Solving technical problems	Joint R&D programs	Commercialization of research results
	Solving technical problems				
Seminars, workshops and Training programs	Upgrading curriculum to suit industry issues	Science & Technology Parks / Centers	Commercialization of research results		
Industry sabbaticals /Fellowships	Commercialization of research results				

6.11 Summary of findings

The major characteristics and their important attributes were explored through the analysis of responses to a postal questionnaire addressed to industrialists, academia and researchers. The findings are summarized in table 6.12.

The findings shows that personal contacts are more prominent in relationships in Sri Lanka. The institutional arrangements seem to have low capabilities to take initiatives. The person-oriented relationships can be seen as more prominent even in coordination and communication patterns. The only exception seems to be little institutional support received by the research institutions in terms of coordinating, funding and communicating with the partners. These evidences lead to a preliminary conclusion on the non-existence of proper systemic mechanisms to promote relationships in the URI system.

The findings on barriers suggest that there is a need to establish an information system to have a closer look on the counterpart. This indirectly means that present perceptions on each other are based on limited experience from person-oriented relationships. These circumstances may develop a positive as well as negative environment. Limited person oriented relationships may create boundaries preventing the visibility of the best options, while in contrast, person based relationships may increase reliability, confidentiality and speed. The higher ranking on the need for information suggest that the existing experience is towards the negative perception. It is further confirmed by the industrialists' higher ranking on bureaucracy of research institutes/universities is a major barrier.

The claim by academia and researchers on the lack of research orientation of industries seems to be an expected outcome considering the above findings. What is important in this context seems to be to find out why such orientation is lacking and how industries compensate the need for innovativeness to keep viable in the market place.

Table 6. 12 Summary of findings: Major characteristics and important attributes by type of respondent

Major Characteristic	Industry	Academia	Researchers
Type of relationship	Seminars workshops & training programs	Seminars workshops & training programs	Seminars workshops & training programs
		Student Projects	Extension services
		Consultation (informal)	Consultation (informal)
Motivation	Access to new knowledge	Application oriented research	Application oriented research
	Keep company updated with knowledge	Assist product/process development	Assist product/process development
Management & Coordination		Managed by individual	Managed by individual
			Assisted by institution
Communication	Informal talks/ meetings	Site visits	Site visits
	Official correspondence	Informal talks / meetings	Informal talks/ meetings
		Personal Communications	Official correspondence
Funding			Funding from the institution
Barriers to initiate	Lack of a reward & incentive system	Time commitment to find a suitable partner	Lack of a reward & incentive system
	Lack of information on research capabilities	Lack of information on research capabilities	Lack of information on research capabilities
Barriers to continue	Bureaucracy of the research institute	Lack of research orientation of industry	Lack of research orientation of industry
	Lack of communication	Dissimilar motives	Lack of communication
Actual benefit	product/process development	Jobs for students/ new recruitments[20]	product/process development
	Solving technical problem	Solving technical problem	Solving technical problem
		Upgrading lab facilities	

[20] For industry

These preliminary conclusions and suggestions calls for further investigation into the issues related to the existence of such relationships. Such investigation needs to address more qualitative features of the circumstances such as how things are done, what are the constraints, what needs to be done, why the players do not have long term oriented relationships, how they see the counterpart organization, what they expect from the others, what are the systemic failures that prevent such developments and what sort of policy interventions are proposed.

On the other hand, with respect to the university and research institution domains, the questions such as what is their present approaches, how do they see the industrial partners and how the industries fit in to their approaches, what they can offer to the industries, what are the real constraints to approach industries, what are the institutional and systemic support/drawbacks and how those can be rectified and what kind of policy interventions are proposed arises.

The indications provided in the responses to the questionnaire survey need more in depth investigation to find answers to the reasons for the existing relationships. Hence, the researcher decided to conduct a series of interviews with the respondents to find reasonable answers to those questions, which are described, in the next chapter.

Chapter seven - Framework conditions

7.0 Introduction

Chapter six explored and described the characteristics of URI relationships in Sri Lanka. The need for an explanation for the existence of such characteristics was highlighted. It was seen that the URI relationships still show underdevelopment in structural, financial, managerial and coordination terms. This requires further investigation to identify the importance of these issues and the issues, which are not disclosed in the questionnaire survey. Also it is important to expose out the underlying issues, which usually provides an explanation to the existence of particular characteristics. With that aim, further interviews with the respondents were planned to obtain in depth information.

As indicated in chapter five, the respondents to the questionnaire and the snowball sample were interviewed to obtain in-depth information. These interviews generated data set C & D respectively (see chapter 5) for analysis. Interviews with persons involved in a national or institutional level decision-making process (see chapter 5 data set E) were used to triangulate the findings of the analysis of data sets C&D.

The present chapter will deal with the framework conditions in which the URI actors operate. It is believed that explanations need to be framed within theories of the process of innovation. The promotional literature on the process of innovation largely concerns the incentive structures and other promotional structures where the firms operate. It ignores internal structures and pays less attention to the process through which research is converted in to commercial innovation (Mowery and Rosenberg 1989). In developing countries, the explanations need both promotional approaches as well as process related approaches (see chapter four for details).

Analytical tools used in grounded theory approach such as coding the interview notes and generating clusters to bring out the important issues have been used. Details of the coding and clustering process are given in the chapter five. Frequency of occurrences was used to measure the level of importance of each of the framework/ structural condition. These conditions are described in terms of the viewpoints of the respondents while triangulating them with the views of the decision makers and survey findings. The researcher's opinion is also incorporated where necessary. Finally, the findings are summarized in the light of the policy framework with a view to proposing policy initiatives.

7.1 Analysis to identify framework conditions that affect relationships

Originally the codes were grouped into ten clusters (figure 5.1). The occurrence of each code was counted and noted against the type of respondents (Table 7.1). Double counting on the same code by one respondent was omitted using interview numbers against the issue and subsequent crosschecking. In other words if a respondent mentioned an issue twice, it was only counted once. The counting was practiced to investigate the issues, which were mentioned more often than the other issues. In addition, counting helps one to be mindful of the important issues, to keep analytically honest and to protect against possible bias (Miles and Huberman 1984).

These blocks show, firstly the overlapping nature of the issues and secondly, the possibility of regrouping them to form more consolidated clusters. Accordingly it was determined that the codes can be re-clustered around three major clusters representing

1. Structural/Framework issues,
2. Procedural issues and
3. Behavioural issues.

The procedural and behavioural issues were extracted for analysis in the next chapter. Hence, as indicated before, the present chapter deals with the analysis of the framework conditions only.

7.2 Observations

The counting against framework conditions were extracted and the relevant frequencies are noted against each type of respondents (Table 7.2). The most frequently cited issues were;

- Lack of systems and mechanisms to support relationships,
- Rigidity of rules and regulations,
- Limitations in the communication facilities,
- Lack of policy directions, absence of incentives,
- Lack of facilities/programmes for industries,
- Inadequate laboratory facilities and services in Government labs, and
- Lack of funds for interactions.

When these issues are looked at from the point of view of different sites, it can be observed that industry is mostly concerned about the following issues.

- Lack of systems and mechanisms to support relationships
- Limitations in the communication facilities,
- Inadequate laboratory facilities and services in Government labs

In addition, industrialists consider market factors such as limited market due to the smallness of the country and the purchasing power of the customers, which are related to the economic condition of the country, as having connections to the relationships.

From the point of view of academia and researchers the mostly cited issues are;

- Lack of systems and mechanisms to support relationships,
- Rigidity of rules and regulations,
- Limitations in the communication facilities,
- Lack of policy directions,
- Absence of incentives and rewards
- Lack of facilities/programs for industries.

The above findings are illustrated below using the experience gained by the researcher through the interviews and through working as a research manager in a leading S&T institution in Sri Lanka. In addition, triangulation technique was used to compare the findings with the questionnaire survey and the interviews with the decision makers. This process of double-checking findings with multiple sources and modes of evidence improves the verification process and hence the personal bias is minimized (Miles and Huberman 1984).

7.2.1 Inadequate facilities & services in Government Labs

The issue "Inadequate facilities, capabilities in Government laboratories " has received strong consensus among industrialists (11 out of 14, or 78%). Industries in developing countries encounter many problems such as a lack of specialized skills within firms, lack of equipment and other resources and some times insufficient understanding to undertake a deliberate effort to solve the problems themselves. To overcome these deficiencies and to generate innovative behaviour, government may need to engage in persuasion, information and technical support (Lall 1996) through state organizations such as research institutions. In this context, in Sri Lanka, the interviews revealed that inadequate facilities at research institutes contribute to the lack of linkages with industrialists. Research institutions have limited facilities to provide the services and testing facilities required by industry. In contrast, the industrial sector has a wide range of testing needs due to the diversified range of production/process alternatives. Research institutes cannot invest the limited funds available to them to provide these specific services to the limited number of clients in a cost-effective manner. Furthermore, the skills in maintenance of sophisticated equipment in research institutes are limited. This environment leaves industrialists with little support from research institutes, discouraging them from investing in developing new products through URI relationships. This calls for policy initiatives for networking S&T facilities within the country and the region (see chapter ten).

Table 7. 1 Framework conditions and the frequency of respondents according to issue by type of respondent

Issue	Industry (n=14)	Academia (n=14)	Researchers(n=13)	Academia + Researcher (n=27)	Total (n=41)	Percentage
Rules & regulations / flexibility	2	6	5	11	13	32%
Change mandate	-	1	3	4	4	10%
Lack of incentives	3	6	3	9	12	20%
No national recognition on technologies developed locally	2	2	5	7	9	22%
Lack of recognition of academia	-	2	-	2	2	5%
Absence of standards	2	-	1	1	3	7%
Lack of systems and mechanisms	6	7	7	14	20	49%
Inadequate facilities, capabilities in Govt laboratories	11	-	-	-	11	27%
Absence of policies on patent rights	1	-	1	1	2	5%
Need industrial experience & tech training	4	2	1	3	7	18%
Brain Drain	-	-	2	2	2	5%
System not conducive for innovations	1	-	-	-	1	3%
Absence of policy directions	3	7	5	12	15	37%
Need Government funds for industrial research & development	6	5	2	7	13	32%
Non-availability of venture capital	2	-	-	-	2	5%
Inadequate / dissimilar tax incentives	3	-	1	1	4	10%
No facilities / programs for industry	3	5	5	10	13	32%
External influence	3	1	-	1	4	10%
Lack of communication among sites	6	4	6	10	16	33%
Avoid political interference	1	2	-	2	3	7%
Low purchasing power of customers	4	-	1	1	5	10%
Socio-economic values	-	-	1	1	1	2%
Limited market	3	-	-	-	3	7%
Need to avoid over shadowing national needs	-	-	1	1	1	2%

Total number of issues (25)

7.2.2 Communication among organizations

The inadequacy of facilities can be regarded as one side of the coin. The other side is the low awareness by the industries of the available facilities in government labs and universities, which are capable of handling industrial problems. Hence, all types of agents have shown concern about having an information system to facilitate information exchange on capabilities, services, facilities available and what kind of support that industry can get or what government institutions can offer. Universities and research institutions are surrounded by institutional, financial and administrative boundaries, which limit the free movement of personal and communication with the users of technological know-how. For example, public sector institutions are provided with limited and inadequate funding for travel and communication services, causing them to restrict using those facilities and opt for low cost methods of communication. This issue surfaced in chapter six also showing that the most prominent way of communication with industries is "official correspondence". The nature of official correspondence involves a sense of bureaucracy, lack of interest and commitment, and inefficient approaches to gaining benefits. The negative perceptions built around the consequences of official correspondence, may further distance the actors, unless conscious effort is made to supplement official correspondence with less formal communication.

This situation calls for the establishment of a network of information services & communication facilities using modern information technologies which needs to be addressed under policy initiatives. (see chapter ten).

7.2.3 System and mechanisms

The evidence indicates consensus among all types of respondents for the need for systems and mechanisms for interactions. However, it is surprising that the lack of systems and mechanisms has not received a very strong consensus as only 48 per cent of respondents commented on this issue. The reason could be diversity of

thinking, non-committal behaviour of respondents or uncertainty of what the critical issues are in relation to URI relationships.

The framework condition on systems and mechanisms implies various functions. Functions such as coordination, evaluation and monitoring require special structures, procedures and differentiated arrangements. The issue of lack of coordination mechanisms surfaced during the interviews. Closer review of the interview notes reveals that the concern of the industrialists is on the coordination mechanism for facilitating interactions with universities and the research institutions. However, research institutions and universities would expect a coordinating body to perform monitoring and evaluation functions also. Academia is concerned about coordinating the dissemination of research findings to potential users while researchers are concerned about the under utilization of sophisticated equipment located in the research institutions to perform services for industry. These findings reiterate the sense of a linear model approach of innovation encouraged by respondents with little movement towards interactions (linear plus model).

It seems that a lack of coordination appears even in institutions due to compartmentalization. This point is confirmed by the two interviewees (IN67 and IN62)[21] in the decision-making domain. With respect to evaluation mechanisms, one interviewee (IN54[22]) stressed this aspect by saying "Nothing will work without evaluation". The interviewee is a senior professor in a university and may have observed in the past where mechanisms did not work due to lack of evaluation.

The lack of back up services for the maintenance of research equipment has been one drawback for many years in the NSI of Sri Lanka. This is evident from the fact that the National Science Foundation of Sri Lanka has made attempts to improve the situation by the provision of spare parts for research equipment and arranging training of technicians on sophisticated equipment. Despite such low volume

[21] One has worked as an advisor to the Science Ministry and the other is the Senior Secretary of the same Ministry

[22] Interviewee is a senior professor in Chemistry in the University

programmes, the situation seems to have deteriorated due to a lack of conscious effort to improve appropriate technical education in Sri Lanka. However, it can be seen that the government has identified the issue and taken steps to reform the technical education system (together with secondary and tertiary).

Universities seem to believe that they do not possess mechanisms to capitalize on their capabilities. Unlike journal publications, there is no venue to disseminate research capabilities and interests to potential users such as those in industry. Therefore, according to interviewee (IN69), universities (also noticed in research institutions) have oriented to institutionally organized outreach activities such as annual research day/seminars to attract potential users.

Participation of industrialists at the decision making level of university councils are more common than any other interactions between the two groups. According to interviewee IN 64, the number of members of the council from outside the academic circles are always kept at higher numbers than academics with a view to "Look after social responsibility". Apart from that, universities have taken steps to establish mechanisms such as career guidance units, curriculum revisions with the participation of local industrialists, and inclusion of new course units into the curriculum to enhance the employability of students and build entrepreneurial capabilities (interviewee IN 64). Industrial training for students is also more common in most of the universities than any other relationship with industry. However, the intensity and commitment of universities varies from one to another. For example, the University of Moratuva seems to have taken trouble to structure its industrial training in a more professional manner than previously. The university has appointed a separate director to head the Industrial Training Unit (ITU) to organize, arrange, monitor and facilitate the evaluation of industrial training. The ITU possesses well-formulated evaluation procedures where they include assessment by industry also. In addition, universities where postgraduate course are conducted, have taken steps to use the opportunity to interact with the industry in two ways. One is to select industry related problems for research/ projects and the other is to enrol students from industry for courses. According to interviewee IN60,

the University of Moratuva has taken steps to allow postgraduate students from industry to enroll and conduct the major part of their research at the industrial premises itself. According to the interviewee, the industry has responded most positively to this move. Also, in many universities, Industrial Consultative Boards are expected not only to review the curriculum to suit industry needs but also to initiate and activate more interactions between industries and universities (interviewee IN21). These changes seem to happen in the light of pending university reforms act which is held in abeyance due to political reasons. The process of changes seems to have had bi-directions need. According to a senior officer in the University Grants Commission, the industry has been informing them about the need for changes. On the other hand, interviewee IN64 mentioned that "They (Industrialists) were surprised for the invitation to come and sit in the Board Room of the Vice chancellor".

Apart from that some universities have implemented more structured mechanisms to interact with industry. Some of these are briefly outlined in the table 7.2.

The cases of Agri-business Centre (AbC), Business Incubator(BI) and University Industry Interaction Cell are discussed in the chapter nine in detail. The case of Engineering Design Centre (EDC) seems to have not achieved expectations due to many reasons. Firstly, the economic situation of the country provided little motivation for the industrialists to invest and embark on new ventures. Secondly, very few industries are operating which require assistance in the area of mechatronics. Thirdly, factors related to the nature of operations of the EDC have affected the success. The EDC has not integrated into all the departments of the University due to its specialized nature. Also, EDC tends to operate as a consultancy unit where the marketing and outreach functions were given little attention.

Table 7. 2 Structured mechanisms recently established by different universities to interact with the industries

University	Mechanism	Major activities/Purpose	Level of operation
Moratuwa	University Industry Interaction Cell	Marketing the intellectual capabilities through SWTPs.	Organisation of SWTP and short course for industries. (2 per week)
		Commercialization of university research	In the process of initialization
		Facilitate and organize contract research for industry	Few research contacts are being negotiated
		Facilitate human mobility through industrial chairs and research assistantships	Possibility of awarding an Industrial chair is being processed. Student placements for industry projects.
	Engineering Design Centre	Undertake contract research in mechatronics for industry	Few projects commenced
	University Consultation Company	Operate as a private company for consultations	Operate at a low key
	Centre of Excellence in Project Management	Formation of theme based knowledge group to work as a team on specific problems	Still operate at a low key. Looking for opportunities
	Industrial chair	Perform industry related research by an academia who is sponsored by industry	Procedures formulated. Waiting for the first chair
Ruhuna	Business Incubator	Incubate innovative ideas by providing facilities, advice and services	Commenced with six incubates
	Creation of a cadre position for Industry Liaisons Officer	Enhance marketability of students through projects Enhance interactions with industries	Recruitment to the cadre position is awaiting

According to interviewee IN13, industrialists feel that the capabilities in research institutions and universities to perform an industrial need are too scattered around many institutions. When the skills are available in one place, the required facilities are available only in another. Hence industry stress upon the need for coordination mechanisms that allow the public sector to respond to industrial needs more effectively.

7.3.4 Funds

Industrialists are concerned about a lack of government support or funds for development activities and services. Universities are also looking for government funds for interactions with industrialists. According to comments made in the interviews, a lack of funding mechanisms seems to be one of the major drawbacks in the NSI of Sri Lanka. At present there is no financial assistance available for industrial research apart from two research institutions conducting industry oriented research with little involvement of industries and contract research directed at solving minor scale industrial problems. One interviewee (IN62) considers that lack of venture capital is one of the biggest drawbacks for industrial development and R&D in Sri Lanka.

This situation can be compared with many other developing and developed countries which have an increasing number of general and industry focused funding mechanisms to promote industrial innovation. For example, in Australia, there are more than 125 funding schemes (verbal communication) available for industrial research and innovation by firms. In the case of India, many mechanisms have been introduced in the recent past. (Table 10.1)

Under these circumstances, industries have to turn to commercial banks for assistance. The financial assistance provided from banks comes with high interest rates. Industries cannot afford to pay these rates, especially in the growth stage of the business. On the other hand the risk involved in marketing a locally developed products is believed to be very high due to a lack of technological advancement to compete with imported items, and the limited local market. These issues prevent

the local industries taking on product and process innovation. Thus, industrialists cannot consider research as a viable investment opportunity. Hence, industrialists' appeal to government to provide financial assistance for product development is well justified.

With regard to universities, the UGC does not provide financial support for R&D in universities. Local funding organizations for research such as NSF do not emphasize industry oriented/demand oriented research. This is evident from the fact that, out of the 79 ongoing research grants awarded by the NSF, there is only one research project which has industry institution involvement. Although there are a few foreign donor agencies assisting research in universities, these agencies do not take adequate interest in funding industry-oriented research in Universities. Hence, if universities are expected to play a role in knowledge utilization and creation, they need to have special funding channels for industry related R&D activities.

Interestingly, the respondents from research institutions have little concern about the need for funds. This may be due to the fact that the most pressing constraint in research institutions is not funding but how the available resources should be organized to meet the demands of the industry and society. This issue is looked into more details at the "Functional failure" section.

Hence, the policy initiatives in this connection should focus on making funds available for industries and universities to exploit and utilize the existing capabilities. The example from neighbouring countries and newly industrialized countries (NICs) can be reviewed before formulating new schemes. The example of Australia, where a chain of new schemes came into existence to transform relationships to more advanced structured stages is one of the examples that need attention.

7.3.5 Incentive structure

The views of respondents on incentive structures are diverse and naturally represent the organizational domains.

The industrialists seem to be worried about disparity in the government incentive structure. The joint venture companies and BOI companies seem to be enjoying many import and export trade related tax incentives, to which the local small and medium enterprises are not entitled.

The main argument of the SMEs is that the production processes of SMEs require importation of certain raw materials which are subjected to high taxes, resulting in heavy expenditure on raw material. Hence they cannot be competitive with completed items which are produced elsewhere. In addition, the SMEs have observed that incentive structures are contradictory with the desire for technological advancement and productivity improvement goals. (for example industries are qualified to claim for tax incentives if the total work force exceeds 50 persons).

Universities and research institutes do not have any kind of incentive structure either financial or non-financial. Due to a lack of motivation (i.e. no incentives) the academia seems to be contesting traditional practices to increase the number of publications for promotional benefits.

Researchers seem to be concerned more about incentive driven technological developments and staff attachments. One interviewee (IN63)[23] mentioned that

> "I have accepted myself, Very little we can do other than all the benefit within my power to encourage, motivate and set to be creative. We always go and mourn to the Ministers. But the Government itself has their own problems, we are not trying to wait until that happens to start doing. ", " There are many ways to compensate for the financial rewards

[23] Interviewee is the chairman of one of the main industrial R&D institutions in Sri Lanka

> that is lacking for them. A proper scientist basically is a person who must be rewarded. When he is given toys to do his job, he is doing that job. Even if he can't get the financial reward he is getting contentment, happiness out of the one he is good at doing and enjoy it."

This shows that within the limitations of the lack of financial incentive structures, individual institutions are capable of making workable arrangements to compensate the drawbacks and keep researchers motivated towards productive activities. However, the nature of workable arrangements may depend on the management structure of the institution and the leadership.

However, in general a lack of financial or other incentives coupled with many other factors such as salary structures seems to prevent the actors becoming involved in collaborative work. Policy initiatives towards generating enthusiasm and rewarding achievements seem to be potential actions that can be taken by Government and individual organizations.

7.3.6 Rules & regulations

Both the researchers and academia have commented on the need for modernization of financial regulations practiced in their institutions. It was observed that research institutions generate a substantial amount of earning through service activities. The existing policy related to earnings does not encourage people to improve earning capacity, as the earnings have to be given back to the General Treasury. Moreover, the years following Treasury allocation is decided based upon the earning capacity of the previous year, in which the total amount required by a research institute is maintained at a stagnated value. This means if you earn more this year, you will get a less allocation from the Treasury for the next year. This "innovation killing" budgeting process may have made the researchers propose policies to retain the earnings for the development of the institution. In the case of Australia, the first step taken in the middle of 80s was to allow retention of external earnings (Garrett-jones and Turpin 1995).

The researchers seem to prefer lesser controls to achieve better productivity. There is a rising need to change the procurement procedure and decentralization of authority on financial matters down to individual or departmental level. The existing procedures, which have been developed more than 50 years ago, have not been subject to major changes despite few ad-hoc decisions regarding shifting the boundaries and limits to accommodate realistic levels. The system is designed in such a way to de-value a persons choice (based on experience and requirements – tacit knowledge) to codified information given on tender documents.

Secondly, the rules and regulations relevant to management practices in universities and public sector institutions provide little room to work on incentive systems and motivation mechanisms by providing incentives for good work. As such individuals and groups are not motivated to perform to their best. For example, university departments are not motivated to provide services based on their resources, as the department does not get any benefit out of the services. Rather they involve themselves in consultancy services at the individual level resulting in a loss of opportunity and valuable financial in-flow through facilitating consultancy services. Lall (2001) suggested the university sector has to undergo considerable changes in terms of rules & regulations connected to financial and administration in order to conduct research that is supported by industry.

Inflexible management procedures also affect promotion schemes where the system does not give weight to outcomes from a person in the evaluation system. This lead to frustration by scientists who do not feel any benefit / appreciation for his/her good work.

The lack of motivation and frustration shapes the attitudes of the individuals and behaviour of the system and is reflected in the overall performance of the organization, de-attaching the hitch between the individual and the institution. However, in certain circumstances, certain individuals and groups develop their own working arrangements to operate within the existing systems but always

confront heavy resistance for making their own arrangements. Some who fail to do so choose no other option than opting out from the system leading to "Brain Drain". Whatsoever, this can be taken as an example for how framework conditions shape micro-level determinants.

On the other hand, bureaucratic culture and the state agencies, in combination with the formal statutory framework in which all are forced to work, impose limitations on how far any new initiatives can go. Whatsoever, we should not abandon in entirety the regulatory structures established over the past generation without at least some confidence that doing so constitutes an improvement. Therefore, carefully developed system modifications become one role of public policy-making institutions in the long run.

7.3.7 Variables less frequently mentioned

It was observed that certain issues of framework conditions were less frequently mentioned during the interviews. Some of them are the accreditation of services and products, IP issues and university reforms.

7.3.7.1 Intellectual Property (IP) issues

One researcher who is dealing with industrial research activities mentioned that "the system is incapable to safeguard the IP issues and hence we keep them as secrets". According to her opinion, the institution is losing in two ways. One is the potential income from Patents and Royalties and the other is the image of the institution. Interviewee of interview no IN63 confirmed that

> " We have got local patent and licensing. We do not have any international. We have not come across any problem with IP. We do not have mechanism to enforce it. To enforce you must have proper legal system".

This shows the evidence for two issues. One is lack of awareness and system for processing IP applications and the other is concern of researchers on the former deficiencies on their research activities.

7.3.7.2 Quality of products

According to one interviewee (IN 63), he, as the chairman of a particular institution ,was keen to restrict the licensing of technologies developed by the institution only to reputed companies. The institution has had bad experiences with customer complaints regarding the quality of products based on technologies developed by his institution. According to him what happens is that

> "Although the institution has recommended particular parts to be imported from abroad, the licensee try to cut cost of production by using low quality spare parts which brings down quality. The institution once tried to set up quality assurance but it is impossible with the existing resources and mandate."

More generally, interviewee IN66 has mentioned that "quality concept is absent in Sri Lanka". He fully supports the accreditation of public and private laboratories although many argue that accreditation is not suitable for labs in third world countries. According to interviewee IN66 "Accreditation brings discipline to labs, then industries will have confidence".

7.3.7.3 Mandates and institutional reforms

Universities claim that they are not allowed to conduct any commercial activities and, therefore, they cannot perform a service function for industries although there is a vast potential for income generation. However, there were examples where the academia conducted services to the industrialists on commercial basis within the framework of a separate project. The income is credited to the project and academia used this income as a revolving fund to continue its service function (my observation through a discussion with an academia outside the sample frame). On the other hand, in cases where there is no such project activities, the services are done free of charge when the client brings the necessary chemicals and material required for the tests (interviewee IN36). This situation calls for streamlining and

modernising the rules and regulations to facilitate commercial activities by the academic institutions.

It was noted that such modernization is in the proposed university reforms (IN 25). It was also noted that many other proposals, which are included in the university reforms are gradually put into practice by university authorities. Out of the student-based reforms such as revision of curriculum with the participation of industrialists, establishment of career guidance units and Industry Consultative Boards, training in teaching, are already being practiced by many universities. In addition, as formula based financial allocations (taking into account out put parameters instead of student intake as the sole criteria for financial allocations) are still on the discussion table. One interviewee (IN 27)[24] was not sure to comment on whether the new formula would include industry revenue or not.

With respect to the establishment of the ICBs in universities, interviewee IN66 who is from the leading S&T policy advisory body in Sri Lanka mentioned that " I am very happy to see that universities are trying to establish these communication links". This statement puzzled me in two aspects. Firstly it is some sort of concurrence and expectation by the national policy advisory body to see that steps are taken towards better interactions. On the other hand, it gives a feeling that the advisory body has been maintaining a low key to promote interactions from his reaction to learn about ICBs. This feeling was further confirmed from the fact when the interviewee was asked to about the actions taken by them to promote interactions, he spoke of specific activities initiated by the body surely towards formulation of policy/regulation on some specific area. Statements like " We are only three years old" and "We must not interfere with other people's affairs" "we always work within our mandate" , "Inter organizational links are lacking", "We would not undertake something that we cannot do. Half way through we don't want to drop something" implies that the advisory body has not only limited scope to become actively involved in the promotion of interactions but also foresees risk of making any impact of their efforts. Such nature of reactions suggest that although

[24] Interviewee is the vice chairman of the UGC

they are expected to function as the policy advisory body in matters related to S&T, the institution is not properly connected to the National System of Innovation in Sri Lanka.

7.3.7.4 Lack of policy directions

The industrialists seem to use the industrial associations and the forums to address the common policy issues with the government. They seem to have succeeded up to now as the government shows keen interest in learning about the needs of the industry. This is evident from the fact that the government has established Industrial Facilitating Forum (IFF) under the Ministry of Industrial Development to resolve the problems faced by the industries. The meetings of the IFF are chaired by the Hon Minister himself, while four other Cabinet Ministers are members of the Forum. The major issues that come to the Secretariat of IFF and need attention at the ministry level are taken at these meetings. Most of the lower level issues are handled by the Secretariat. According to the Secretariat, only very few issues related to technology is raised by the industries. This shows

- The existence of political will to handle the bottom up issues.
- The local industries are confronted with many logistic problems which need attention before addressing the technological considerations.

On the other hand, the industrialists feel that inconsistency in policies and introducing new policy directions without giving adequate notice leaves them in an uncomfortable situation (IN 33). Industrialist also experienced that although the policy directions are formulated, the behaviour of the society and the public institutions seems to remain unchanged. They see the private sector as a distant partner.

The SMES in particular are unhappy with current government policies. They claim that the government policies do not support local industries.

The researchers seem to be looking for motivation oriented policies. The present mandates do not allow commercial activities in certain research institutions. However, these issues are being dealt in the political circles and the necessary changes are expected to come through. Interviewee IN65 mentioned that the university mandate does not promote development through cross-sectoral relationships.

The academia have expressed that they are not adequately represented in the policy making process (IN 52 & IN54). The academia also feel the influence of World Bank in certain policy proposals, which are put to Government by the academia and professional organizations (E.g. construction bill).

Interviewee IN62 who advocates policy directed top down approach, observes that "the system does not have the people with necessary know-how to assess the capacity of institutions and determine what they should be doing"" He continues "the national planning department should have S&T people, so that there are people there who will know what needs to be done in relation to development of various industries and what those institutions are capable of doing, and then directing the necessary funds in such a way that it will be properly utilized." He also remarked that, "S&T is not at all represented in the national planning".

Similar evidence is provided by the interviewee IN65. He revealed that the "Regain Sri Lanka" programme of the new government, which came to power in 2002, has not included universities as a part of the programme. A closer look into the document "Regain Sri Lanka" reveals that there is very little involvement of a few R&D institutions. This suggests the low key of representation of S&T in the national plans even in the present circumstances. It could happen due to either lack of awareness of the importance of the S&T by the individuals who are involved in the policy making process or the government focusing it's faith solely on industry for development.

7.3.7.5 Skills enhancement

The lower percentage on industrial experience and technical training (18%) suggests that the issue on skills enhancement has received less attention of the respondents. However, the industrialists seem concerned about a lack of industrial exposure of researchers and academia, while the academics seem to be concerned about a lack of technical training in the education system.

7.4 Summary

The framework conditions, which are important for URI relationships, are identified. The government has a major role in taking policy initiatives to overcome the constraints in the framework conditions. Different institutions also can play a major role within the institutional policy arena. These conditions partly explain the characteristics of existing relationships. For example the absence of mandates of the institutions for demand oriented approaches, IP and Quality related issues give rise to the occurrence of product /process development activities at a low key.

The analysis of framework conditions is able to explain the reasons for the lack of structured research based relationships. It also shows, what industrialists expect from the universities and research institutions and the constraints faced to achieve them. Furthermore, the systemic support mechanisms/drawbacks that are seen in Sri Lanka are also revealed. However, the questions related to micro level process related issues are still not clear and need explanation.

In this line, open codes are revisited and analysed for process related codes to provide better explanation. The next chapter will deal with these procedural and behavioural conditions considering the micro-level procedures in which the researcher will attempt to identify conceptual framework for the URI relationships in small developing countries.

Chapter eight – Micro level conditions

8.0 Introduction

In chapter six, we identified the main characteristics of URI relationships existing in Sri Lanka and discussed the questions that arise in relation to those characteristics for which the questionnaire survey was not capable to provide reasonable explanations. Accordingly, the framework conditions that affect the relationships, which provided partial explanations for some of those questions, were identified and presented in Chapter seven. The importance of understanding the micro level conditions was emphasized in the literature review and in the research design. In this context, the follow up interviews with the respondents to the questionnaire survey, and the interviews with the 'snowball' sample (Data sets C&D) were revisited and analysed to seek reasonable explanations. This chapter deals with the qualitative analysis of micro level conditions.

The methods used in the analytical process are discussed in chapter five. The steps involved were preparation of interview notes, coding (open coding and clustering process) of those notes, listing the main clusters, mapping these clusters according to sites, and writing up memos for each of these maps and clusters. Finally the analysis using the above qualitative analysis tools were used to extract and highlight the importance of micro level issues in promoting relationships. These findings are summarized with a view to propose policy initiatives for small developing countries.

8.1 Brief review of analytical tools

First we described the coding of the interview notes with respondents and the persons in the 'snowball' sample. As indicated in chapter five, the revised code list (annexure five) was used to prepare a list of clusters (given below).

A. Central facilities
B. Coordination

C. External influence
D. Functional failure
E. Funding
F. Incentives
G. Industry dynamics
H. Access to Know-how
I. Characteristics of the market
J. Modernization
K. Opportunity
L. Orientation
M. Perception
N. Policy culture
O. Research
P. Responsiveness
Q. Social dynamics
R. Systemic failure
S. Technology culture

These clusters contain issues related to the framework conditions also. The clusters which are entirely related to framework conditions, and cannot be described in terms of micro level conditions, were removed from further analysis on micro level conditions. The following are the clusters removed as a consequence.

A Central facilities
B Coordination
E Funding
F Incentives

It was also noted that segments of some clusters such as 'policy culture' deal with framework as well as micro level conditions. Those clusters were kept for analysis under micro level conditions, while specific segments that relate to framework conditions were referred to in the discussions of in chapter seven.

Codes developed from interview notes were allocated to types of respondents (i.e. academia, researcher or industrialist) by type of organization table. Type of organization is decided based on the comment of the respondent (i.e. TOR). These

tables are called as 'type of respondent (agent) by type of organization (site)' matrices. Such matrixes were prepared for each cluster.

The issues related to the process of innovation are more interrelated and the analyzer needed to observe interconnectedness. In this context, memos can be used as analytical device to integrate data and to demonstrate connectedness with each other and with framework conditions. Such memos, which are descriptive analytical tools to explain the attributes and connection between raw data and concepts, are central to the process of data collection and analysis in qualitative research, and used to link empirical data to abstract concepts (Neuman 2000). Hence, in this context, 'memoing' has been used in preference to counting, as the main analytical device in the process of developing the conceptual framework. The memos are used as the part of the thesis, which describes the themes connected to developing the conceptual framework. As indicated in chapter five, observations were triangulated with the opinions of the decision makers (Data set E).

8.2 Clusters related to micro level conditions

After the removal of clusters related to framework conditions, the following clusters remained for 'memoing'.

Theme	Notation
External influence	C
Functional failure	D
Industry dynamics	G
Access to know how	H
Characteristics of the market	I
Modernization	J
Opportunity	K
Orientation	L
Perception	M
Policy culture	N
Research	O
Responsiveness	P
Social dynamics	Q
Systemic failure	R
Tech culture	S

The properties of each of these clusters are described in the following section using memos. These clusters are displayed in the form of matrices for better understanding. "Matrix form is considered as a creative, yet systematic –task that furthers your understanding of the substance and meaning of data" (Miles and Huberman 1984). Accordingly, clusters were allocated to site by agent matrices, using the type of respondent (TOR) and target type of organization (TG) which is shown below (figure 8.1).

Agent ↓ Site →

	Univ	Industry	Research
Academia	J, L, M, N, P, R, D, K, O	P, G	M, O
Industrialists	H, J, L, M, P, S, D, K	H, I, J, N, S, G, O	J, L, M, P, D, K, O
Researchers	M	P, G, O	H, I, J, L, M, N, P, S, R, D, K, O

Figure 8. 1 Type of respondent (agent) by type of organization(site) matrix

8.3 Memos

Memos were written for each cluster based on open codes. The major portion of these memos were extracted for the thesis. The extracted versions of the memos are given below under the heading of the cluster.

8.3.1 Access to know-how

Table 8. 1 Site by agent matrix for access to know-how

Site →

Agent ↓

	Univ	Industry	Research institutes
Academia			
Industrialists	O	O	
Researchers			O

Access to know-how deals with how different types of respondents access new knowledge. The interviews with industrialists revealed that they access technological know-how through out-reaching activities such as the Internet, magazines & journals and participation in conferences/exhibitions. It also shows that suppliers and buyers provide technology related information and production problems. On the other hand, local companies belonging to proprietors who are living abroad do have access to know-how through the proprietor (IN 48). In contrast, in the case of joint venture companies and the local arms of transnational companies do have access to know-how through parent/sister companies.

These observations raise our concern about two interrelated aspects. One is the internationalization of access to know-how which challenges the local S&T organizations including universities for their existence as a social organization. The other concern is about the usefulness of local R&D efforts and technological achievements of the local organizations that seem to be severely underestimated, not appreciated and neglected. The above also show the failure of universities and research institutes to fulfil the knowledge requirements of the industry. Interviewee (IN 66) mentioned that the

> "Industry did not look upon university as a source of information or as a source of human resource for their purposes. At the same time university staff also had no relationships or interactions with industries because their research was never planned or motivated by the industry. Their research were planned based on their background, own experience and expertise."

With regard to the current position he mentioned, " I think the overall situation is changing, but the rate is very slow. Local research and the scientists have not gained enough confidence of industrialists". "Trust and commitment are important factors". Interviewee (IN 65) mentioned that the "Universities lack concern on national needs. They have their own programme systems." He reiterated his past 10-12 years experience and said that

> " University culture was the problem. Even if mechanisms exist to facilitate relationships, it would not work. The existing mandate does not promote development through partnerships". He continued to say that " What is needed is to develop programs jointly with universities, and universities should take over certain responsibilities. "

The question that arises in this context is who should take the initiative to organize nationally important programmes and at what level should it start. It is clear is that it should be a top down, directed programme. According to the interviewee (IN 62),

> "We have to identify what technologies we need for the type of industrial activity that we are going to develop, for which we are capable of developing, we need to know our natural resources & human resources, then in terms of local and foreign market possibilities and requirements , and then based on that we have to decide on what S&T inputs are required . This is something that should be done by policy makers, say, national planning commission at that level they should be doing that type of thing. So, that has not been done. "

He advocates policy directed, top down approaches such as "identification of priority areas, formulation of mission oriented research and passive motivation of individuals and institutions through grants and incentives to conduct research in those areas". In his own words, "conscious orientation" of the system is necessary nowadays.

However, industrialists still feel that in process related problems, the local experts could solve problems (IN 13). Industrialists also see universities as a source of

knowledge (IN 31). This may be a positive reason that industrialists tend to keep in touch with the university through different mechanisms. In contrast, there is no evidence to say that industrialists see the research institutes as a source for know how. Rather, according to the interviews industrialists consider research institutes as a provider of testing services (IN 50 & 51). It was also observed that some companies in the inland fisheries industry do have a know-how sharing culture whilst competing (IN 50). This knowledge sharing culture among competitors is one of the unique features observed in the series of interviews[25].

According to researchers in research institutes, they get access to new knowledge from international exposure such as participation in meetings, seminars and conferences, (e.g IN 15), which is being used as an input to the local research programs.

In summary, industrialists tend to use available sources of knowledge such as the Internet and journals rather than rely on local research institutes and universities. In order to make these organizations usable for industrial activities, more focus on conscious orientation is recommended.

8.3.2 Characteristics of market structure & composition

Table 8. 2 Site by agent matrix for characteristics of market structure & composition

Site ⟶

Agent ↓

	Univ	Industry	Research institutes
Academia			
Industrialists		O	
Researchers			O

[25] The scientists involved in the technical aspects of the fish farming in different companies had been working together in a state run organization few years back. This state organization was closed down due to political reasons and the scientists had to find jobs in different private firms in related field. Hence, previous work relationship has created environment for knowledge sharing although they are competitors.

respondents from the universities commented about market structure and composition. Furthermore, the respondents from research institutions and industrialists are concerned about the purchasing power of the consumers in the local market. In addition researchers seem to have a perception that the local market does not need quality products. This issue has also been raised in the previous chapter on framework conditions.

The lack of quality consciousness in society seems to be one of the major behavioural factors that retard the innovation process.

Also, it seems that particular sectors of the economy have different constraints and limitations. For example, it was also highlighted that an average family in Sri Lanka spend 70% of their income on food. One of the interviewees (IN 47) expressed his view that this limits the opportunity to introduce value added food products to the local market. However, value added food products may find a market in one segment of the market, hence a market mix approach may be necessary in this context.

On the other hand, interviewee IN 60 has expressed his views that IT related industries suit the developing countries very well as they need little financial capital and space but intellectual capacity for analyzing problems which most developing countries such as Sri Lanka possess. According to him, the competitive advantage for developing countries can be based on the innovative capabilities in analyzing problems, rather than not trying to innovate new products.

The industrialists are also concerned about difficulties in marketing. One industrialist who is exporting canned food items to Western countries as well as Australia and New Zealand, does not use any marketing strategy other than word of mouth. Another industry that is manufacturing electronic components is involved in production of spare parts through sub contracts for reputed companies overseas. Their technical skills, Internet searchers and labour intensive work force provide them competitive advantage over other bidders in the bidding process. According to

this particular industrialist, the real challenge is to keep up to the level of quality of the product which is expected by the original manufacturer (IN 31).

In summary, the analysis reveals the influence of economical factors such as purchasing power on the market demand for quality of products, and hence shapes the level of technological growth. Furthermore, it was observed that market opportunities are different for different sectors and initiatives have been taken by industries (specially SMEs) at the micro level to capture these opportunities. Hence the policy initiative in this regard needs to capture and promote micro level initiative capacity. For example, the above subcontracting firm needs to upgrade quality control aspects to keep rejects at a minimum level. These matters call for inputs from S&T base.

8.3.3 Modernization

Table 8. 3 Site by agent matrix for modernization

Site →

Agent ↓

	Univ	Industry	Research institutes
Academia	O		
Industrialists	O	O	O
Researchers			O

The analysis of data sets C&D also revealed the need for modernization as one of the important clusters.

The term modernization can mean either modernization of physical conditions or modernization of approaches. The present analysis deals with only modernization of approaches which is a micro level condition.

The interview data shows that the codes connected to modernization can be categorized into three sub-clusters such as modernization in skills, modernization related to regulations and modernization in service functions. The following sections will describe each of these sub-clusters separately.

8.3.3.1 Skills

The interviewees from industries and research institutions have proposed the following people based modernization approaches.

1. Provision of industrial experience to researchers,
2. Allowing the industrialists to work in research institutes
3. Allowing the researchers to perform private practice (especially for animal scientists)
4. Releasing researchers to work in industry

In addition, recruitments of staff to research institutes and universities, who posses industrial experience rather than only educational qualifications, is also proposed by the interviewee IN63. He further mentioned that research institutions and universities should have 30-40% of staff who have worked in private sector industries. He thinks that such people can bring practical experience and a market oriented approach to research institutions. According to interviewee IN65, the government has allowed researchers to join private sector industries to work up to maximum of 5 years and return to their position in the research institution. This policy directions, according to interviewee IN65[26] , is quite new and the consequences are still unknown. Nevertheless, what can be observed, according to interviewee IN76[27], is that many senior scientists are absorbed by industrial organizations, for a comparatively very high salary packages, and leave the research institutions permanently. This has resulted in manpower degradation in research institutions (IN76).

This indicates a need for the facilitation of skill mobility among sectors based on incentive packages to downgrading of the level of skill of the S&T base.

[26] Interviewee is presently working as an advisor at the Ministry of the Policy implementation and has long time experience working as an secretary to an important ministry portfolio.
[27] Interviewee is the director of a research institute in the field of animal husbandry

8.3.3.2 Testing and Service function

The second sub-cluster generated by the interview data is modernization in performing testing and service functions. It was observed that industrialists tend to more concerned about quality products. One firm has established laboratory facilities in his industry premises to improve the quality of products (IN43). According to him, many industrialists now go to accredited private laboratories to get tests done rather than to government research laboratories. This indicates the dissatisfaction of industrialists with the services provided by the research institutions. These findings have connections with the findings of chapter seven in which industrialists consider lack of facilities as a major framework condition to impede relationships. Along this line, one industrialist has proposed that they should be allowed to carry out the tests themselves in the government research labs (IN47).

In this context, what I observed is that such arrangements call for procedural changes in research institutions to bring industrialists in to the laboratories. Hence, a more realistic approach is establishing Science and Technology park structures for industrialists to develop innovative ideas.

8.3.3.3 Regulations

The third sub-cluster originated from the interview data is modernization of regulations. The universities still function under the University Act of the 16 of 1974 and subsequent amendments in 1980s. The financial and administrative regulations used in the public sector organizations, which are also being used by the universities, are more than 50 years old.. In contrast, market driven approaches demand more flexible financial and administrative regulations. Along this line, the existing regulations have been reported as a major constraint to conduct research in universities and research institutions (NSF 2001).

According to the interview data, the researchers and academia commented on the modernization of existing financial and administration regulations. The need for change in regulation related to the retention of generated income has been addressed

in the previous chapter. The consequence of the absence of such policy is that the people are not motivated to improve the earning capacity of the institution.

Although research institutions are capable of providing training for industries and earning profits for the benefit of the institution, some research institutions still maintain cost recovery approach in their training programs. The reason is that the particular research institution which provides training for farmers and small scale industries in the agriculture sector hesitate to adopt a profit making approach as the recipients do not have the capacity to pay increased charges (IN16A). In this context, I feel that the social/national responsibility of research institutions draws the attention of policy makers in the context of a tendency to push research institutions towards market driven approaches.

In summary, modernization is looked at in three dimensions: skill, facilities and regulations. Contractual and permanent placements in industry, industrial experience, and permission for private practice were highlighted under modernization of the skills base. The need for increased performance of testing and experiments by the industrialists came up as an issue for modernization in testing and experimentation facilities. This calls for Science park type structures. Apart from a revision of Administrative and Financial procedures, regulations related to keeping earning for their benefit was again highlighted as an issue for modernization of regulations.

8.3.4 Orientation

Table 8. 4 Site by agent matrix for orientation

Site →

Agent ↓

	Univ	Industry	Research institutes
Academia	O		
Industrialists	O		O
Researchers			O

Here the term orientation is used to denote a change in position or process to suit the requirement.

The interview data set generated the cluster on orientation as an issue for micro level conditions. Historically, the universities and research institutes performed their functions in isolation. According to the data, it can be observed that universities and research institutions have made incremental changes to orient their activities towards industrial needs and expectations. For example, researchers who are presently dealing with industrialists seem to understand the importance of maintaining confidentiality. (IN 15 & IN 55). Their continued personal contacts with industrialists show that the researchers who have interactions on product development have maintained their obligation to the satisfaction of the industrialists. They seem to have identified the need to run the industry related activities in a new form with a private sector outlook and as a commercial venture. Industrialists also see that confidentiality is one of the important norms in the relationship (IN13). With respect to technology licensing activities one institution (NERD) has taken steps to create a competitive environment among dealers[28] by transferring more responsibilities to them (IN03).

At the same time universities appear to have identified the importance of promptness to respond to industry queries and recruitment of trained committed people. The university authorities have permitted a particular university department[29] to retain a portion of funds generated from consultancies to use for essential work of the department within the framework of rigidity of financial process (IN08).

In summary, there is evidence from the interview data that all types of respondents have taken steps to change the positions or process to meet the expectations. Essential attributes for relationships such as confidentiality have been recognized. Research institutes expect the need for new forms of organizations for commercial venture with an outlook of a private sector organization. University authorities have

[28] Dealers are the firms who have got licenses from the research institution to manufacture and market products based on the technology developed by the research institute.
[29] This department is reputed to have more close relationships with the industry than other departments. Hence the funds retained are being used for urgent field visits, essential pieces of equipment etc (IN08)

taken steps to lessen the rigidity by allowing the departments to retain funds generated from consultancies.

8.3.5 Perception

Table 8. 5 Site by agent matrix on perception

Site →

Agent ↓

	Univ	Industry	Research institutes
Academia	O		O
Industrialists	O		O
Researchers	O		O

Perception is the next cluster generated by the interview data. The term perception is used in the general way to denote how the respondents view the counter part organizations.

Interview data revealed that the perceptions of the industrialists towards research institutions and universities are not positive. Their perception is mostly directed towards universities in general and towards the attitudes, behaviour, commitment, and political inclinations of university students in particular (IN 31, IN47, IN51). However, some industrialists commented about the positive side of students, as they are intelligent, enthusiastic and knowledgeable (IN13, IN14, IN33, IN50). This shows a conflict of viewpoints among industrialists on university students working on projects.

Students had the opinion that non-graduate (from a SL university) industrialists have difficulty in understanding the actual life style within the political environments in universities and that they see only superficial viewpoints through the media. In contrast, the industrialists who had gone through the system many years before know the intensity of the quasi-political inclinations of most students to political parties. Secondly, students have the view that the industries that are more vulnerable to infringement labour laws are reluctant to take in students.

The interviewees from industries have commented that university courses are not practically oriented and are not relevant to actual world applications of industry. They also do not involve in any product development activities. In addition, industrialists see the academia as uncommitted and usually tardy to respond industry requirements. No product development is possible with universities. However, they seem to be aware of the fact that the universities are overloaded with teaching due to the intake of double batches[30] (IN31). The intake of double batches to universities in Sri Lanka to clear the backlog of students is probably a unique feature in the world.

With respect to research institutions, industrialists seem to have negative remarks on the service related aspects. Promptness seems to be a key issue, while issues of reliability, attitudes of officers and lack of industrial exposure also contribute to the negative perceptions.

One of the research directors (interviewee IN75) confirmed this type of negative perception of staff by commenting that researchers are not committed to carry out the functions that are expected of them.

On the other hand researchers feel that universities are in a disadvantageous position as it is not easy to maintain confidentiality of university circumstances. Also, the lack of sophisticated facilities and student based research approaches gives rise to the question of accuracy. One research manager (interviewee IN76) commented that there is a trend of mobility of researchers from research institutions to universities for better salaries and a more "relaxed" environment. It seems interviewee IN76 feels that the work environment in universities is more relaxed than in research institutes. In contrast, one academic (interviewee IN 45) commented that the research institutions lack vision and most of the researchers are interested in

[30] The civil unrest during the period 1989-1991 resulted in closure of universities for three years. However, the general school education continued creating a waiting list of students for university entrance. After re-opening in 1992, it was decided to take two batches of students per year to clear the waiting list in three years. This resulted in heavy teaching load for academia. Unfortunately, due to subsequent problems in the higher education sector, many universities still could not clear the waiting list even after 10 year. The academia still quote heavy teaching load as a result.

personal benefits. This shows that there is conflict of perception between research institutions and universities.

It seems the academia also accept the importance of the promptness. One senior researcher commented that, University is "sluggish" and students lack self learning abilities.

In short, it revealed that the actors do not have a positive perception of each other. The negative perceptions are mainly on behavioural aspects and can be controlled within the boundaries of the organization.

8.3.6 Policy culture

Table 8. 6 Site by agent matrix for policy culture

Site →
Agent ↓

	Univ	Industry	Research institutes
Academia			
Industrialists		O	
Researchers			

The cluster on policy culture was developed based on the interview data. The issues related to policy culture were also discussed in the previous chapter. Hence, the main points are reiterated and any new points of view evolving from the interview data are presented here.

Industrialists seem to feel that the current policy structure does not promote industries, specially local ones. Labour laws do not promote productivity of the work force. The incentive structure (for example industries are qualified to claim for tax incentives if the total work force exceeds 50) is contradictory with the desire for technological advancement and productivity improvement (IN 51).

In addition, with the signatory to international agreements, certain new regulations came into force, which affect the operations of local industries. The local SMEs are concerned about the cost of the testing to be done to conform to the standards proposed in those agreements (IN 43). They claim that the government has to take satisfactory action to lessen to burden that will fall on the SMEs as a result. For example, the regulations on certain products need certification for quality (such as nutritional contents to be displayed on the label), requiring regular testing performed in accredited labs (in most cases state owned laboratories) which is costly. Industrial organizations are reluctant to transfer this additional cost to customers as they might lose the thin market advantage of low production cost (IN43). Over and above, the type of tests to be done seem to vary in nature and some specific kinds of testing facilities are not available in state run service organizations(IN46). Furthermore, only a few of those labs have accreditation status. Hence industrial organizations have failed to get the relevant testing undertaken in state run service organizations (IN43).

In contrast government agencies view this as an opportunity for industry to improve the quality of products to international standards (IN 66). Therefore, the situation requires government intervention such as providing partial support for either the establishment of quality control methods in industrial premises or to subsidize the cost of testing by providing adequate financial resources for the testing authorities to conduct the relevant testing services for the industries.

The points highlighted in the previous chapter are related to industry & government initiatives to address problems faced by the industries, a need for consistency of policies, inadequate representation of S&T issues in national policies, a need for legislative changes and a need for national programs to promote technological advancement of the country. The present section highlighted the lack of support for SMEs from the existing policy structure, ineffective incentive structures and the need for new policy initiatives to meet the challenges of globalization.

8.3.7 Responsiveness

Table 8. 7 Site by agent matrix for responsiveness

Site →

Agent	Univ	Industry	Research institutes
Academia	O	O	
Industrialists	O		O
Researchers		O	O

The issues on responsiveness deal with how actors respond to the need for interactions. The interview data provided substantial evidence to show that universities and research institutes have initiated several activities, with a view not only to interact with industry but also to bring up the technological inputs into the industry. For example, IN 75[31] mentioned that the private sector industry had been assisted with the establishment of laboratories in industry premises. Also, industrialists are invited to attend scientific meetings where they can provide input to the research agenda of the research institution. Dissemination of scientific information to industrialists through seminars and accommodating PG student projects to conduct their industry oriented research projects are two other ways (IN 42) that were observed as measures taken by research institutions to respond interactions.

Industrialists seem to expect responses from the University by having a practical oriented curriculum and not limiting the relationship to regular visits, seminars and lectures. The industrialists believe that delays for industry inquiries lessens their desire to become involved in relationships (IN33).

On the other hand, universities appear to have made a lot of effort to respond to the current needs of industry. Among many actions taken by universities, according to the interviews with Vice Chancellors of Universities and Deans of respective faculties, attempts to reveal that getting industry involvement in postgraduate

[31] Interviewee is the director of the particular research institution

courses as visiting lectures, enhancing industrialist role in student supervision, representation at industrial forums ,curriculum changes towards industry requirement , getting industrialists involved in councils and advisory bodies, formulating part-time degree programmes to facilitate enrolment of industry personnel, and the establishment of industry licensing committees can be observed. However, some academics believe that industry is not interested in relationships (IN 54) while others commented, "industry has started moving" (IN 45). Industrialists seem to have personal contacts with University professors and contacts through students projects. One university department in computer science has arranged for the industrialists to conduct seminars to qualifying students (IN34). The major purpose of these seminars seems to be motivating student recruitment.

Academia also commented that industrial associations can play a more active role for encouraging relationships between industry and academia (IN55).

In response to the current needs of industry, (also probably due to a low demand for enrolment of students for general courses) the University of Peradeniya is planning to commence a new practical oriented specialized degree programme with a self learning based curriculum. The programme will be structured in collaboration with existing industrialists and the visiting industrialists will deliver lectures in addition to the existing faculty (IN 45).

Having identified the training needs and technical inputs in SMEs in the food sector, one interviewee (IN 18) has established a consultancy type spin off company to respond to industrial needs on access to know-how. However, this company is registered in his wife's name as the University Act restricts commercial activities by the academia.

In summary, all types of respondents have identified the need for interactions for mutual benefits. The universities and research institutions have responded to find ways to get closer to industrialists within organizational mandates. Also, individuals have found different ways to respond where organizational norms do not allow to do so.

8.3.8 Social dynamics

A few points of interview data clustered around issues related to the behaviour of society, and hence those cannot be represented in matrix form. These issues are beyond direct control of the respondents but require mentioning for completeness.
Social dynamics seem to be the least concern of all respondents. The comments are diverse and disconnected in nature. However, it is worthwhile to note that universities have observed that the demand for agriculture degree courses have become low (IN 64 & IN 36). Also, industrialists observed that the trend in the society is moving towards traditional foods (IN 47).
Apart, from that the respondents tend to comment about cultural norms. Some of these comments are given below,
"People do not like to share (IN41)."
"People are culturally bound[32], hence more automation is preferred to improve productivity (IN24-B)."

8.3.9 External influence

As in the above 'Social dynamics', there were a few comments by respondents clustered around external influence by mainly donor agencies on the political agenda and policy decisions of the country. Also, these issues cannot be represented in the form of a matrix as the comments falls outside the matrix form.

It was observed that the general belief of the respondents seems to be that government policies are influenced by the external sources such as the World Bank and IMF. Industrialists view the government as weak in negotiations with the donor agencies and therefore see the economy regulated by those agencies (IN14 & IN51). Some other industrialists have remarked that although the above is true, most of the recommendations of the agencies are in parallel to the proposals made by the industrial organization to the government. However,

[32] The interviewee gave the example that if there is a function related to a worker , such as a wedding or a funeral of a relative, the worker him self and many of his/her friends take days off from the working place to help the worker. Hence, automation can compensate the poor turnover of the workers

government has failed to maintain consistency in policy directions where the industries need to know the policy trends beforehand (IN33). For example, if the Government is planning to ban polythene products in the market, industry needs to know this beforehand to switch to other ways of packaging which need testing, installation and sometimes market trials.

8.3.10 Technology culture

Table 8. 8 Site by agent matrix for technology culture

Site →

Agent ↓

	Univ	Industry	Research institutes
Academia			
Industrialists	O	O	
Researchers			O

The analysis of interview data sets C&D produced a cluster on Technology Culture. Technology culture deals with aspects related to handling technology by different types of respondents.

Interview data shows that industrialists maintain technology related relationships with local experts and buyers (IN14 & IN50) . One industry maintains very close relationships with competitors (IN50). This was explained under 8.4. 'Access to know how'. Some industrialists seem to prefer having an in-house innovative culture rather than contracting out research to institutions/universities (IN33).

It was observed that SMEs tend to depend on their own technical skills related to machinery for product and process development. The main reason for such behaviour seems to be the high cost of turnkey equipment, non suitability of turn key equipment for low volume of production and interest of SMEs to test their own technical skills (IN47, IN32, IN46 & IN43).

There is evidence of contract research done in research institutions for industrialists (IN55). For example, IN55 works on a pet food made out of local raw material but competitive enough in the international market. The research work is done as a contract for industry. In other example, IN 44 worked on an infant food which is now highly popular in the local market.

Research institutions find that their approaches for technological development is mostly based on their own perception, for which they see problems of commercialization (IN01). Such technologies developed by research institutions are not adequately recognized (IN55). It was observed that some of these technologies have received international awards (IN03), while other technologies are only copying from somewhere else. However, in the application of technologies developed locally in a commercial setting, lending organizations that are expected to fund such new ventures do not depend on the version of the research institution on applicability of the technologies developed by them. Hence, those lending organizations tend to carry out a separate evaluation due to lack of confidence on the practicability of those technologies (IN55). Hence, the interviewee proposed recognition for those proven technologies by an independent body is needed to facilitate commercialization of technologies, which are developed locally. The need for recognition for locally developed technologies has also surfaced under the framework conditions.

Interviewee (IN 02) also felt that the extension arms of research institutions are needed to be restructured to reach out to the potential industries. Currently, these extension arms use a one-way approach of disseminating the news of the research institutions to the general public.

In summary, industrialists tend to outreach to grab technological information while experimenting in-house innovations. However, they tend to keep informal relationships with the universities and research institutes. The technological skill of proprietors (entrepreneurships) seems to matter in SMEs. The research institutions

seem to face many constraints related to technology transfer and commercialization activities and these have connections to other issues such as functional failures.

8.3.11 Systemic failure

Table 8. 9 Site by respondent matrix on systemic failure

Site ⟶

Agent ↓

	Univ	Industry	Research institutes
Academia	O		
Industrialists			
Researchers			O

A comparatively large volume of interview data falls under the cluster on ' Systemic failure'. 'Systemic failures' in this context deals with situations due to failures of the systems which are beyond direct control of individuals and organizations. It is interesting to note that almost all the comments on systemic failure are by the academia and researchers on their own sites. They tend to be critical about the systemic features as they know best about the failures.

One of the directors of the research institution was very dissatisfied with the workers' attitudes towards work (IN75). He mentioned that "They always demand for what they can get but do not think about what they can offer (in terms of work) to the institution and to the country". The lack of support from service sector [banks] for proven technologies can also be considered as a systemic failure (this issue came up under tech culture also). It was also observed under framework conditions that the system does not help the individuals and institutions to promote technological related relationships, as there is no quality related and IP related consciousness in the system (IN55).

The university mandate which limit commercial activities require reforms (IN54). As the system does not facilitate academia exposure to industry, they get isolated and obsolete (IN18). The interested individuals have to strive hard to develop their self-image to be noticed by industrialists (IN66 &IN55). The

university system does not provide any assistance to improve relationships with industries (IN18). The system failure also has historical prospects.

> "Universities had an easy time as it did not have any pressure although the economy was open 30 years ago. The graduates were absorbed into the government positions and hence, the science based graduates did not have any unemployment problem. Hence, the universities did not have any need to collaborate with the industrialists or become industry oriented" (IN66).

Senior academic members seem to have an unfavourable perception of the new generation of academics. They claim that the new generation is money and position oriented and not committed to research. To change their attitudes it needs a systemic based pressurization (IN45). With regard to the administration function of the universities, the academia claim that the delay to respond are due to bureaucracy of the administration process. The academics seem to be concerned about management styles in the university and commented that "management style has failed" and " universities lack leadership" (IN45).

Apart from the comments on their own sites, the respondents have expressed their concern about general systemic failures. Industrialists have commented on the government structure as "Negative" and "Pull back innovations"(IN46). The testing facilities are not adequately established and quality aspects are totally neglected (see chapter seven). Academics are concerned about vocational training aspects which is under review by the government. The need for training of technicians is a very neglected area in the present context (IN45).

In summary, systemic failures have produced unfavourable work attitudes, lack of IP/Quality consciousness, mandatory & regulatory inadequacies, poor management and inadequate technical training.

8.3.12 Functional failure

Table 8. 10 Site by agent matrix for functional failure

Site →

Agent ↓

	Univ	Industry	Research institutes
Academia	O		
Industrialists	O		O
Researchers			O

It was observed that a large volume of interview data falls in the cluster "Functional failure". This cluster deals with failures due to poor management of institutional functions including resource management and efficiency.

According to the interview data from industrialists, they experienced difficulties in contacting academia and researchers when required (IN33, IN 51). One obstacle is the lack of information on the experts available in universities and research institutions. In such cases, university authorities do not take interest in replying promptly and providing information on available experts to the industrialists (IN33).

One industry claimed that government institutions do not visit industries (IN48) while another claimed that interactions are limited to visits, meetings and seminars (IN51). Although there seems to be a conflict of opinion, this reveals the dissatisfaction of industrialists on the role of research institutions which has resulted in negative perceptions.

The permanent drain of research personnel towards industries and universities seems to be a critical problem in research institutions (IN76). This can be regarded as a failure of management to take necessary steps to retain people. In contrast, interviews with researchers show that the training provided to researchers is inadequate (IN75). Probably what happens in real terms is that the qualified well trained researchers are absorbed by industrialists (IN76) while less trained researchers are compelled to manage the institutions.

The researchers seem to be concerned about the problem in the governance of organizations and granting promotions. Researchers propose merit based promotions rather than "hand pick" methods (IN42). One interviewee (IN45) from universities commented that a particular research institution "needs another set of top people", reflecting his dissatisfaction about the management of the institution.

The lapses of research institutions such as duplication of work, inadequacy of facilities (covered in the chapter seven also), lack of vision and improper use of equipment have received attention of industrialists (IN13, IN18 & IN51). They propose that the research institutes should focus their strength and resources on core research areas (IN56). Industrialists have also observed that the capabilities of research institutions are scattered among many places and coordination to form a network is necessary to achieve the benefits (IN13).

Researchers see that the technology diffusion function of research institutions is ineffective (IN01). This has relations to the lack of an industry orientation approach and project selection based on individual perspectives. It appeared that involvement of industrialists in research project selection is at low key.

Academia believes that the university system is incapable of providing support for industry related activities unless it is connected to the normal education function (IN18). For example, there was a case where it was difficult to arrange space in universities to conduct a training programme for industries.

In summary, the functional failures related to research institutes are highlighted prominently. Lack of communication, limited outreach activities to meet industrialists, poor internal management and leadership, duplication & lack of coordination, lack of focus on resources and capabilities and lack of industry orientation are highlighted as functional failures. Drain of human capital is seen as another issue that research institutions suffer. Lack of industry orientation of academic institutions is also highlighted as a functional failure.

8.3.13 Opportunity

Table 8. 11 Site by agent matrix for opportunity

Agent → Site

	Univ	Industry	Research institutes
Academia	O		
Industrialists	O		O
Researchers			O

Opportunity is one of the clusters developed through the interview data sets C&D. In this instance the term opportunity denotes the avenues for interactions among the types of respondents by providing better services.

Despite the negative perceptions of universities and research institutions, the industrialists still feel that the local experts could solve the process-related problems. The industrialists feel that local experts have better understanding on local conditions including knowledge on local raw material. Hence, industrialists tend to keep in touch with the universities and research institutes by making informal contacts (IN13 & IN14). They seem to believe that there is potential for product development through partnerships. Nevertheless, industry sees that new areas of problems evolve and the knowledge base in the universities and research institutes is very important. Also, industrialists see the relationships are useful to overcome problems related to materials and enhance the strength of capabilities of industries in negotiation with supplier and buyers (IN14).

The research institutes, specially ITI and NERD feels that they are capable of long term large projects and consultancies (IN55 & IN03). With regard to services they feel restructuring the functions is necessary to capitalize on capabilities through provision and marketing services efficiently. They feel confident to generate a regular income through testing services and training.

The academia feel that they are capable of embarking on start up companies, but the university mandate still does not provide provision for academics to do so. However, it was noted that academia are involved in business indirectly and some have registered their companies in the name of a family member (IN 18). The important point in this context is to bring these business activities within the legislative framework and receive the benefits for the institution while the entrepreneurial academia is allowed to conduct business.

In summary, all types of respondents have shown the desire to take the window of opportunity to utilize their capabilities. Also, legislative and functional barriers seem to prevent the academia and researchers to capture those opportunities.

8.3.14 Industrial dynamics

Table 8. 12 Site by agent matrix for industrial dynamics

Site →

Agent ↓

	Univ	Industry	Research institutes
Academia		O	
Industrialists		O	
Researchers		O	

The interview data sets also clustered around the issue on industrial dynamics. The term industrial dynamics is used to describe how the industries operate in the present context, specially in relation to technological development.

According to the interviews, researchers realise that industry lack sufficient capabilities for technological development in terms of manpower, facilities and understanding technology related issues (IN40 & IN75). However, they feel that some proprietors who have a technological background face the challenge successfully (IN55). Also they believe that industries are grouping up to face the challenge of development (IN55). For example, a consortium on rubber manufacturing companies has been proposed to deal with pre-competitive research and development activities (IN41).

Academia has also shown concern about the technological capabilities of the industrialists. Academia realise that local industrialists cannot compete with foreign companies (IN52). Hence it has become necessary to improve quality and knowledge base in the industry (IN18). In this regard, the decision makers' point of view was expressed as;

> " The biggest weakness is their short term profit motivation"." though we call industries, most of them are small , medium and micro industries. It is only when you go up the scale, that people are earning; larger profits while they will be prepared to put into this type of thing. In relation to the SMEs, we can't expect the industrialists to help, because they lack the capital. So, you have to have either some scheme to provide what is necessary , for capital for R&D . You have to have some scheme to provide them with the necessary capital for R&D on easy terms which they will be able to make use of them. Or the R&D institutes & universities will have to consciously be given the necessary support by the government or may be the chambers of industries and all get together and have a fund through which this money is made available so that the necessary R&D could be done. "

However, it has been observed that the technologies available in the international market are prohibitively expensive for local industry. In this context, where financial assistances is difficult to arrange from local sources, industrialists attempt to locally manufacture manually/ semi automatic operated machines required for the production process (IN32, IN43, IN46, IN47). Such attempts are highly favoured by the industrialist's background education, technical skills and interests. For, example, the automatic cap machine manufactured in Germany costs more than Rs 2m. The proprietor of a firm dealing with processed food has developed his own hand operated cap machine only for Rs. 7,000/- which does the same job (IN43).

Industrialists have little concern about skill development of the staff. The low key efforts made in skill development focus on management aspects rather than technology capability building(IN51).

Industries seem to have taken an interest in improving quality to compensate the internal drawback by establishing mini scale laboratory facilities (IN43). This progressive development together with relationships with local experts and contacts with foreign sources (through personal contacts) seems to be effective in finding solutions and carrying out critical testing related to technological matters. Also, industries have formed sector related associations. For example, more than fifteen industrial associations were formed under the USAID assistance during the last 5year period (IN 72). Most of these industrial firms are also members of the chambers of commerce and industries in geographical areas. These chambers are used as the channel to take up the pressing issues to the political spheres more effectively (IN51).

In summary, weak technological capabilities in industries has been highlighted. Lack of skills, facilities, and size of the firms are seen as possible reasons for these weaknesses. Need for collective approach has been felt and been practiced in addition to relationships with local experts and contacts with foreign sources.

8.3.15 Research

Table 8. 13 Site by agent matrix for research

Site →

Agent ↓

	Univ	Industry	Research institutes
Academia	O		O
Industrialists		O	O
Researchers		O	O

Cluster on research was developed based on the analysis of interview data. The term research is self-explanatory but, in this context, we use the term to represent industrial research.

The bottom line issue with respect to research culture seems to be a scarcity of funds and funding schemes. This aspect has been discussed under the framework conditions in chapter seven. Industrialists see research institutions as service providers (IN 50, IN51 & IN43). It seems industrialists have experienced good relationships with RI and possess a mixed set of opinions. Industrialists are concerned about functional failures of research institutes such as mismanagement of resources and capabilities. This aspect has been covered under that of functional failure. It suggested that a good management process with flexible operation and coordination mechanisms would attract the industrialists for more productive relationships, and efficient services.

Academia also have expressed an opinion on a similar line and expressed that the research culture in research institutes is not satisfactory (IN45). It has been expressed that research institutes lack vision and experience to perform industry related activities (IN45). With respect to universities it was mentioned that universities need research management function with flexible financial administration to be incorporated to the system.

Industrialists are concerned about lack of industrial exposure, skills and lack of practical orientation of researchers towards industrial activities. Decision makers also expressed opinion on the similar lines and proposed recruitment of persons with industrial experience for the cadre position in research institutes (IN 63)

The reliability and hence the quality of the research done in certain research institutes have been questioned. One respondent has expressed that "It needs a different set of people".

Industrialists see research institutes as a service centre. Most of the comments made by industrialists seem to fall within that framework of service functions. Researcher appear to have considered industrialists as product development partners, but weak, in terms of their capabilities and ability to fund research (IN01). Researchers have felt that they are grouping up for more strength and becoming prepared to address R&D problems (see cluster on industrial dynamics).

In the meantime, research institutes seems to be concerned about preparations for long-term service oriented as well as research oriented relationships. In this process, researchers seem to have identified the essential attributes of long-term relationships namely confidentiality and reliability (IN 15).

In summary, despite the need for funds, the image of the research institutions seems to be important to develop research based relationships. The functional failures, poor management, inflexible operation, rigidity of procedures and lack of industry orientation seem to blur the image of research institutes.

8.4 Summary

Summaries of each of the above memos can be used as a tool to synthesize the findings and analyse how they relate amongst themselves while connecting to the framework conditions. The summaries of memos are given in the table 8.14

Table 8. 14 Summary of findings in each cluster

Cluster	Summary
Access to know-how	Industrialists tend to use available sources of knowledge such as Internet and journals rather than rely on local research institutes and universities. In order to make use of these organizations for industrial activities, more focus 'conscious orientation' is recommended.
Characteristics of the market	Influence of economical factors such as low purchasing power on the market lessen demand for quality of products, and hence affect the level of technological growth. Furthermore, it was observed that market opportunities are different for different sectors and initiatives have been taken by industries (specially SMEs) at the micro level to capture these

	opportunities. Hence the policy initiative in this regard needs to capture and promote micro -level initiative capacity.
Modernization	Contractual and permanent placements in industries, industrial experience and permission for private practice was highlighted under modernization of skills base. The need for performance of testing and experiments by industrialists appeared as an issue for modernization in testing and experimentation facilities. This calls for Science park type structures. Apart from revision of Administrative and Financial procedures, regulations related to keep what they earn for their benefit was again highlighted as an issue for modernization of regulations.
Orientation	All types of respondents have taken steps to change the positions or process to meet the expectations. Essential attributes for relationships such as confidentiality have been recognized. Research institutes expect the need for new forms of organizations for commercial ventures with outlook of a private sector organization. University authorities have taken steps to lessen the rigidity by allowing the departments to retain funds generated from consultancies.
Perception	Respondents from different types of organizations do not have positive perceptions of each other. The negative perceptions are mainly on behavioural aspects and can be controlled within the boundaries of the organization.
Policy culture	Lack of support for SMEs from the existing policy structure, ineffective incentive structures and the need for new policy initiatives to meet the challenges of globalisation have been highlighted.
Responsiveness	The need for interactions for mutual benefits. Universities and research institutions have responded to find ways to get closer to industrialists within the organizational mandates. Also, individuals have found different ways to respond where organizational norms do not allow to do so.
Technology culture	Industrialists tend to outreach for grab technological information while experimenting in-house innovations. However, they tend to keep informal relationships with the universities and research institutes. The technological skill of proprietors (entrepreneurships) seems to matter in SMEs. The research institutions seem to facing many constraints related to technology transfer and commercialization activities.
Systemic failure	Unfavourable work attitudes, lack of IP/Quality consciousness, mandatory & regulatory inadequacies, poor management and inadequate technical training are viewed as systemic failures.

Functional failure	Functional failures such as lack of communication, limited outreach activities to meet industrialists, poor internal management and leadership, duplication & lack of coordination, lack of focus on resources and capabilities and lack of industry orientation are highlighted. Drain of human capital is seen as another issue that research institutes confront and is also highlighted as a functional failure.
Opportunity	All types of respondents have shown the desire to take the window of opportunity to utilize their capabilities. Also, legislative and functional barriers seem to prevent the academia and researchers from capturing those opportunities.
Industry dynamics	Weak technological capabilities in industries has been highlighted. Lack of skills, facilities, and size of the firms are seen as possible reasons for these weaknesses. Need for collective approach has been felt and been practiced in addition to relationships with local experts and contacts with foreign sources.
Research	Despite the need for funds, the image of research institutions seems to matter to develop research based relationships. Functional failures, poor management, inflexible operation, rigidity of procedures and lack of industry orientation seem to blur the image of research institutes.

The above section identified and explained the process related issues that affect the URI relationships in Sri Lanka. Some of the issues such as research, structure and composition of market, access to knowledge, etc, are more generic and hence can be generalized at least for the small developing country context. The analysis of interviews was able to find suitable answers to find out how industries access know-how and technological capabilities, how industries see university and research institutes, what they expect from universities and research institutions, and what are the constraints faced by the industries to become involved in relationships and enhance their technological capabilities. The answer for the questions such as what is the benefit they gain from relationships and why the players do not have long term oriented relationships need to be interpreted in relation to the findings of the analysis. Finally the answer for the question "what sort of policy interventions" are needed should take the form of recommendations where the actual answer will need more focused investigation and supporting information.

On the other hand , with respect to university and research institution domains, the questions such as how they see industrial partners and what are the real constraints to approaching industries have been adequately answered. How those drawbacks can be rectified, what are the present approaches towards interactions, what they can offer to the industries and how the industries fit in to their approaches should examine with the practical world examples.

In this context, the research direction diverted to examine the ways that the actors attempted to overcome the constraints and weaknesses. It was noted that in all three types of organizations involved in changing their role towards interactive modes, sometimes by setting up organizational structures where multidisciplinary, multi-actor interactive approaches are performed.

Along this line the next chapter discuss such new organizational forms and how those forms are oriented towards overcoming the weaknesses and constraints of the system.

From the point of view of the sites, the issues take two forms such as internal causes & external causes. Internal causes are the issues that the actors in the site have identified as important issues for their site. External issues are the issues that counterpart actors have identified as important issues for the former site. These issues can be put in to a diagram as shown in the figure 8.1. The issues identified by actors on their own sites are given within circular diagrams. The boxes represent the issues identified by the actors on the counter part organization. The double line boxes, which are represented at the bottom of the diagram are framework conditions and the other conditions which are beyond direct control of the actors or sites.

Once the issues identified through the analysis are allocated to the relevant boxes and ellipses as indicated in the figure 8.1 , it helps to identify the following for each type of organization,

1. Issues which are under both internal and external causes (Issue set A)
2. Issues which are under internal causes only (Issue set B)
3. Issues which are under external causes only (Issue set C)

Accordingly, the issues sets which can be developed for each type of organization are shown in Table 8.15

Although these sets of issues can face difficulties to generalize in the light of differences in organizations with a specific type of organization, differences for different sectors of the economy and differences in the contents within the same issue, it can be used as a checklist of issues for each organization to see how they deal with the micro level conditions. In this context, it is useful to apply these sets of issues in the real organizational setting to evaluate how they perform.

Hence, the application of the above sets of issues is expected to test four new forms of organizations established for promoting interactions. The details of the application of these to a case study from each area – industry, university and research institutes – are described in the following chapter.

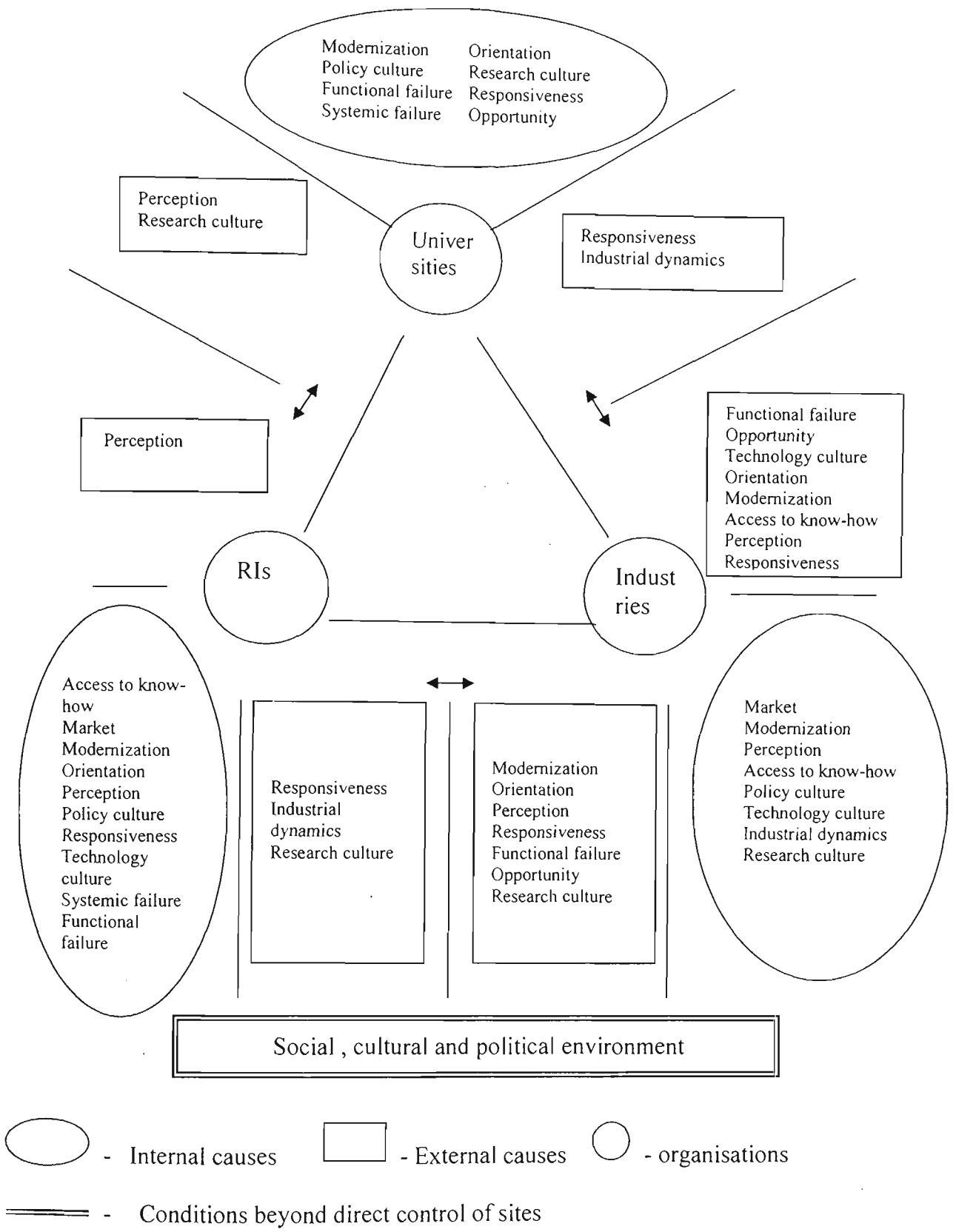


Figure 8. 2 Diagram of internal and external concerns of micro level issues for different types of organizations.

Table 8. 15 Three sets of issues (A,B & C) for each type of organisation

Type of organization	Issues set A	Issues set B	Issue set C
Universities	Modernization Orientation Functional failure Responsiveness Systemic failure Opportunity	Policy culture Research culture Systemic failure	Perception Access to knowledge
Industries	Industrial dynamics Research culture	Access to knowledge Market culture Modernization Perception Policy culture Technology culture	Responsiveness
Research Institutes	Modernization Orientation Perception Responsiveness Functional failure Opportunity Research culture	Access to knowledge Market culture Policy culture Technology culture Systemic failure	

Chapter nine – Case studies

9.0 Introduction

Chapters seven & eight discussed the major framework and process related issues prevailing in universities, research institutions and industries. Conditions such as need for funding, flexibility, lack of incentives, lack facilities in universities and research institutions, and need for change of mandates of public institutions to facilitate commercial activities, are highlighted as framework conditions to promote relationships (see chapter seven for details). Issues such as modernization, orientation, perception, responsiveness, functional failure opportunity and research were highlighted as important micro level conditions in the previous chapter. These two chapters illustrate that each type of organization possess a set of framework and micro level related weaknesses. According to figure 8.2, internal causes suggest that the respondents are well aware of their own micro level weaknesses.

In this context, it was investigated how different sites reacted to those weaknesses. Chapter nine deals with a few such examples from the URI system in Sri Lanka, in which these institutions tried to overcome negative features with respect to relationships by the evolution of new forms of organizations. This chapter will discuss how these new form of organizations manage with the framework conditions and micro-level conditions which were revealed in the previous two chapters.

In this context, I consider at least one example from each type of organization for discussion. The focus on industry-institution interactions is taken as the major criteria for selection of the example. Likewise the following examples were selected for discussion in the thesis.

Name of organization	Type of Organization
1. Agro Business Centre (ABC)	Centre in the University sector
2. Agro Enterprise Development & Information Service Centre (AgEDIS)	Centre in a research institution.
3. Protected Agricultural Entrepreneurs Association (PAEA)	Industrial Association
4. University-Industry Interaction Cell (UIIC)	Cell in the University sector
5. Foundation for Innovation & Technology Transfer (FITT)	Foundation attached to Indian Institute of Technology, New Delhi

The persons in charge of these organizations were interviewed. They were informed about the purpose of the interview and advised that the case of their organization would be taken as an example in the thesis. They were very willing to participate and cooperate throughout the interview. Interviews were conducted in a relaxed atmosphere.

Interviews were tape-recorded and subsequently transcribed. Notes were made on the printed copies of the interview notes. Each case was written to highlight the ways that those organizations attempted to overcome the weaknesses of the relevant type of organization. For example, AbC is established as a Centre in the Faculty of Agriculture of the University of Peradeniya. We tend to investigate how AbC has overcome the weaknesses of the university set up which are highlighted in chapters seven and eight. The write-ups were sent back to the interviewees for comments and verifications. Accordingly the final write-ups are given below.

Finally a similar case from India (i.e. Foundation for Innovation and Technology Transfer of Indian Institute of Technology in New Delhi) was taken for comparative purposes with an example taken from Sri Lanka.

9.1 Agri-business Centre (AbC)

9.1.1 Introduction

The AbC can be considered as one of the new forms of organization, which has evolved in response to the contemporary need to market knowledge by interacting with industry. The AbC was established in 1997, within the organizational framework of the University of Peradeniya, with the objective of capitalizing on the knowledge base in the faculty of Agriculture and promoting interactions with industry. The Faculty felt the lack of interactions with the private sector and the main goal of AbC is to improve interactions through which the faculty expects "to understand the problems of the industry and on the other hand to train graduates to meet those needs"(interviewee IN39)[33]. AbC is not set up under an act of Parliament as an organization but is registered with the University Council. AbC is managed by its' Management and Coordinating Committees and chaired by the Dean/Faculty of Agriculture. A Director, assisted by an Office Manager and an Administrative Secretary, manages the centre.

9.1.2 Need for establishment

The Faculty is the largest Agricultural Faculty in Sri Lanka with almost one hundred staff members with Doctoral qualifications in a variety of agriculture related disciplines. Almost all of these doctoral qualifications have been obtained from abroad. The AbC feels that the knowledge of the faculty remains unexploited, and do not want to waste this resource and hence wanted to embark on promoting collaborative research and a consultancy culture in the faculty in a deliberate manner. The AbC has evolved to fulfil that need.

9.1.3 Resources, strategies and competitive advantages

The Centre is not block funded either by any external funding organization or the university. The university provides the infrastructure and related facilities. Also, it

[33] Interviewee is the director of the AbC who has taken the initiative to establish the AbC.

allows the Director to perform his functions while performing his academic responsibilities in the faculty. The AbC staff is maintained from the project funds of international collaborative research projects (although these funds can be categorized as external funds, they are more suitably considered as earned funds), which are offered to the AbC through consultancies and research projects. The major benefit of the centre is it's ability to form project teams to look into a particular problem. The members for the project teams are mainly from the human resource pool of the faculty. In cases where the intellectual resources in the faculty are not available, AbC has capability to contract out resource persons from the university or any other source such as research institutions. In other words, it promotes a multidisciplinary approach. The AbC maintains an open relationship with colleagues of the faculty but creates awareness of their existence and benefits. It believes that the attractive features of AbC are the simplicity of procedures including payments, validity & recognition of academic standards(i.e. for promotional benefits) of the work done through AbC and less processing time & effort to carry out the work.

The academia have their shown desire to utilise AbC to expand the usability of the academic resources of the faculty. By doing so, they expect to gain benefits such as making themselves known to others while making their individual consultancies count towards their promotional benefits. In this context, the AbC seems to be a very useful instrument for academic members who are new to consultancies to make themselves known to potential clients.

9.1.4 Progress & achievements

AbC has gradually increased undertaking consultancies mainly through the contacts and the commitment of the Director. The annual turnover is expected at Rs 10m (approximately 0.1m US$) with which the centre is capable of self sustainenance. At the time of the investigation, there were ten ongoing consultancies inclusive of one training programme, two business plan and seven contract research projects. More than 22 academics from the faculty were involved in these ongoing programmes.

Apart from the significant progress made during the short period of 4-5 years, AbC, through its continuous efforts, strategically achieved a workable arrangement to overcome bureaucratic hurdles in rules and regulations of the institution. The process of getting things arranged is dealt with understanding & tolerating the situation, and provision of monetary benefits to those who are "processing AbC dealings". According to AbC such motivations are essential to get workable arrangements within the broader framework of rules and regulations. The AbC emphasizes that personal qualities also matter to plan the workable arrangements.

9.1.5 Future plans

During the last five years of operation, the organizational form/structure has remained stable. The centre still manages with the existing infrastructure and organizational framework but with increasing workload and workable arrangements in favour of efficient and effective functioning of the centre. In response to the question about any changes that the director perceives in the organization of the AbC, he seems to be adopting a perception that necessary changes will evolve to meet environmental changes from time to time. In the present context, the main focus is on research and consultancy through which people are brought together. However, up to now very little has been achieved in the sphere of industrial placement and career development of students but, expansion of the scope to integrate career guidance for students is being considered. (Indirectly done in the present context).

It was noted that there is a suggestion to convert AbC into a university company. The AbC seems to have a perception that the fully fledged commercial based organizational form would not be suitable for universities as it does not need that level of formality. However the Director strongly feels that the centre should be given more decision-making autonomy. It should not transform into a Company, as it needs additional and different kinds of personal to operate in a different culture. The Director feels that the company requirements and responsibilities add burden to academic freedom.

AbC has so far developed research-based relationships with foreign universities, international organizations, local government organizations, NGOs, private industrial associations and individual firms. AbC is represented in the National Chamber of Commerce of Sri Lanka but partnerships with individual firms are yet to come. The Director greatly believes in personal contacts for industrial relationships.

AbC seems to be patiently working towards what they want to achieve. It believes that ambitions to become one of the best consultancy centres in SL in Agriculture related areas can be achieved through a gradual process and by convincing those in the industry.

9.1.6 Issues that need attention

Instead of many positive factors, such as reputation of the university and context of the intellectual capacity of the faculty, the ABC believes that distance to the places where the industry are in operation has become a negative factor for its growth. The education & training related matters are dealt with at a low key. However, the weaknesses in the micro level issues are well addressed by the AbC probably due to the keen interest and commitment of the Director. The increase of the workload and the repeated appearance of the same clients show evidence for the success in the performance of the AbC. The AbC was able to establish a workable arrangement on financial matters within the rigid financial regulations of the university. The AbC has felt that individuals in the system of support services are not cooperative enough and sometimes the reason for such behaviour may be an ego problem. They need to feel as having authority. Or else they may just want to avoid additional work. But these attitudes can be changed if they also get some benefits out of the system. They should be considered as a part of the beneficiaries. In this context, it was informed that all the financial statements are prepared within the AbC, but an accounting person of the university, who comes to AbC to put his signature, gives the final approval. The AbC pays a little compensation for his visit and signature. Also, it was noted that one of the national research institutions has agreed to oversee the financial matters of some foreign funded projects through the AbC due to the

financial flexibility it enjoys. AbC seems to be a nurturing ground for the academia to interact with industry, based on intellectual resources as the main criteria.

9.1.7 Conclusion

The establishment of the AbC itself can be regarded as a step to overcome the systemic failure that the universities in Sri Lanka undergo. Fulltime staff for administration of functions, more autonomy in financial control and facilitation of consultancy work of the are a few attributes of AbC aimed to overcome systemic failures. The AbC can be taken as an example of reducing functional failures and orienting themselves to respond to needs and seek opportunity for development through interactions. In this process, AbC has taken steps (responded) to modernize its functions to speed up performance and attract clients. They have made this knowledge base more accessible to users. It performs a role of promoting and managing the research of the faculty that was done before mostly on an individual basis. Increased numbers of consultancies and workload provides evidence for better management of the functions expected from a university domain.

The above suggests that AbC was in control of the issue set A and the issue set B. However, there was no evidence for any positive action taken to overcome the issues related to negative perception. One can argue that the steps taken to overcome issue set A and B will automatically act as a path to overcome the issue set C. Student based issues and lack of industry orientation were seen as the reasons for negative perceptions on universities. In this context, the steps taken by AbC are rather passive. AbC needs to expand its functions to deal with student based industry related R&D activities where it may be useful for them to be careful about the perceptions of industrialists on the students.

Finally, it is useful to reiterate that issues related to Intellectual Property, which are crucial in product/ process related R&D projects, are inadequately addressed by the AbC.

9.2 Agro Enterprise Development & Information Service Centre (AgEDIS)

"One stop service centre for Agro-business"

9.2.1 Introduction

The Department of Agriculture (DOA) is the largest state run agricultural research organization in the country. In 1997, DOA established AgEDIS as a one stop service centre, within its organizational framework, with a mission to promote a Public-Private partnership for Agro Enterprises Development for Agricultural Prosperity in Sri Lanka. It was established to fulfil the social requirement to interact with the private sector. The centre has identified the existing and potential agro based entrepreneurs and organizations that are seeking technical assistance and related information to improve their productivity and quality as the target group. The main function of the centre is to exchange information with the private sector about the technologies available at DOA and workout the technological needs of the private sector. The centre also plays the role of an intermediary as a information (Technology) provider. It also plays a passive role for linking the user and the producer of technology based information when the producer is not DOA. The centre even undertakes research (to be done in DOA) for private entrepreneurs and provides various services including provision of marketing information and designing labels for the products. Earlier these functions were scattered among various divisions of the DOA and obviously may have experienced many bureaucratic hurdles due to compartmentalization of divisions.

9.2.2 Need for establishment

The DOA has a vast resource base in terms of human capital and research capabilities. However, it was under pressure from both the state and society for lack of effectiveness, irrelevance and low level of interactions with the private sector. DOA was also blamed for not providing technological back-up services to the private sector and for not working on private sector needs and problems. Hence, there was a need for the DOA to utilize the resource through more industry orientation. However, the existing structures and bureaucratic barriers prevented

them from becoming closer to users. Hence, the new form of organization was established to perform the function of bridging the gap between the DOA and the industry sector.

9.2.3 Resources, strategies and competitive advantages

A senior research officer of the DOA heads the centre The staff consists of five fully qualified technical officers and secretariat staff. It has strategically organized in five major areas: Agro processing, Pre and Post harvest losses Prevention, Protected agriculture, Agricultural information collection and dissemination, and Seed and planting materials production promotion. The technical officer deals with matters in each of these areas. The computer based information system on technology and related matters is being developed to facilitate and make their work more efficient. The centre has identified areas in which the private sector would like to be involved. The major step taken by the DOA through AgEDIS is to give due attention to processing, marketing and market extension which were not there earlier. "We started this unit to go in that direction. We have developed that environment, developed the infrastructure. Now, all what were hidden are coming out"(interviewee IN38)[34]. The centre is also involved in market surveys and tries out productions based on market needs using the DOA technologies. " DOA was not thought about some of the things, but we have to fulfil the demand". Although it is functioning under the rules & regulations of the DOA, adequate liberalization has been granted to perform it's functions effectively. This includes administration and financial flexibility, a prestige, which seems not available to other divisions of the DOA.

9.2.4 Progress & achievements

The services of the centre are provided to a wide range of customers but mostly limited to SMEs. The AgEDIS has a legitimate mandate and potential to outreach and fulfil customer requirements. The AgEDIS sees that the customers who are

[34] Interviewee is the Director of the AgEDIS

coming to them are educated people and "they can capture what we give". AgEDIS has also organized a forum for interactions with the private sector. The major impact seems to be that the AgEDIS was able to convert the existing knowledge of DOA into transferable knowledge. As a result, it plays a catalysing role for knowledge transformation. AgEDIS has changed some traditional practices of the DOA such as conducting training programmes. It identifies the themes for training, based on the market demand and previous years statistics. The training programmes are advertised now, instead of the previous approach to call nominations from district agricultural extension officers. This change has enabled them to deliver the training programmes to the people who really need it. Also, these programmes are now fee based (to cover the cost), instead of the free of charge programmes conducted earlier.

AgEDIS has developed its outlook different to a usual public sector organization. One interviewee claimed, "The people who come here have mentioned that they can not think that they have come to a government institution". However, the interviewee was reluctant to comment about the promptness of the DOA, which suggests the continued existence of bureaucratic culture in the main organization.

The centre has developed links with various public sector organizations, banks and industrial associations. The interviewee believes that "this place has very good fortune, because this is what is required nowadays". AgEDIS is ready to collaborate with any other organization and compete with private sector. AgEDIS believes that multi actor competition brings quality outcome.

The centre sees that the present public policies related to agriculture are favourable and guiding. It gives more weight for agro enterprises. Even research functions can be encouraged in the private sector for competition. With respect to the debate about disconnection of policy directions and implementation, he says that "Implementers need to understand their role as implementers. AgEDIS has bottom up mechanisms to make them aware and convince the decision makers. Need for collaboration and team work has been accepted by the policy". Such attitudes and commitments seem

to be encouraging in terms of promotion of relationships. However, the interviewee sees that AgEDIS is still not popular because it is a part of the government organization.

9.2.5 Future Plans

Evolution of the AgEDIS is felt as timely. "Nobody can escape. It is a need of the time. You need to understand the requirements and adapt to fulfil the requirement". AgEDIS has positive thinking and commitment to approach the private sector, which they have done successfully within a short period. However, it still has a non-profit making, service-oriented mindset. Its marketing approach seems to be absent, probably due to traditional culture of providing services by the government organizations at no cost/free of charge. Apart from that, the centre does not have any specific plan for the future rather than carrying out the new functions more efficiently and effectively. Probably, it is too early to think about new plans before exploiting fully what the new organization can perform.

9.2.6 Issues that need attention & conclusions

This case shows that the government research organization has understood the current needs and oriented them to capture the opportunities. AgEDIS, the new form of organization has evolved to fulfil the requirement within the existing framework with a view to provide the services to the users at one place reducing the bureaucratic hurdles. The financial flexibility (although limited) enjoyed by the Centre seems to be adequate to perform the existing functions. The attitudes and thinking of the leaders of the new form of organization seems capable enough to change the negative perception about the RIS by industrialists and the society in general. Demand-driven approaches and subsequent product development approaches of AgEDIS are encouraging. However, the centre is still at growth stages and any significant impact on the relationships seems too early to measure. Despite, it was noted that many products have been developed through back up support from the centre.

This shows that the AgEDIS has taken steps to overcome the issue set A. However, there is no evidence to show any steps taken to deal with issues related to issue set B such as market failure, technology culture and systemic failure. It seems those issues are beyond direct control of the Center.

9.3 Protected Agricultural Entrepreneurs Association (PAEA)

9.3.1 Introduction

The PAEA is an association of agro business enterprises formed in 1997 under the partial sponsorship of a USAID project (one of the 15 associations formed by the project). The project provided technology and an opportunity to find markets for the associations whist covering 50 per cent of cost. The Project also provided the associations with international exposure in terms of participation at exhibitions/ trade fairs.

The association consists of a variety and diversity of members from growers, researchers, service providers, suppliers, entrepreneurs and exporters. The membership has grown in numbers from 22 in 1997 to 174 in 2003. Almost all members have good educational backgrounds. Attributes such as qualified membership, diversity of membership and growth have enhanced the credibility of the association to function as a professional body.

9.3.2 Need for establishment

The objectives of the PAEA are to bring stakeholders involved in promotion and development of Controlled Environment Agriculture (CEA) in to one forum and to collectively address issues pertaining to production, processing, marketing, quality control, R&D and other issues related to CEA. One of the objectives of the association is to enhance the voice of industry for its benefits. To achieve this, the association is involved in lobbying government. If the members are powerful and possess personal contacts with decision makers, lobbying is done through personal contacts. Otherwise, lobbying is undertaken in the form of increasing public opinion

while making people aware of issues. In this context, seminars/ workshops, and press releases take place as a form of activity. The association also organizes forums to people together, speaks for the industry and lobby's where necessary. These events are organized during government budget time. The association rejects lobbying in the form of "Gift giving".

9.3.3 Resources, strategies and competitive advantage

The association feels that members and the technological knowledge of the association as the major competitive advantages. The association needs to strategically face market challenges. The members cooperate in this process as the association was able to help members develop attributes namely sincerity, integrity and motivation. PAEA delivers the products from its members to supermarkets country-wide.

9.3.4 Progress & achievements

It seems that the association has succeeded in many instances of lobbying such as on issues related to tariffs on imported items for greenhouses. The association also organizes pre-targeted seminars where politicians and officials are invited to attend. These seminars usually focus on creation of awareness, provision of information and bringing up the issues that they need to focus on. The association believes that they have been able to impress target groups. At the events from which favourable responses were not received, politicians and decision makers were tolerated: "The association did not want to agitate." The association feels that the negotiation process needs patience and waits for the environment to become conducive. These were two attributes contained within the
"Plan for a long journey."

The formation of an association with diversity of members is a new concept in Sri Lanka. The attitudes of the members are different to the traditional union attitudes. But "Some members feel it as a trade union. New thoughts are still not there. People

are not used to this culture". "When we are discussing one point, people do not wait, most of them do not listen, they like to talk. You must respect other person's point of view. They try to attack the other person mainly because of various political influences".

They need to work together at one level while competing with each other at another. "Our society is not quite acceptable, shall we say, they do not perceive this idea of working together". However, "the attitudes are being changed". The association has organized various workshops and educational programmes, discussing productivity, quality and how they should corporate, in this process of changing attitudes. The reasons for such attitudinal behaviour could be due to the hierarchical society, which is production oriented and centrally planned and inherited from earlier times. The decisions are always top down and a lot of politicisation is involved.

The association has been able to achieve many favourable policy changes through lobbying. For example, tariff reduction on imported items for intensive agriculture system was quoted as an achievement by the interviewee. The association feels that it is getting closer with the government RIs and Universities.

> "They are increasingly cooperative. The perception of the Government, research organization about research needs to be changed. They perceive a sense of ownership of research. Now those boundaries need to be broken and the private sector should also be able to deal with research. Government needs to develop sectoral and research policies. Public sector researchers who possess knowledge and experience should be promoted to cross over to the private sector. They need to be exposed to a business culture, where they can convert the research in to some kind of income or product, in a short period. The public sector needs to be reoriented towards that direction."

9.3.5 Issues that need attention

One interviewee(IN) has the opinion that the private sector also needs to be improved. "Most of them are short-term profit oriented". In this context, the association plays the role of intermediary to change the orientation of the industries. This interviewee commented that, "People should look for new ways countrywise. This sort of thing has not got into the people who are involved in the system. System needs to be reoriented to compete. Lessons can be learnt from cricket."

9.3.6 Conclusion

The case of PAEA shows that many of the comments of academia and the researchers on lack of capabilities, facilities, manpower, understanding of basics and industry not being strong enough to address development activities are well addressed. One of the comments addressed the need to improve the knowledge base of industries. The PAEA reported that members of the association are qualified people. They have at least a diploma and most have degrees. Apart from that, PAEA conducts regular training sessions for its members. Also, contacts with the government research institutions (interviewee IN who is currently working as the consultant to the PAEA has worked as a researcher for the DOA) provide evidence for the strengthened nature of the knowledge base.

Also, the small and medium agro business sector seems to have gained strength by coming together to form an association. The grouping for lobbying policy issues provides evidence for steps taken to overcome issues related to policy culture. It was noted that the number of members is gradually increasing.

The market segmentation approach shows evidence for taking steps to avoid general problems of purchasing power of consumers. Incorporation of researchers as members of the association and conduct of research is evidence of steps taken to overcome problems related to both perception and research culture.

This evidence shows that PAEA has taken steps to overcome most of the issues related to issue sets A and B. The empirical evidence does not give evidence for steps taken to overcome issue on "responsiveness" which is under issue set C. Rather than the participation by officers of the PAEA at meetings, seminars and conferences organized by universities and research institutions (passive action), any positive action towards enhancing "responsiveness" was not revealed during the interviews. This means private industries are still weak in responding to the issues related to issue set C.

9.4 University Industry Interaction Cell (UIIC)

9.4.1 Introduction

The University of Moratuwa is one of best technical universities in Sri Lanka, comprising of an Engineering faculty ,an Architecture faculty and an Information Technology Faculty. It has about 3000 students from all around the country. The mission of the University of Moratuwa is to be an internationally recognized center of excellence in higher learning, research, consultancy and other professional activities in Engineering, Architecture and allied professional fields by creating an environment conducive to nurturing the inquiring mind and developing skills for a diversity of challenges, and thus to be a leader in contributing to sustainable scientific, technological, social and economic development of Sri Lanka. (http://www.mrt.ac.lk 2003).

9.4.2 Need for establishment

In its brief history, the university (35 years) has encountered several changes to suit the national needs of the country. However, these changes seem to be mostly education and training based changes in engineering and technical education. The changes towards promoting industry partnerships were limited to industrial training and individual consultancies (in certain disciplines) until the University Industry Interaction Cell (UIIC) was established in 2001. UIIC was realised as a result of the

S&T Personnel Development project of the Ministry of Science & Technology in Sri Lanka.

9.4.3 Resources, Strategies and completive advantages

The UIIC is headed by a full time manageress under the supervision and guidance of the Dean of the Faculty of Engineering and the senior academic member who act as a part-time Chairman of the cell. The office of UIIC is located within the university premises. The Cell is funded by the STPD project for a period of two years. The project support included the recurrent cost of running the cell for two years and the initial capital to establish the cell as a project office.

The activities of the Faculty of Engineering before the establishment of UIIC were limited to industrial training, individual consultancies (in a limited number of disciplines) and some initiatives towards promoting partnerships which were operated at a low key. UIIC has started with organizing seminars and workshops to attract the notice of industrialists. Before the UIIC was established, staff members had to deal with all academic and administrative matters connected to such seminars and workshops, which "they did not enjoy". Prior to this the university charged very nominal fees to cover the cost of the seminars that were usually held on University premises. Now, the UIIC is able to do the same function by arranging it in the city and charging a higher rate and providing a very good venue, facilities and refreshments. This process is reported as "taking the faculty up market" by interviewees (IN60)[35] & (IN61).

Interviewee (IN61)[36] expressed that "When I came, I was given the guideline that I should work on seminars. What we did was, we made seminars workshops, short courses kind of things as the initial test to interact with industry." "Up to December we had 6 seminars, mainly from departments, which have never done a short course

[35] Interviewee is the Dean of the Faculty
[36] Interviewee is the manageress of the IIC

or a seminar. With these seminars, we are breaking ground which the faculty has not broken before ".

This shows the UIIC is orientated to use seminars and short courses to take the opportunity to interact with industry (responsiveness) and transferring their knowledge base in a usable form, which was not done before. It seems the cell makes adequate profits from this knowledge transfer mechanism. "We organize it in such a way because we have to be self financed. ADB will carry us only up to a certain point, and then we have to be self financed." During the short period of its existence (8 months) it is reported that UIIC has produced "Very good results"(IN60) . The UIIC is expected to be self-financing after one year of operation. However, the ADB has agreed to support the second year also, for which the sustainability of the UIIC will depend on its performance of the second year. One of the main reasons used for its success is leadership.

Apart from that, the UIIC has realized how cultural factors are affecting their initiatives. "What we are realizing is people have to be spoken to. Sri Lankan people are backward in coming forward ". Hence, it needs event specific market approaches where a lot of personal contacts are involved.

During the seminars, UIIC conducts on the spot evaluation as a strategy to check whether their delivery satisfy the customers. On the spot evaluation (quality control) can be regarded as a desire to minimize the functional failures. "As soon as we realize the participants are unhappy, we address it immediately. We go to coordinator who is a academia from the faculty and say, the participant's expectation is this, level of study is this , can we do something about this".

9.4.4 Progress & achievements

The impact of the establishment is seen in terms of quantity, quality and scope. Now, the UIIC has a target of 96 seminars, workshops and short courses for industry per year compared to a few number of such seminars and workshops arranged

before. The university departments who have not undertaken any such activity before are now arranging seminars and workshops. Also, the cell now earns a substantial amount[37] of money that is capable of running the cell without outside funds or university funds. Finally, it seems the Cell has received a reputation in the industry as the contacting point for interactions.

9.4.5 Future Plans

After the initial session of interactions with the industries through seminars and workshops, the UIIC also plans to take steps to address research needs of the industry.

> "We have lot of things that I can't tell you. Which are confidential also. There are certain organizations very closely linked with UOM through UIIC on very specific things. It is very valuable for our country. For that respect, there is a lot of research potential. People are coming to us with research ideas. Once the research ideas are evolved, the UIIC forms a project team across the university, bringing all the experts in relevant field. We bring experts in (from the faculty) and work together ".

However, it was noted that, the multidisciplinary research approach appears to be functioning at a low key at present. In this context interviewee(IN61) claimed that " it is coming because industry is responding, I see faculty responding. To me these signals are good future things". According to her, the university possesses many research reports that are lying on the shelves. " Next step if you ask, is to see that, commercialize some of the research that the university students and faculty have done. " However, it seems this needs extra effort and careful selection process.

> " It is a slow process. Nobody knows how exactly to get across. We are working on it. We are looking at what is available and how to use it. I have done lot of homework in that respect. It might be in one or two areas".

[37] Interviewee did not want to give figures.

On the other hand UIIC plans to promote MSc (by research) courses which is one of the drawback areas in Sri Lanka.

> "We have spoken to some organizations who are willing to support MSc research. The student can be from the industry or from outside, who can be placed in industry or university doing this particular research which is relevant to that company. So we got one or two requests immediately. We plan to cultivate that approach. It seems UIIC has identified the potential of the underutilized knowledge base in terms of intellectual capacity and research."

9.4.6 Issues that need attention & Conclusions

The establishment of UIIC itself can also be considered as a step taken to overcome the problems of systemic failure of universities by orienting to new ways of doing things (market approach). UIIC has intelligently captured the market opportunity for knowledge transfer through seminars, workshops and short courses. Also, it seems the UIIC has taken care to avoid the "lack of promptness": generic problems which can be seen in universities. " Industries are finding their ground with us. What I say is, I ask them to write to my email, I forward it to the respective department, I also give the respective person the particular contact that I made. Within 24 hrs- 48 hrs, I respond to email. I am from the service sector. So, I believe service is very important." This statement also shows the consideration of importance of different qualities, such as customer orientation and marketing approaches, to be integrated in to the university system. " I do a lot of the cost management and everything, in the particular programme. What we also do is, when it is a corporate programme, we give a special package. So, we are working in a very business oriented way, with industry. "

The UIIC seems to have the much-needed commitment towards the task.

> "Well we have been entrusted a job task. We are doing our very best as a team. Staff is committed towards the task. Our days are not 8(am) to 5(pm). When we have workshops and seminars we work till 9.30(pm). So, we have

private sector outlook in our work. And we believe when we do some thing good it is sort of job satisfaction. What ever we do, we try to deliver our best".

This evidence shows that UIIC determined and practiced in such a way that functional failures do not appear in the cell and the perception on UIIC became positive. However, UIIC has still not taken solid steps to respond to the problems related to research culture. It is clear that UIIC is not geared to step into those aspects within its existence for a short period. The evidence shows that UIIC would step into these areas in the future.

These evidence shows that UIIC has already taken steps to address almost all the issues related to issue sets A, B and C, except the issue on research culture which is in the pipe line.

9.5 Foundation for Innovation and Technology Transfer (FITT)

9.5.1 Introduction

The Foundation for innovation and Technology Transfer (FITT) was registered as a society by the Indian Institute of Technology, Delhi (IITD) in 1992. The mission of FITT is "to be an effective interface with the industry to foster, promote and sustain commercialization of Science and Technology in the institute for mutual benefits".

9.5.2 Need for establishment

The first and foremost principal objective of FITT is promoting interaction between academia and industry in a proactive manner to create a greater measure of trust and collaborative work, which benefits both. Right from its inception, FITT has been directing its efforts as an effective interface between academia and industry by marketing the "intellectual ware" of IITD to industry on competitive terms and injecting industrial relevance to IITD's teaching and research activities.

9.5.3 Strategies

FITT offers a number of flexible modes and mechanisms in IITD for enhancing interactions with industry –leading to technology transfer. These include faculty visits to the industry, visits from industry to IITD, participation in industry exhibitions and presentations to industry associations, special and customized continuing education programs and technology development/R&D oriented consultancy projects.

FITT utilizes all the resources and infrastructure of IITD without duplicating it. More than 440 faculty scientists and researchers are the potential contributors to R&D and technology development efforts leading to technology transfer in FITT. However, teaching and research supervision being their primary activity, in any given year typically 15 to 20 % of the faculty is involved in work with industry. FITT can avail the additional services from both public and private institutes outside IITD to complement those available from IITD.

9.5.4 Progress and achievements

FITT has been in the forefront of facilitating the change process in IITD by giving boost to some of its programs and starting some new initiatives. FITT has enhanced efforts towards safeguarding intellectual Property Rights (IPR) of faculty and researchers of the institute, through measures like seminars /clinics to increase the awareness among the faculty and researchers, and streamlining the processing of IPR applications. To encourage entrepreneurship based technological innovation, a partnership mechanisms is evolving at the institute in the form of Technology Business Incubation Unit (TBIU) program in the IIT campus with FITT acting as its administrator.

FITT has been taking proactive steps in protecting IPR for technologies developed by IITD faculty and students. FITT had processed and filed 108 IPR applications

since April 1998 to 2000, which include Patent, Design, and Copyright applications. In 2000-01 , 12 IPR applications were filed. Since April 2001 FITT has facilitated three technology transfer agreements with industry clients at a total value of Rs 23 lakhs. FITT facilitated short and medium term consultancies, and executed them effectively. During the year 2001-02, more than 254 projects were undertaken. After the review mission FITT has decided to drop consultancy assignments involving evaluation, testing, vetting of design, advice. FITT will handle those projects from industry that involve investigation and R&D input and have the potentiality of technology development and transfer.

Continuing education for industry has been a sustained activity as an important focus area of FITT and a means to initiate projects on technology development and transfer. During the year 2001-02 eighteen programmes were conducted.

FITT initiated a corporate membership program at which about 80 industries have become corporate members. Corporate membership is given a 10% concession in the participation fee in HRD programs organized under FITT. Also, they are offered access to published information on technologies, patent information searchers, information about seminars and meetings held in IITD or elsewhere and FITT-Forum newsletter.

9.5.5 Future plans

Recently, FITT reviewed its' functions and it changed its' attention on facilitation of IPR protection for IITD faculty, identification and marketing of IITD technologies, organize exhibitions, administration of TBIU and management of consortium projects of groups of industries. In addition, FITT will take projects from industry aimed at development of technology involving investigation and research inputs having potential for technology transfer. FITT will also develop and manage special, long term and customized HRD programmes for industry or group of industry clients.

Technology Business Incubator Unit (TBIU) is being established at IITD under the ICICI/World Bank Fund with objectives to promote partnership with new technology entrepreneurs and start-up companies. It seems successful examples in developed countries have motivated IITD to propose this establishment. Some of the lessons learnt from developed countries seem to

a) Emphasize on assisting new start-up entrepreneurs and spin-offs from the universities
b) Management of the organization in an autonomous mode.
c) Provision of variety of assistance packages to promote the development needs of specialized technical help
d) Access to venture capital
e) Emphasize on R&D

An order of priorities for eligibility and administration criteria have been developed. Applications for admission are short-listed based on these criteria. Among them, entrepreneurial capability (technological education & experience) and R&D intensity were also considered. FITT is responsible for overall administration of the TBIU and management of its common facilities. The capital cost of infrastructure was borne by IITD. However, recurrent costs connected to maintenance of infrastructure and facilities are to be borne by FITT whose charter permits such expenditure from its funds. FITT also facilitates marketing of TBIU among potential clients and dissemination of information to industry associations, government departments and sister organizations, financial institutes and venture capital companies, etc.

9.5.6 Comments & conclusions

FITT has commenced with the objective of capitalizing on the knowledge base of IITD. Maintenance of the trust and collaborative work seems to be major approaches while transferring the teaching and research activities towards industrial relevance. Many channels have been used to get close to the industries and to initiate interactions. Education based programs still play a major role as a means to initiate

interactions. FITT seems to have taken the role of facilitator where the academia shows lapses in doing so on an individual basis.

The significance of FITT seems to be its effectiveness in terms of IP, HRD programmes for industry. TBIU, which is a new concept, is expected to provide impetus to developing an entrepreneurial culture in academia.

The statement made by the Director of the FITT "i.e.I always bend the regulations, some people say that I bend them too much so that it might break" shows an indication about the management capabilities of FITT. He added, "Not all are interested in interactions with industry. We can't expect that ". This indicates the ability of FITT to understand the academic culture, and the process of selection and identification of opportunity that is the key to take the FITT into a maturity stages.

9.6 Summary

The above cases taken from university, industry and research environments show the evolution of new forms of organizational structures to facilitate dynamic interactive process. Chapter seven has identified framework conditions that affect the interactions. Firstly, most of the framework conditions such as incentive, funding by the government, mandates & organizational reforms, policy directions, new system, rules and regulation are outside the reach of the actors involved in these new forms of organizations. However, these organizations are capable of lobbying for those framework conditions (e.g. PAEA lobbying tariff relief and AbC lobbying for workable set of rules and regulations). Secondly, these new form of organizations can make an impact on the creation of the other framework conditions such as IP culture, quality consciousness, development of skills in terms of capitalizing on existing knowledge, improve facilities and facilitate information flow. A summary of actions taken by these new forms of organizations against framework conditions is given in Table 9.1.

With respect to micro-level conditions, Chapter eight has identified three sets of concerns for each type of organization.

Table 9. 1 Overview of reaction to framework conditions and micro level conditions by the new forms of organizations

Condition	AbC	PAEA	AgEDIS	UIIC	FITT
Framework conditions					
Funding	Generate funds through contract research	Generate funds through membership	Government block allocation	Generate funds but initially supported by project funds	Generate funds from several activities including licensing and consultations
Incentives	Outside the control of the new forms of organizations				
New systems	Not applicable as the hybrid organization itself is a new system				
Skills development	New knowledge generated through interactions are transferred to curriculum students	Regular seminars and workshops on productivity and management focus on enhancing entrepreneurship skills	Regular training programmes on agriculture technologies for the needed groups	Frequent demand driven training courses, seminars and workshops for industries	Long term and customized human resource development programmes for industry or group of industry clients.
Rules & regulations	financial incentives provided to those who authorize transactions.	Flexible as function as a private organization	Limited flexibility were given	Flexible granted by the University Council	"*Rules and regulations are bent not broken*"[38]
Improvement of Facilities	Contract research comes with new facilities which	Provide necessary technology know-how and	Utilize existing facilities as new facilities	Improve facilities of the Faculty by	Improve facilities of institutions

[38] Comment by the interviewee

	are not available at the Faculty	how to utilize to the member	are anticipated as not required at this stage	contributing to the faculty fund	
Mandate	New mandate expected	Not applicable	Operate within the mandate of mother organization with new objectives	Objectives and work to be performed are identified by the university	New objectives formulated to match the new challenges such as technology business incubation
Quality	No information available	No information available	No information available	Quality of service is maintained through on the spot evaluation at seminars and workshops	No information available
IP concerns	Not yet thought about	Not concerned as commercial applications are performed	Not concerned as work on existing technologies	Not yet thought about	Processing and filing IPR application is done
Communication	Concerned to keep personal contacts with partners despite lack of facilities	Regular meetings keeps members informed	Through mass media and public relations	Regular visits and other activities of the faculty keep counterparts informed	Continued education for industry , corporate membership program and industrial visits keeps the institute in touch with industry.

Policy direction	Limited impact as no participation in policy making process	Lobby for policy change	Keep policy makers aware of the required changes in policy directions (consider as a duty of the centre)	Limited impact as no participation in policy making process	Information not available. However, the CEO represent IITD at many policy making forums.

With respect to micro level conditions, I wish to bring the attention of the reader to the Table 8.15 where three sets of issues were identified for each type of organization. The issues in a set of issues vary according to the type of organization. For example, negative perception and access to know how falls under issues set C for universities where as only responsiveness falls under issues set C for industries.

As discussed in the above cases, it was observed that new forms have made less attempt to overcome issue set C (except UIIC), although action has been taken to overcome most of the issues related to issue set A and issue set B (described under each case above).

The above table shows that these new forms of organizations encompass remedial measures against the weaknesses perceive by the counterpart partner. In addition, these organizations show the features of the mode 2 operations as well as some features of the triple helix model. For example, the action taken to overcome issues related to issue set C and the existence of common issues between external causes and internal causes of each type of institutions shows evidence for the reflexive nature of influence of one type of organization on the other. In another example, UIIC and AbC form temporary multidisciplinary groups, when and where necessary to approach specific problems, which is a feature (trans-disciplinarily) of the mode 2 of knowledge production.

This shows that the new forms of organizations are capable of shaping the process related innovation process. This suggests that the public policy needs to encourage the establishment of such organizations.

Chapter ten - Conclusions

10.0 Introduction

The final chapter on "Conclusions" provides an overview of the thesis objectives, research objectives, hypothesis, synthesis of methods used and research findings, new knowledge generated from research, and policy recommendations for small developing countries to promote university industry research relationships. It also addresses the issues related to the extent which the research objectives have been achieved and areas needing further research in the future.

The major objectives of this thesis was to find whether the characteristics of university, research, industry relationships seen in industrialized countries can be seen in small developing countries and if the theoretical concepts developed in industrialized countries are appropriate for analysis of relationships in small developing countries. In this context, research objectives such as the characteristics of relationships in small developing countries, and reasons for existence of those characteristics were examined taking Sri Lanka as the case of study.

In this context, it was hypothesized that small developing countries indicate the lower end of short-term service and training based relationships. It was also hypothesized that innovation theories, which explain the existence of those characteristics, assume that fulfilment of framework conditions in the innovation process works automatically and hence pay little attention to micro level conditions. In this context, it was hypothesized that the mimicking nature of policy initiatives are inadequate for developing countries and that an understanding of the micro conditions is also important. The objectives of this thesis were extended to identify policy recommendations suitable for small developing countries through the analysis of framework conditions as well as micro level conditions.

10.1 Major characteristics

In order to address this issue, the research problem was divided into three major sections.

Firstly, with respect to the objective one of the thesis (i.e. to find whether the characteristics of university, research, industry relationships seen in the industrialized countries can be seen in small developing countries) the existing characteristics of the URI relationships were identified through a postal questionnaire survey sent to academics, researchers in research institutions and industrialists followed by quantitative analysis. The details of these characteristics are given in chapter six. The investigation of the characteristics in relation to small developing country itself is a new addition to the knowledge on URI relationships, due to a dearth of such information in the literature. The findings in this chapter concluded that the URI relationships are dominated by the education and training and service based relationships. The research-based relationships are very uncommon compared to other types of relationships. This finding is in agreement with the nature of relationships in large developing countries like India.

The findings concluded that personal contacts are more prominent in URI relationships in Sri Lanka. This again agrees with observations by OECD(1992) and observations of many other researchers such as Sutz (1998) who emphasized the importance of personal(informal) relationships. Institutional arrangements have low capabilities to take such initiatives and with person-oriented relationships being more prominent even in coordination and communication patterns. The only exception is that research institutions provide little institutional support in terms of coordinating, funding and communicating with activities among partners. This evidence lead to a preliminary conclusion on the non-existence of proper systemic mechanisms to promote relationships in the URI system in Sri Lanka.

10.2 Appropriateness of theoretical framework

Secondly, to achieve the second objective (i.e. to find whether the theoretical concepts developed in industrialized countries are appropriate for the analysis of

relationships in small developing countries) it was necessary to gather in-depth information related to existing relationships. Hence, respondents to the survey and a snowball sample of respondents were interviewed to gather in-depth information, and to look for explanation for the existence of such characteristics. The interview data was analysed qualitatively using the grounded theory approach. The interview data was handled using two analytical methods one with framework conditions and the other with micro level process conditions. The analysis and findings are discussed in chapters seven and eight respectively.

10.2.1 Framework conditions

With respect to framework conditions, inadequate funding, limited facilities in the S&T base, and lack of communication between the sites have been identified as major structural drawbacks in the Sri Lankan context. Limitations of the existing mandates of universities and research institutes, and lack of an understanding on quality and IP rights, retard research oriented structural relationships. What is evident in the promotional literature, specially with respect to the need for making available new targeted schemes to support the industrial innovations are corroborated by these findings. A list of such schemes in India and Sri Lanka is given in the table 10.1. This table shows the inadequacies and weaknesses of the NSI in Sri Lanka in terms of framework conditions. The absence of such framework conditions, and the under developed industrial research culture limits the scope of the URI relationships to education and training and services based relationships. The limited research based relationships are also restrained by mandate related constraints and IP and quality related constraints. This calls for public policy initiatives to develop programs focusing on remedial measures to overcome such weaknesses.

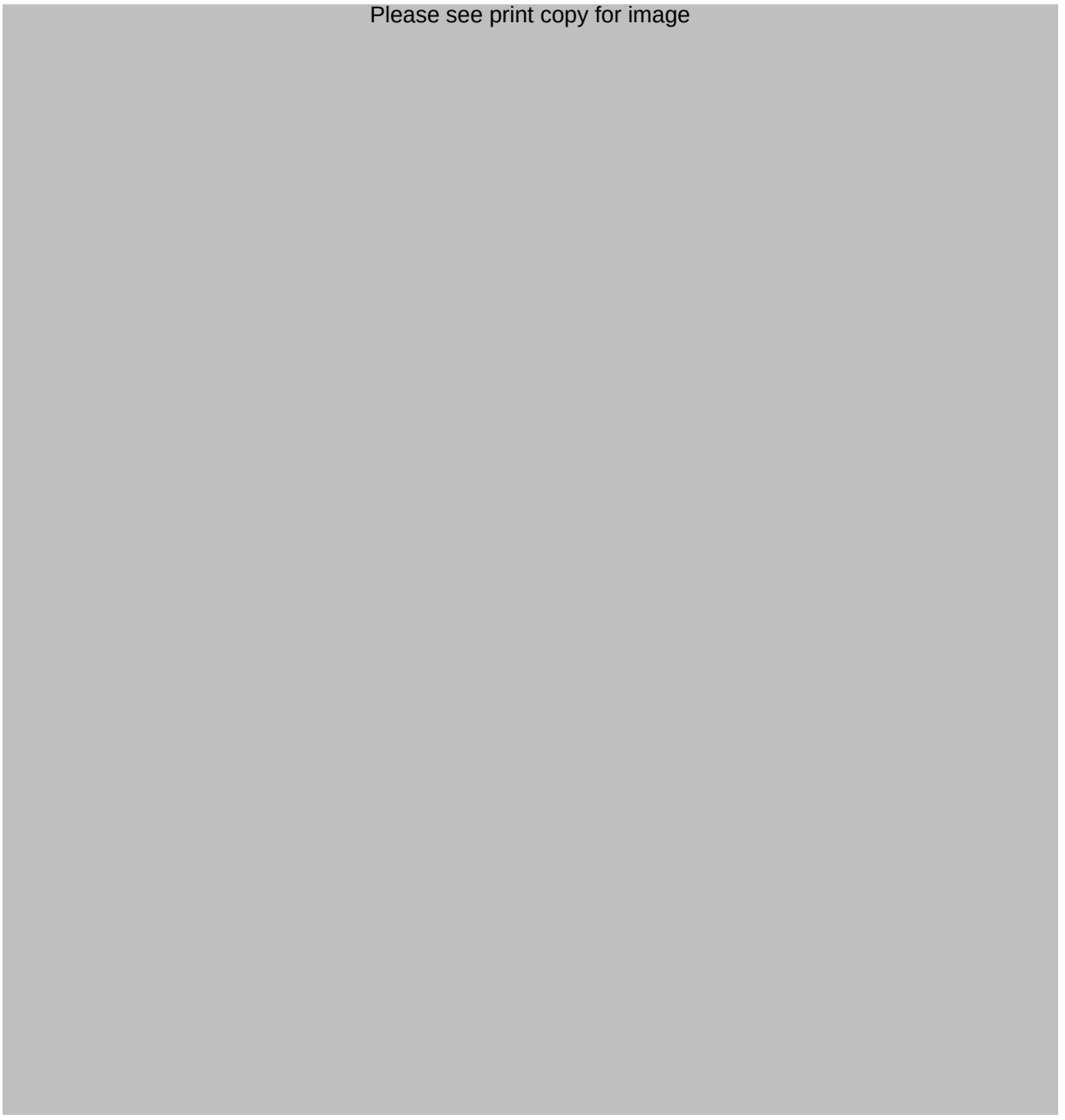
10.2.1.1 Facilities

With respect to the limited facilities in public S&T institutions, the formulation of policy initiatives to overcome such system failures seem to be complex in nature.

In a way, the establishment of central facilities with basic sets of instruments seems to be a viable approach. However, the coordination of actual demand and supply of such facilities needs a flexible and private sector type management approach. Also, it calls for networking of S&T facilities within the country and for collaborations with similar international S&T organizations. For example, ITI in Sri Lanka could/might form closer relationships with similar institutions in India and NIC countries where they can be mutually benefited. Probably, this could be one of the policy agendas that needs attention of inter-governmental agencies such as UNESCO, within its purview to assist the developing countries in S&T development.

Table 10. 1 Schemes to support industrial innovations in India and Sri Lanka

[39] Sources : (Howells, Nedeva et al. 1998; Srinivasan 2001)



Sources : (Howells, Nedeva et al. 1998; Srinivasan 2001)

[40] Rainbow Master plan of Sri Lanka has noted the constraints in the financial system such as high interest rates, lack of long-term funding at reasonable cost , loans provided against securities, lack of effective credit guarantee system and poor credit analysis and management on the part of banks. Hence it has recommended several financial and fiscal improvements.

1. Concessionary loans for industrial sector at a low interest rate
2. Fiscal incentives to promote introduction of advanced technologies, marketing , training and R&D for SMEs
3. Effective credit guarantee system for SMEs and Venture capital support
4. Improve loan recovery rates through reinforced credit analysis and management skills in Banks
5. Improve accounting and financial skills of banks and increase transparency and accountability of banks.

10.2.1.2 Communication

The lack of communication facilities calls for the establishment of network of information services and communication facilities using modern information technologies. The policy initiatives required in this connection may fall on government to facilitate the establishment of the information system, and on individual organizations to organize and manage such systems while connecting to a web of information exchange.

10.2.1.3 Coordination

The lack of coordination and funding schemes again requires new policy initiatives. However, these initiatives need proper understanding of micro level issues which requires continuous monitoring.

10.2.1.4 Funding & incentives

The lack of schemes / programs to promote URI relationships, financial or other incentives, coupled with many other factors such as salary structures, prevent the actors getting involved in collaborative work. Policy initiatives towards generating enthusiasm and rewarding achievement seem to be possible actions that can be taken by the Government and individual organizations.

10.2.1.5 IP awareness

The lack of awareness and systems to support intellectual protection need immediate attention of policy circles. In this context, establishment of a national IP facilitations cell is a policy tool that can be implemented. In the meantime, with respect to enhancing the quality consciousness, accreditation processes could be encouraged as a policy initiative.

Taking into account the existing environment, some generic policy initiatives are recommended. (see table 10.2) In these recommendations, implementation

agencies such as foreign donor agencies and other local organizations such as banks are also brought in as providers of necessary inputs.

The above weaknesses in the structure have prevailed in the system for many years and still no signals can be seen for the formulation of adequate instruments to overcome them. The capabilities of individual institutions are limited to address these issues individually. This calls for an understanding of micro level issues related to the relationships.

10.2.2 Micro level conditions

The investigation into micro level process related conditions, propose opportunity driven self –adaptive policy initiatives at organizational level legitimized by the National Policy framework. For example, the establishment and functions of Industry Interaction Units in universities and research institutions, first needs legitimate existence and then, these units should seek opportunities and orient themselves to capture those opportunities to perform it's functions effectively. Similarly, administrative circulars on human mobility can set the stage for mobility of human resources between knowledge users and producers, but the actual implementation would rest on the initiative of individual organizations. However, some policy initiatives need less authorization in terms of legal perspectives. For example incentive based systemic changes should have been implemented within organizational regimes that can promote interactive modes of innovations. The new forms of organizations have provided evidence for such a capacity to generate interactive modes of innovation processes.

Table 10. 2 Policy recommendations for framework conditions

Issue	Requirement	Policy initiative(s)	Tool(s)[41]	Implementing Agency					
				Government	Industry	Universities	Research Institutes	Foreign donors	Other
Funding	Provide financial assistance for industrial innovations	Establish funding schemes and loan schemes for encouraging industrial innovations	Venture capital, Loans for industrial innovations	x				x	x
		Promotion of consortia for pre-competitive research	Grants for research for pre-competitive research	x	x	x	x	x	
		Modernization of existing research grants schemes	Research grants for industrial research with active industry participation	x	x				
		Provide venture capital for funding industrial innovations	Establish venture capital fund	x				x	x
		Provide financial support for structured mechanisms for industrial research	S&T parks, incubators, Collaborative research centres	x	x	x	x		
Incentives	Encourage innovations at all levels	Provide special incentives for products based on local technologies	*Tax holidays, tax concessions, incentives for up gradation*	x	x	x	x		
	Maintain uniformity of existing incentives for all industries		Extend the existing incentives for SMEs	x	x				
	Make incentive compatible to the national economic objectives	Review existing incentives regularly	Incentive review committee	x					x

[41] Already established tools are given in italic letters

	Motivate the actors of the S&T base	Provide productivity based incentives	Institutional level incentive schemes (financial or kind) based on performance evaluation. Appreciation of achievements	x					
Systems	Monitoring, coordination, evaluation & facilitation of interactions	Establish coordination, evaluation and monitoring mechanism at national level	S&T cell in the National Planning Department	x					
		Establish coordination, evaluation & monitoring mechanism, specially for interactions, at institutional level	*Liaison office, Industry institute cells, Centres of excellence*, S&T marketing units, Business centres with business out look		x	x	x		
Skills	Develop technical skills in the labour force	Modernize technical education through review of existing curricula and incorporate modern courses according to the needs of the country	Modern technical education system	x	x			x	
	Capitalize the existing knowledge base of the universities	Commercialisation of knowledge base	Commercial arms, Marketing units, Incubators, Spin off companies, *Centres of excellence*	x		x	x		
	Industry orientation of education & training programs	Formalize interactions with industries towards development of education and training programs	*Industry consultative Boards, Industrial training for students, Members from the industry for councils and Boards of managements*	x	x	x	x		
Rules & regulation	Minimize rigidity of financial & administrative controls	Relaxation of financial & administrative regulations on R&D activities	More autonomy to councils & Boards of management with performance based accountability	x		x	x		

	Promote marketing approach	Retain generated income for institutional development	Development fund/ account for institutions without strings attached to the General Treasury	x			x		
Facilities	Organize and strengthen public sector testing and service facilities for industrial requirements	Establish central testing & service facilities with market oriented and industry based management approach	Central testing & service facilities with market oriented and industry based management approach	x	x	x	x		
		Network with national & foreign laboratories	Formalization of the concept in policy agendas of global and regional organizations	x	x	x	x	x	
		Maximize the productivity of the existing facilities with market oriented approach	Service arms in research institutes with private sector outlook	x		x	x		
Mandate	Legalize commercial activities and modernization of universities and public R&D institutions	Encourage commercial activities in public S&T sector institutions by providing legal coverage	Joint venture, Commercial arm, Service centres, Spin off companies	x		x	x		
Quality	Accreditation of products and services	Encourage accreditation of products and services	Declare standards, Incentives for laboratory accreditation	x	x		x		
IP	Promote and establish IP systems/ culture	Promote IPR issues	*Awareness programs, training on IP rights process,* bring in IP issues and protection mechanisms to the organizational structures. National IP facilitation cell	x	x	x	x	x	
Communication	Facilitate the information flow between industry and the universities & research institutions	Information system to brokerage resources, capabilities of the universities and research institutions with the technological problems of the industry	*Information system with demand oriented out look*	x	x	x	x		

		Allocate adequate resources and make flexible arrangements for human mobility to and from counterpart	Regular visits, Communication facilities, Sabbatical leave in industry, Contract appointments		x	x	x		
Policy direction	Ensure consistency	De-politicisation of policymaking bodies	Independent commission for policy planning	x					
	Enhance role of S&T in the decision making process	Economic development missions to couple with inputs from S&T	S&T cell in the National Planning Department	x					
	Enhance policy analysis capabilities of the Government	Enhance policy analysis capabilities of the Government	Recruit scientists to the S&T cell of the National Planning Department	x					

The analysis identified a list of thirteen micro level conditions based on the interview data. This list can in no way be considered exhaustive and may not be seen in each and every relationship. In other words, some new issues may come to light according to circumstances and the country specific conditions. The issues identified in this thesis were classified into three sets:

1. Both internal and external causes
2. Only internal causes
3. Only external causes (see chapter eight for more details)

These three sets of issues can be used as a checklist of sets of issues (Table 8.15) related to relationships to evaluate the micro level conditions (weaknesses) existing in small developing countries. Further, it is important to note that, all of these issues may not appear in the same context and intensity for all institutions within a specific type of organization. For example, the list may be different in contents from one university to the other. Also, the number of issues in the list may change according to the industry sector. Accordingly, the policy interventions can also be different from one organisation to the other. However, the list of issues can remain as a checklist of issues to gain an understanding of micro level conditions and subsequently propose suitable policy interventions.

Micro level weaknesses are not confined to universities industries and research institutes. It was noted in the findings that those weaknesses can be seen in policy making circles also. The continued nature of these weaknesses is exaggerated by macro level weakness in policy making and decision makers' compartments. The lack of national level programs and directions connected with passive motivations, ignorance of S&T in the national planning (with an exception in the IT sector), policy statements limiting to list of wishes and discussions without designing implementation tools, and a lack of allocation of resources are seen as major flaws in policy making circles. Again this calls for public policy to undertake remedial measures in terms of the policy making process itself.

The lack of policy directions needs to be approached in a different angle. The lack of policy directions is related to the capabilities of the government in the formulation of policy initiatives. In this regard, establishment of a S&T cell in the National Planning Department, and recruitment of scientists to this S&T cell of the National Planning Department is recommended as a policy initiative. Also, the inconsistency of policy directions arose as a major issue in the Sri Lanka context. This is mainly due to a change of interests of political parties and sometimes change of ministry portfolios within same political party. The existence of such problems is reported in "The report of the National Policy Framework on General Education" which was presented to the Executive President of the Government of Sri Lanka, by the Chairman of the National Education Commission.

"Furthermore, lack of continuity of policies and programs and reversal of policy and termination of programs after the change of governments or even change of Ministers in the same government during the last five decades have seriously affected education development in Sri Lanka"

(http://www.dailynews.lk/2004/01/01/new21.html 2004)

Hence it is recommended that an independent commission on policy initiatives could be established to maintain consistency and connect this commission to the S&T cell of the National Planning Department for evaluation monitoring and formulation of new policies without disturbing existing positive policy directions.

The education and training and service-based relationships are shaped by the micro level determinants. These determinants vary according to the type of organization. "Self understanding of the weaknesses" and the "opportunity driven learning-adaptive approach" (Chaudhuri, 1986) are evident in all types of organizations. The four examples provide evidence for the initiatives of these organizations to facilitate the evolution of new forms of organization to overcome weaknesses. Similar experience in the Indian context has been reported by Chaudhuri (1986) who looked at "Technological innovation in a research laboratory in India". These findings support the nature of triple helix model and the mode 2 functions within the education and training and service based relationships (see chapter nine). This again calls for policy directions towards strengthening micro level dynamics to maximize the benefits and to capture the opportunities through continuous responsive, learning and adaptive process.

Taking this evidence into consideration, it is proposed that policy initiatives and instruments for Sri Lanka to promote URI relationships be established (Table 10.3). The requirements are extracted from the interview notes and based on those requirements I derived the proposed tools. However, most of the tools are in line with the tools proposed by the respondents and policy makers. This table fulfils thesis objective 3. (i.e. to recommend policy interventions to promote URI relations for technological innovations taking into account the micro level dynamism of the actors and organizations that support/constraint interaction)

Table 10. 3 Policy recommendations for micro level conditions

Issue	Requirement	Policy initiative	Tool(s)[42]	Implementing Agency					
				Government	Industry	Universities	Research Institutes	Foreign donors	Other
Access to know how	Provide technological information to industries	Establish unit to facilitate search and dissemination of useful technological information to the Industry	*Technology information centre* established in close relation to industrial organizations	x	x	x	x		
	Make industries accessible to locally developed technologies	Publicize proven local technologies	Commercial arms, Marketing units	x		x	x		x
	Develop national programs on specific technologies suitable to the resources, capabilities and needs of the country	Encourage national initiatives on development of local technologies	National technology development program	x	x	x	x	x	
Characteristics of Market	Assist promotion of locally produced export quality products in the export market	Formalize aggressive export marketing	*Exhibitions, trade shows in potential market niches*	x	x				
	Facilitate sub-contracting by local firms for multinational/foreign companies	Provide flexible arrangements, importation of raw material/parts and incentives for sub contracting firms	Incentive review committee for subcontracts	x					
Modernization	Facilitate quality control aspects in SMEs	Encourage establishment of mini scale laboratory facilities in SMEs	Mini-laboratory scheme for SMEs		x	x	x	x	

[42] Already established tools are given in italic letters

	Share human capital between industry and private sector	Facilitate human mobility between industry and public S&T institutions through recruitments and secondments in both directions	*Administrative circulars encouraging human mobility*	x	x	x	x		
	Share public sector S&T capabilities & resources with the industries	Facilitate maximum utilization of public sector resources & capabilities for industrial development	S&T centre/parks, Mutual agreements, joint venture	x	x	x	x		
	Enhance grass root level skill development (e.g. farmers)	Encourage grassroot level skill development	Subsidized skill development programmes	x		x	x		
Re-orientation	Formalize informal relationships	Develop confidentiality agreements , improve internal efficiency and remove rigidity of regulations of public institutions	Performance based incentive system for re-orientation			x	x		
Perception	Eradicate negative consequences of student industrial training	Formalize industrial training for university students with appropriate management & evaluation	*Establishment of industrial training units in universities*			x			
	Enhance industry orientation of universities and public research institutes	Recognize and promote industry oriented programmes	Incentives for involvement in industry oriented programmes	x		x	x		
	Change negative attitudes of researchers and academia on industry related programmes	Encourage commercial activities in public S&T sector institutions by providing legal coverage	Joint venture, Commercial arm, Service centres, Spin off companies	x		x	x		
Responsiveness	More university industry research relationships	Encourage URI relationships	Incentives (financial and non-financial) for interactions	x	x	x	x		

Social dynamics	Eradicate culturally bound negative behaviour	Improve productivity orientation of the labour force	Industry automation scheme	x	x				
External influence	Minimize negative influence from external sources	Improve negotiation capabilities of agents and the government	Policy analysis unit at National Planning Department	x					
Technology Culture	Strengthen the in house innovative activities of firms	Encourage in house technology development activities in industries	Consultation scheme for industries to obtain consultations from universities and research institutes	x	x			x	
			Incentives for industries for adaptation of technologies for low cost but quality operations	x	x				
	Utilization of locally produced technologies	Enhance commercialisation of locally produced/adapted technologies	Special incentives for spin off companies			x	x		
Systemic failure	Make available all the assistance to universities and research institutes to promote interactions with industry	Promote formation of separate units to deal with interaction	*Industry interaction units in universities* and research institutes			x	x		
	Create demand for interaction	Recognize interaction oriented course and activities	Promotion schemes with adequate recognition for interaction oriented activities, job opportunity schemes	x	x	x	x		
	Develop market oriented management and administration style	Inculcate market orientation to the management of public S&T institution	Schemes to promote competition among public institutions and with private sector	x	x	x	x		
Functional failure	To improve management of research institutes and universities	Enhance management capabilities of research institutes and universities	Training programmes for managers, De-politicisation of appointments to the top positions	x		x	x		

	To minimize brain drain	Provide incentive based encouragement to retain key personnel	Incentive schemes for key personnel	x		x	x		
	Develop skills of staff	Enhance skills to match modern requirements	Training schemes			x	x		
Opportunity	Utilize knowledge base in universities	Enhance utilization of university intellectual resources	Spin off companies, S&T parks, Interaction cells	x		x			
	Capitalize on capabilities of research institutes	Restructure & support research institute in order to market it's capabilities	Marketing/commercial arm, Service centres	x			x		
Industrial dynamics	To improve quality and knowledge base of industry	Enhance technical capabilities of industries	*Technology promotion scheme for industries*	x	x				
Research	Effective R&D work done in research institutes	Improve research culture in research institutes	Vision oriented research funding for research institutes	x			x		
	University to manage R&D	Improve research culture in universities	Structure research management function in universities			x			
	Enhance exposure to industry culture	Minimize cultural gap between industry and research institutes and universities	Short term/long term exchange programs, Sabbatical leave to be spent in industries			x			
	Change attitudes of researchers and academia on industry	Develop conducive attitudinal changes for interactions	Incentive based systemic changes			x			
	Minimize mismatch of expectations of partners (cultural differences)	Regular dialogue between partners on technical problems and R&D	Forum as a meeting place		x	x	x		

10.3 Policy initiatives

Polt et al (2001) indicates that "in all countries, science and technology policy aims at fostering industry science relations through promotion programmes and in recent years, most countries have put increasing attention on such programmes and have extended their scope and size, addressing more or less the full range of channels". The need for an extensive set of policy initiatives imply that the Government still has to play a major role in the industrial development in the country. In other words, it provides evidence for the existence of linear (plus) model. The initiatives taken in the recent past are worthwhile to note as it provides evidence for the existence of the linear (plus) model. The industrial Master Plan (Rainbow plan) provides similar evidence for linear model approach. For example, the Master Plan recommends compartmentalization of research, development and design functions at universities, research institutes and industrial enterprises respectively, where very little interactions can be expected between academia and "enterprises". Although the plan seems to have identified the deficiencies in the policy making and implementation instruments such as isolated policy dialogues by various affiliated policy making bodies in different ministries, weak interface among these affiliates and ministries, fragmented nature of policies, and duplication of functions in different ministries, the Plan itself seems to have ignored the existence of micro level deficiencies, to some extent. The plan does not provide recommendations or instruments to bring universities and research institutes to act within the R&D circle for common benefit.

The above policy recommendations and the industrial master plan might face immense resistance to implementation as it has ignored micro level determinants. The Rainbow plan proposes institutional differentiation as a remedy to overcome these problems. The researcher is of the view that the implementation of policy tools may also have unfavourable strings attached to the social, cultural and political environment.

10.4 The case of India

The case of India is a good example for the establishment of structured policy making instruments, usually immune to the interest of political parties, and incorporation of S&T in the national planning agenda. The S&T structure in India and the policy directions with respect to relationships are discussed in chapter three . However, it is argued that its heavy concentration on a few selected high profile, but nationally important areas such as defence, atomic energy and space research may lead to a neglect of the potential benefits of S&T capabilities for social welfare. Hence India may need to perform a dual public policy approach as proposed by Krishna (2001).

It was stressed that the URI relationships in the Indian context are more dominated by education and training and service based relationships (Venkateshwaran 1999). Deepak (2002) observed that research based relationships in Biotechnology in the New Delhi region is still lacking. However, the case of FITT shows accelerating development of private sector investment for infrastructure in IITD in the field of IT and BT. Also, the development in IP applications implies the trend towards commercialization of intellectual capabilities and technology advancement.

10.5 Significance of the research

Firstly the characteristics of URI relationships in Sri Lanka were not known, except for some vague understanding based on experience of individuals. Hence, the exploration itself is considered as a significant outcome. These findings will have more intrinsic value for managers and policy makers in Sri Lanka in the policy-making process.

Secondly, the characteristics of the relationships that can be seen in Sri Lanka can be used as the basic framework for a similar study in any other small developing countries. The characteristics of the URI relationships in small developing countries that are technologically backward has not been covered in most literature.

The present research therefore provides new insight into the issues. The research confirms the findings related to India that the existing relationships are mostly on education, service and training based relationships rather than research based relationships (Venkateshwaran 1999). This leads to the conclusions that URI characteristics in Sri Lanka are similar to large developing countries in general. Furthermore it suggests that mode 2 operations and triple helix –research mode- relationships are quite new in many developing countries including India and Sri Lanka. Thirdly, the deficiencies in framework conditions demand that the Government should play a major role in industrial development in the country, which provide evidence for the existence of linear (plus) model rather than interactive model of innovations. This argument is more realistic for many countries where the conditions such as technological advancement and resource management skills are similar to that of Sri Lanka.

Thirdly, the methodology developed in the analysis of micro level conditions is unique and novel. The methodology consisted of coding, clustering, actor by site mapping, amalgamating, summarizing, grouping clusters according to analytical objectives and finally developing a checklist for evaluations. This long and exhaustive process finally developed a checklist of weaknesses for different types of organizations. As discussed in chapter eight, this checklist cannot be intrinsic but provides a baseline for developing a country specific list, especially to define specific parameters. Finally, the research led to a set of policy initiatives for Sri Lanka which once again could be used by any country as a basic guide.

10.6 Summary of findings

The major findings of the research are

1. The URI relationships in Sri Lanka are mostly based on education and training. Service based relationships can also be observed between industries & research institutions.

2. Inadequate funding, lack of communication, and limited facilities in R&D institutions and universities are the major structural drawbacks in Sri Lanka.
3. Funding schemes to support industrial innovations are almost absent in Sri Lanka compared to many developing countries, such as India and Malaysia, and obviously compared to developed countries such as Australia and UK.
4. Severe weaknesses in the S&T infrastructure have been observed in terms of standards and IP issues, which calls for immediate policy interventions. This can be the reason for the lack of evidence for research-based relationships.
5. Education and training based and service based relationships suffer numerous draw backs both in relation to industries and research institutes which are mostly considered as micro level conditions. But these issues seem to be converging towards self-understanding and opportunity based learning- adaptive approach.
6. Micro level issues differ from organization to organisation. Their perceptions and expectations from the counterpart site also differ from site to site.
7. New forms of organizations have evolved during the last 5-6 years in which they show confidence in overcoming the weaknesses of the mother organization. These new `organizations show features of the mode 2 operations and triple helix model. It is too early for a real evaluation of these organizations as they are still at the infant stage or early stages of growth.

10.7 Future research

The findings of the research are subject to some limitations. Firstly, the low response rate raises two important issues. One is whether those reluctant to respond were involved in relationships which they would desire confidentiality, or alternatively whether they attempted to be involved in relationships that failed to develop. The snowball sample that captured the important individuals who were involved in relationships covered former issues partly. Secondly, the follow-up

interviews reached a level that indicated that these were rarely a new issue. Hence, the error connected to the sample size was minimized within the time frame of the field research of the study program.

Although the research was originally planned for five different sectors, the number of industries that responded during the survey did not allow an analysis of data sector wide. A focus on one industrial sector could have been one of the options, but once again such an approach could lead to neglect of general issues in other sectors.

The actors have commented on some general issues that encompass social, political and cultural attributes. These issues are not directly relevant to the relationships but may shape the fine features of the innovation behaviour. For example, some actors felt that external influence from donor agencies are in agreement with the policies related to industrial development while the others felt that those agencies influence negatively on the economic, political and policy directions of the country. The latter version shows some logical coincidence with the mimetic behaviour of developing countries since these donor agencies apart from lacking understand on social and cultural behaviour, send misguided signals through the "so called consultants" who are totally ignorant about ground situations. However the present study did not include an investigation of this aspect, and is an area for a future study.

Similarly, the study did not give any positive clues in respect to the possible effects of social and cultural influences on the innovation behaviour. However, a few indicative trends gathered from the interviews suggest that cultural norms and attitudes had no significant impact on innovation behaviour. But at the same time it can be argued that when the cultural barriers are harder, the nature of the innovativeness tend to be more non-productive.

It was noted that many of the respondents from the industry sector have established collaborative links with foreign agencies (e.g. Section 6.2-table 6.2) not only in the cases where the required facilities such as testing samples are not available in Sri

Lanka but also in respect of evolving more structured collaborations. This shows the existence of a demand for such structured types of collaborations. In the present context, there may be many such collaborative links in operation. These kinds of collaborations are usually built into the foreign donor funded projects which are operated through the Central Government and administered by state organizations. Also, many such programmes directed at improving the role of private sector have been evolved. Hence the influence of this type of connections with foreign establishments on the URI relationships, and the technology capability development activities seems to play a major role in developing countries.

Funding agencies such as UNIDO and USAID have taken a leading role in shaping the role of private sector performance, and in forming new mechanisms for collaborations. In all of these promotional activities, URI relationship is considered as a key player. All these examples show the influence of the foreign donor agencies in the URI relationships.

10.8 Concluding remarks

The study shows that relationships in Sri Lanka are based on lower end of the spectrum which are characterized by short-term orientation such as education & training and service based relationships. The micro-level constraints and weaknesses are wide spread in all three types organizations in addition to the weaknesses related to the framework. Within these weaknesses of the framework conditions, the URI relationships contain a vast potential of opportunity while micro-level issues prevent them from exploiting the opportunities for mutual benefits. A check-list of issues was developed for a particular type of organization which could be used for any developing country. The new forms of organizations, which shows the features of the mode 2 operations and the features of the triple helix model concludes that the URI relationships in developing countries show similarities to developed countries in a broad context but shows differences in nature. It also concludes that in addition to removing weaknesses in the framework, it is imperative to understand micro-level conditions to propose public policy interventions, that are needed to promote URI relationships.

The study enabled me to explore the nature and characteristics of the URI relationships in Sri Lanka. I was able to argue that the models and concepts that describe URI relationships in developed countries can also be used in developing country context. The micro level conditions in developing countries , which are not adequately discussed in the literature were brought into light. The level of significance of these conditions needs to be tried out in different country specific attributes that need further research.

References

1. Abdullah, M. L. (1997). Strategies for the development, acquisition, assimilation and technology transfer - The Malaysian experience. SAARC workshop on development, acquisition & transfer of technology, Colombo: 26-30 Dec 1997.

2. Aggarwal, A. (2000). Deregulation, technology imports and in-house R&D efforts: an analysis of the Indian experience. Research Policy 29: 1081-1093.

3. Alam, G. and J. Langrish (1984). Government research and its utilisation by industry The case of industrial civil research in India. Research Policy 13: 55-61.

4. Alam, M. S., R. Jayakumar, and D. Balakrishna (2003). Management of university industry science partnerships: A case study of the IIT Madras, India. Unesco, Paris.

5. Allen, T. J., D. B. Hyman, D.L. Pinckney. (1983). Transferring technology to small manufacturing firms: A study on technology transfer in three countries. Research Policy 12(4): 199-211.

6. Amaradasa, R. M. W. (1998). Research collaboration in Sri Lanka; 1995-1997, Proceedings of the annual session of Sri Lanka Association for the Advancement of Science, Colombo, 2-6 Dec 1998.

7. Amaradasa, R.M.W., R.Pathirage, A. Tennakoon (2003). National survey of Research and Development: 2000. National Science Foundation of Sri Lanka, Colombo.

8. Anonymous, (1991). Final report of the Presidential Task Force on S&T development, Ministry of Plan Implementation; Colombo, Sri Lanka.

9. Anonymous, (1992). Enhancing interaction between business and higher education research. Business Higher Education Round Table on Promoting Partnerships, New York.

10. Anonymous, (1995). Project proposal on Science & Technology Personnel Development in Sri Lanka for funding by Asian Development Bank , Ministry of Science & Technology, Colombo.

11. Arnold, E. and B. Truriaux (2001). Contribution of basic research to the Irish national innovation System. Science and Public Policy 28(2): 86-98.

12. Arocena, R. and J. Sutz (2001). Changing knowledge production and Latin American universities, Research Policy 30: 1221-1234.

13. Baba, M. L. (1988). Innovation in University-Industry Linkages: University Organizations and Environmental change. Human Organization 47(3): 260-269.

14. Balazs, K. and G. Plonski (1994). "Academic-Industry relations in middle-income countries: East Europe and Ibero-America." Science and Public Policy 21(2): 109-116.

15. Bonaccorsi, A. and A. Piccaluga (1994). A theoretical framework for the evaluation of university- industry relationships. R&D management 24 (3): 229-247.

16. Cardoza, G. (1999). "Learning and innovation paths in East Asia." Science and Public Policy 26(4): 259-276.

17. Central Bank (2002). Annual Report. Central Bank of Sri Lanka, Colombo.

18. Central Bank (2000). Annual Report. Central Bank of Sri Lanka, Colombo.

19. Chaudhuri, S. (1986). Technological innovation in a research laboratory in India: a case study. Research Policy 15: 89-103.

20. Dailynews [homepage of the News Paper "Dailynews"], [Online]: (01/01/2004-last update), Available http://www.dailynews/2004/01/01/news21.html [Acessed 2004, Jan 1].

21. Deepak, B.(2002). University-Industry-Government relationships (Triple Helix) in New Delhi region; Case of Bio technology sector. MPhil Thesis, University of Sri Jawaharlal Neru, New Delhi.

22. Dierdonark, R. V., K.Debackere, and B. Engelen (1990). University-industry relationships: How does the Belgian academic community feel about it?, Research Policy 19: 551-556.

23. Dodgson, M. and J. Bessant (1996). Effective Innovation Policy: A new Approach. Routledge, New York.

24. Etzkowitz, H. and L. Leydesdorff (2000). The dynamics of innovation : from National Systems and "Mode 2" to a Triple Helix of university-industry- government relations. Research Policy 29: 109-123.

25. Etzkowitz, H. and L. Leydesdorff (1997). Universities and the global knowledge economy: A triple helix of university-Industry-Government Relations. London, A Cassell Imprint.

26. Fernando, C. and R. M. W. Amaradasa (1998). National Survey of R&D in Sri Lanka: 1996. National Science Foundation of Sri Lanka, Colombo.

27. Garrett-Jones, S. and T. Turpin (1995). CSIRO and Australian Science Policy: An international and historical perspective , in Peter Ewer (ed), Leichhardt : Pluto Press Australia limited: 6-44.

28. Geisler, E. and A. Furino (1990). Factors in the success or failure of industry university cooperative research programmes. Interfaces 20(6): 99-109.

29. Gibbons, M., C. Limoges, H. Nowotny, S. Schwartzman, P. Scott and M. Trow, (1994). The new production of knowledge: The dynamics of science and research in contemporary societies. Sage, Stockholm.

30. Glaser, B. G. (1998). Doing Grounded Theory : Issues and Discussion. Sociology Press, Mill Valley, CA.

31. Hage, J. (1987). Organizational change as a development strategy: models & tactics for improving third world organizations. In Hage, J. and Finsterbusch, K. (Eds). L. Rienner Publishers, Boulder, Colo.

32. Hill, S. (1993). The 3rd conference on academic - industry relations, New York.

33. Hof, P. (2000). A tentative definition of the interface of innovation: the model of the three millstones: POSTI-ESST workshop. Strasbourg: 27-28 May 2000.

34. Howells, J., M. Nedeva, and L. Georghiou. (1998). Industry-Academic links in the UK. University of Manchester press, Manchester.

35. ITI (2002), Annual Report of Industrial Technology Institute of Sri Lanka, Colombo.

36. James, L.W. (2002). Policy Implications of Sri Lanka's Competitiveness Ranking, The competitiveness initiative. USAID, Colombo.

37. Kharbanda, V. P. (1999). Academia-industry symbiosis: The new form of science in socialist China. Current science 77(7): 866-874.

38. Konishi, Y. (2000). Industry-University Linkage and the Role of Universities in the 21st Century. In Pedro Conceicao et al .; forewarded by Diamantino F.G. Durae and Robert Ronstadt. Green wood Publishing Group, Inc, Westport CT USA.

39. Krishna, V. V. (2001). "Changing policy cultures, phases and trends in science and technology in India." Science and Public Policy 28(3): 179-194.

40. Lall, S. (2001). Competitiveness, technology and skills. Edward elgar publishing ltd, London.

41. Lall, S. (1996). Learning from the Asian Tigers: Studies in Technology and Industrial Policy. Macmillan Press ltd, London.

42. Leydesdorff, L. (2000). The triple helix: an evolutionary model of innovations. Research Policy 29: 243-255.

43. Lundvall, B. A. (1992). National innovation systems: towards a theory of innovation and interactive learning. printers publishers, London.

44. Mani, S. (2002). Government, innovation and technology policy : an international comparative analysis. Edward elgar publishing ltd, Northampton.

45. Martin, B. and A. Salter (1996). The relationship between publicly funded basic research and economic performance. SPRU report, University of Sussex, Brighton.

46. Meyer-krahmer, F. and U. Schmoch (1998). Science based technologies: University-industry interaction in four fields. Research Policy 27: 835-851.

47. Miles, M. B. and A. M. Huberman (1984). Qualitative data analysis: A source book of new methods. Sage Publications, New Delhi.

48. Ministry of Industrial Development (2000). The Rainbow Plan. Ministry of Industrial Development of Sri Lanka, Colombo.

49. Mohannak, K. (1999). A national linkage programme for technological innovation. Prometheus 17(3): 323-335.

50. Mowery, D. C. and N. Rosenberg (1989). Technology and the pursuit of economic growth. Cambridge University Press, New York: 329.

51. Narayan, K.(1998). Technology acquisition. De-regulation and competitiveness: a study of Indian automobile industry. Research Policy 27: 215-228.

52. NASTEC (2002). SWOT analysis -Research leader's forum. NASTEC, Colombo.

53. Nelson, R. R. and R. Levin (1986). The influence of science, university research and technical societies on industrial R&D and technical advance. Yale University, Newhaven.

54. Nelson, R. and S. Winter (1982). An Evolutionary Theory of Economic Change. Harward University Press, Cambridge Belknap.

55. Neuman, W. L. (2000). Social research methods: qualitative and quantitative approaches. Pearson Education Company, Needham heights.

56. Niosi, J., P. Saviotti, B. Bellon and M. Crow. (1993). "National System of Innovation: In search of a workable concept." Technology in Society 15: 207-227.

57. NSF (2001), Report of the workshop on solving problems encountered in conducting scientific research, NSF; Colombo: 28/06/2001.

58. OECD (2002). Bench marking Industry- Science relationships. OECD, Paris.

59. OECD (1992). Technology and the economy: the key relationships. OECD, Paris.

60. Pathirage, R.P., P.R.M.P.Dilrukshi, and A. Hettiarachchi. (2003). Tracer study of Science & Technology (S&T) graduates passed out from universities in Sri Lanka (2000/2001). National Science Foundation of Sri Lanka, Colombo: 55.

61. Polt, W., C. Rammer, H. Gassler, A. Schibany and D. Schartinger. (2001). Benchmarking industry-science relations: the role of framework conditions. Science and Public Policy 28(4): 247-258.

62. Porter, M. E. (1990). The Competitive Advantage of Nations. The Macmillan Press Ltd., London.

63. Pray, C. E. (2001). Public private sector linkages in research and development : Biotechnology and the seed industry in Brazil, China and India. American Journal of Agricultural Economics 83(3): 742-747.

64. Rahm, D. (1990). Academic perceptions of University- Firm technology transfer. Policy studies Journal 22(No 2): 267-278.

65. Ramanathan, K. (1988). Evaluating the national science and technology base: a case study on Sri Lanka. Science and Public Policy 15(5): 304-320.

66. Rothwell, R. and W. Zegveld (1981). Industrial innovation and public policy ; Preparing for the 1980s and the 1990s., Frances Printer (publishers) Ltd., London.

67. Sarantakos, S. (1993). Social research.: Macmillan Education Australia, South Melbourne.

68. Senker, J. (1999). European comparison of Public Research Systems (EUPSR), Final Report of project funded by the European community under the targeted Socio-Economic Research Programme. SPRU Report, University of Sussex, Brighton.

69. Sikka, P. (1998). Analysis of in-house R&D centres of innovative firms in India. Research Policy 27(4): 429-433.

70. Silva, M. A. T. D., G. Yapa, and J. Karunasunghe. (1996). Sri Lanka Science & Technology Indicators - Part IV. Natural Resources Energy & Science Authority, Colombo.

71. Souder, W. E. (1993). Getting together : a state-of-the art review of the challenges and rewards of consortia. International Journal of Technology Management 8(6/7/8): 122-134.

72. Srinivasan, S. K. V. (2001). IPR and implications for R&D. New Delhi, News Letter - Department of Scientific & Industrial Research: 126 & 133.

73. Sripaipan, C. (1993). Financing Industry-University Interaction: a South Asian Perspective. TDRI Quarterly review: 8-16.

74. Sutz, J. (2000). The university-industry-government relations in Latin America. Research Policy 29: 279-290.

75. Sutz, J. (1998). The new location of Research. A commented report of the conference on "Triple helix of university, Industry, Government Relations. New York: Jan 1998.

76. Tait, J. and O. Williams (1999). Policy approaches to research and development: Foresight, Framework and Competitiveness. Report of Scottish Universities Policy Research and Advice network. University Edinburgh, Edinburgh: 21.

77. Thorsteinsdottir, H. (2000). "Public sector research in small countries : does size matter?" Science and Public Policy 27(6): 433-442.

78. Turpin, T., D. Aylward, S. Garrett-Jones, R. Johnston. Knowledge-based cooperation: University-industry linkages in Australia, Report No 96/17 of the Centre for Research Policy, University of Wollongong and Australia Centre for innovation and international competitiveness, Australia.

79. Turpin, T. (2000). Science and technology policies and strategies for the twenty-first century. Proceedings of the expert group meeting on science and technology policies and strategies for the twenty-first century. United Nations, Beiruit.

80. Turpin, T., D. Aylward, S. Garrett-jones, G. Speak, L. Grigg and R. Johnston. (1999). University and Industry Research Partnerships in Australia; An evaluation of ARC/DETYA industry-linked research schemes, Department of Education, Training and Youth Affairs, Australia.

81. Turpin, T. and S. Garrett-jones (1997). Innovations networks in Australia and China. In H. Etzkowitz and L. Leydesdorff (eds), Universities and the global knowledge economy- A triple helix of university-industry-government relations. A Cassell Imprint, London: 21-32.

82. Venkateshwaran, S. (1999). University-Industry linkage programmes at BITS, Pilani- A case Study. Strategies for University Industry Corporative programme in Science, Technology, and Engineering in India. UNESCO, New Delhi.

83. Wignaraja, G. (1998). Trade liberalization in Sri Lanka. Macmillan Press Ltd, London.

84. Wijesundera, S. and R.S.Ramakrishna, (1990). University Industry Cooperation. CVCD Publications, Colombo.

85. Wong, P.K. (1999). University -Industry technological collaboration in Singapore: Emerging patterns and industry concerns. International Journal of Technology Management 18 (Nos 3/4): 232-255.

86. Wu, V. F. S. (2000). An empirical study of university industry research cooperation: The case of Taiwan. Workshop of the OECD-NIS Focus group on Innovation firms & networks. OECD, Rome.

87. *University of Moratuva* , [Home page of University of Moratuva , Sri Lanka], [Online].(18/08/2003- last update), Available : http:// www.mrt.ac.lk, [Accessed 2003, Dec 12]

Appendix one - Objectives of S&T management organizations

A) National Science and Technology Commission (NASTEC)

Objectives and functions

- to advise the government on policies and plans for the development of Science & Technology (S&T) and its application for economic growth and the improvement of the efficiency and the competitiveness of industry, agriculture and services.
- to address the application of Science and Technology in relation to health, nutrition, poverty alleviation and the general improvement of the quality of life of the people.
- To formulate policies and plans for the proper development and management of the natural resources of Sri Lanka.
- To advise the Government and help formulate policies and plans that will ensure the development of human resources, the allocation of funds, the proper management and the promotion of the conditions necessary, for the advancement of Science and Technology and the Research and Development that the country requires.
- To identification and prioritization of Science and Technology in areas of national interest as well as the development of a Science and Technology Agenda for National Development (STAND).
- To promote the objectives of the S&T Act listed below

a. the use of Science and Technology as an integral part of the effort to achieve rapid economic development and improved quality of life, alleviate poverty, involve scientists and technologists in the formulation of policy and in decision making;

b. foster scientific and technological activity in all its aspects with a view to developing self reliance in scientific and technological capability, and to ensure the allocation of a reasonable proportion of the Gross National Product (GNP) for Science and Technology activities;
c. support the development of indigenous technology wherever feasible whilst promoting the import, adaptation and assimilation of technology for rapid growth in industry, agriculture and services;
d. ensure that institutions of higher education and technical education and research institutions produce scientists, technologists and technicians of high caliber and competence and to secure the provision of incentives to them with a view to ensuring their retention in Sri Lanka;
e. provide adequate opportunities for all persons to acquire a basic education in science and its practical applications;
f. cultivate among the people, appreciation of the value of science, scientific method and technology and of the integral role that science plays in modern society;
g. disseminate the benefits of Science and Technology activity to all sectors of the people;
h. encourage and strengthen cooperation in Science and Technology between scientists in Sri Lanka, and between scientists in Sri Lanka and scientists outside Sri Lanka, and to provide access to global scientific and technological knowledge and activity;
i. develop the capability to continuously plan, evaluate and review strategies, legislation and the institutional frame work for Science and Technology in Sri Lanka;
j. identify priority areas of Science and Technology likely to be of benefit to Sri Lanka and to promote research and development in such areas.

B) National Science Foundation (NSF)

Objectives

1. To initiate, facilitate and support basic and applied scientific research by universities, science and technology institutions and scientists, with a view to -
    - strengthening scientific research potential, including research in the social sciences, and scientific education programs;
    - developing the natural resources of Sri Lanka;
    - promoting the welfare of the people of Sri Lanka; and
    - training research personnel in science and technology;
2. To foster the interchange of scientific information among scientists in Sri Lanka and foreign countries;
3. To award scholarships and fellowships for scientific study or scientific work at science and technology institutions;
4. To maintain a current register of scientific and technical personnel, and in other ways to provide a central clearing house for the collection, interpretation and analysis of data, on the availability of, and the current and projected need for, scientific and technical resources in Sri Lanka, and to provide a source of information for policy formulation on science, technology and other fields;
5. To popularize science amongst the people by funding programs for that purpose.

C) Council for Agricultural Research Policy (CARP)

Objectives

- Identification of sub-sectoral policy perspectives and formulation of agricultural research policy
- Research planning-priority setting in key disciplines
- Sustainability of funding for high priority research areas- Establishment of Competitive Research Grants Program
- Development of suitable mechanisms for research monitoring and evaluation
- Facilitate linkages with public/private sector organizations, universities, regional and international research institutes/agencies and CG centers
- Stakeholder information dissemination on appropriate technologies generated
- Widen and strengthen the scope of agricultural database and CARP electronic library
- To achieve financial and administrative targets
- Strengthen research fund disbursement procedure

Appendix two - Extract from the task force report on the Science & technology

Science and Technology Policy for the 1990s

1. To use science and technology (S&T) as an integral part of the effort to achieve rapid economic development, improved quality of life and poverty alleviation, and to involve scientists and technologists in the formulation of policy and in decision making at the highest levels.

2. To foster scientific and technological activity in all its aspects and widest possible scope to maintain a vigorous drive towards developing self reliance in scientific and technological capability, and to allocate a reasonable proportion of the GNP for S&T activity.

3. To support the development of indigenous technology wherever feasible while vigorously promoting the import, adaptation and assimilation of technology for rapid industrial growth.

4. To ensure that our institutions of higher education and research and technical education produce scientists, technologists and technicians of the highest caliber and competence and there by build up adequate numbers of them in Sri Lanka by providing incentives for retaining and attracting such persons.

5. To provide equal and adequate opportunities for all to acquire a basic education in science and its practical applications.

6. To cultivate among the people of Sri Lanka, an appreciation of ht value of science scientific method and technology as an essential aspect of modern society.

7. To disseminate the benefits of S&T activity as widely as possible within the country, to all sections of the people.

8. To encourage and strengthen cooperation in S&T both within Sri Lanka as well as with other countries and to provide access to global scientific and technological knowledge and activity.

9. To develop the capability to continuously plan, evaluate and review strategies, legislation, and institutional framework for S&T and to support this with an information Technology capability.

10. To identify priority areas of S&T likely to be of benefit to Sri Lanka and to specifically focus and promote research and development in such areas.

Appendix three – Sample questionnaire (for Academia)

A. Section One General Information	Serial No.				

1. Personal Information

Name :

Dept | Institution :

Sector of Performance

Food & beverages [ ] Information technology [ ] Construction [ ]
Rubber & Plastics [ ] Textile [ ] Fisheries [ ]

Official Address

Contact T'phone | Fax | E.mail

2. Post graduate Supervision (if any)

How many postgraduate students you supervised in 2001

How many of them worked on a problem of the industry in their research

3. Major functions that you are involved in other than teaching	Rank (0-not at all, 1- very low to 5- very high)					
Research grants – Funded research	0	1	2	3	4	5
Contract research	0	1	2	3	4	5
Technology development and transfer	0	1	2	3	4	5
Documentation of research results	0	1	2	3	4	5
Arranging professional training programs/workshops	0	1	2	3	4	5
Developing industrial liaisons	0	1	2	3	4	5
Facilitating consultancy services	0	1	2	3	4	5
Facilitating patent application and licensing	0	1	2	3	4	5
Other(Please specify)	0	1	2	3	4	5

B. Section two - URI linkages						
1. What are the types of industry linkages currently taking place	Rank					
	(0-not at all, 1- very low to 5- very high)					
Student projects	0	1	2	3	4	5
Consultations (informal)	0	1	2	3	4	5
Interest groups/Study committees	0	1	2	3	4	5
Information /equipment sharing	0	1	2	3	4	5
Consulting agreements	0	1	2	3	4	5
Committees/Advisory boards	0	1	2	3	4	5
Seminars/workshops and short training courses	0	1	2	3	4	5
Industry sabbaticals/fellowships	0	1	2	3	4	5
Contract research grants	0	1	2	3	4	5
Joint R&D arrangements	0	1	2	3	4	5
Incubator facilities	0	1	2	3	4	5
Technology licensing programs	0	1	2	3	4	5
Endowed chairs and professorships	0	1	2	3	4	5
Extension services	0	1	2	3	4	5
Science/Technology Parks and centers	0	1	2	3	4	5
Collaborative Research Centers	0	1	2	3	4	5
Other (Please Specify).....	0	1	2	3	4	5

2. How those linkages were initiated	Rank					
	(0-not at all, 1- very low to 5- very high)					
Personal relationships	0	1	2	3	4	5
Previous work relationships	0	1	2	3	4	5
Initiative by the university	0	1	2	3	4	5
Personal interest to from (technical) relationship	0	1	2	3	4	5
Family relationships	0	1	2	3	4	5
Relationship formed by a third party through grants	0	1	2	3	4	5
Invitation by the industry partner	0	1	2	3	4	5
Other (Please Specify)	0	1	2	3	4	5

3. What is the reason for you to involve in linkages with industry	Rank					
	(0-not at all, 1- very low to 5- very high)					
Funds to continue research	0	1	2	3	4	5
To assist industrial product/process development	0	1	2	3	4	5
Develop image of the university	0	1	2	3	4	5
Student's projects	0	1	2	3	4	5
To keep the relationships on the mutual benefits	0	1	2	3	4	5
Student's recruitments	0	1	2	3	4	5
To involve in application oriented research	0	1	2	3	4	5
Laboratory development	0	1	2	3	4	5
Development skills of the staff	0	1	2	3	4	5
Other (Please specify)	0	1	2	3	4	5

4. How do you receive funds for those linkages	Rank (0-not at all, 1- very low to 5- very high)					
Funds from University	0	1	2	3	4	5
Funds from the industry	0	1	2	3	4	5
Third party support as a grant	0	1	2	3	4	5
Direct Government funds	0	1	2	3	4	5
Foreign Funds	0	1	2	3	4	5
Other (Please specify)						

5. How do you coordinate/manage those linkages	Rank (0-not at all, 1- very low to 5- very high)					
University Licensing office/Contact office	0	1	2	3	4	5
Commercial /Service arm	0	1	2	3	4	5
Independent project officer	0	1	2	3	4	5
Student based management	0	1	2	3	4	5
Managed by the Industry	0	1	2	3	4	5
Assisted by the faculty	0	1	2	3	4	5
Managed by individual researchers	0	1	2	3	4	5
Other (Please specify)	0	1	2	3	4	5

6. How do you communicate with your partners in the industry	Rank (0-not at all, 1- very low to 5- very high)					
Regular meetings with industry and researchers	0	1	2	3	4	5
Official correspondence	0	1	2	3	4	5
Visits to sites by researchers	0	1	2	3	4	5
Informal talks/meetings	0	1	2	3	4	5
Assistance from students	0	1	2	3	4	5
Manage personally	0	1	2	3	4	5
Other (Please specify)	0	1	2	3	4	5

7. Please indicate the actual benefits that you have gained through your linkages with the industry	Rank (0-not at all, 1- very low to 5- very high)					
Funds for research	0	1	2	3	4	5
Product/process development New recruitment	0	1	2	3	4	5
Financial benefits to researcher	0	1	2	3	4	5
Commercialization of research results	0	1	2	3	4	5
Jobs/training for students	0	1	2	3	4	5
Upgrading curriculum to suit industry issues	0	1	2	3	4	5
Solving technical problems	0	1	2	3	4	5
Other (Please specify)	0	1	2	3	4	5

8. (a) According to your opinion, what are the major barriers to initiate a linkage	Rank (0-not at all, 1- very low to 5- very high)					
Difficulty in making appropriate contacts	0	1	2	3	4	5
Time commitment to find a suitable partner	0	1	2	3	4	5
Lack of reward & incentive system	0	1	2	3	4	5
Lack of information on research capabilities	0	1	2	3	4	5
Other (Please specify)	0	1	2	3	4	5
8. (b) According to your opinion what are the barriers to continue already established linkage more effectively	Rank (0-not at all, 1- very low to 5- very high)					
Lack of research orientation of the industry	0	1	2	3	4	5
Dissimilar motives	0	1	2	3	4	5
Absorptive capacity of the industry	0	1	2	3	4	5
Bureaucracy of the university	0	1	2	3	4	5
Lack of Communication	0	1	2	3	4	5
Other (Please specify)	0	1	2	3	4	5

C. Section three – Opinion on Policy issues

1. In your opinion, how the industry linkages with universities and research institutions can be made more productive (in terms of policy, legislative and organizational changes)

(Any other suggestions)

2. In your opinion, do you think that those linkages are important to improve the technological development of the country

(YES, (Please indicate the strategy of the Faculty/University to promote linkages)

No(Please comment)

D. Section four – Concluding section

It is expected to interview a group of respondents for further clarification and better expression on the above answers. Please indicate whether you would be willing to be interviewed?

Thank You

For spending your valuable time to fill this questionnaire

NSF –Study on University –Industry- Research Institutes Linkages

ABOUT THE SURVEY

Statement of confidentiality
The information that you provide will be held strictly confidential and will be used for the proposed PhD programme. The results and recommendations will be used as an input to the NSF policy directions for improving the industry linkages with the universities and research institutions. The information will not be reported in an identifiable form with individual, organization or business unit.

Survey endorsement:
The survey is conducted by the National Science Foundation of Sri Lanka as a part of the PhD study programme of Mr R.M.W.Amaradasa of NSF who has registered for a PhD degree at the University of Wollongong, Australia. The time frame available for the survey is pre-scheduled and hence, it is vital to perform the survey activities conforming to the time schedule.

Purpose of the survey:
The survey is designed to explore the major characteristics of linkages between industries and universities/research institutions in Sri Lanka. Information collected from academics, administrators in academic institutions, research managers, researchers, managers in industrial organisations and scientists & engineers in industries. It is expected to analyse the data collected from the survey and explore the existing linkages(types), motivation factors, barriers, etc. Also, the survey will lead to recommendations to NSF on policy and legal framework necessary for improving the linkages towards technological development of the country.

Assistance available

You may use the enclosed self stamped envelope to send your completed form to reach R.M.W. Amaradasa National Science Foundation 47/5, Vidya Mawata Colombo – 7.	If you have any problem or need further clarification in completing he questionnaire, please contact R.M.W. Amaradasa at; **Tele : 694163 Fax : 694754** e.mail: **wasantha@nsf.ac.lk**

Responses : Please return your completed form by 11th Mar 2002.
Your timely response is very important and very much appreciated

Person who should be contacted if any queries arise regarding this form

Name:	Tele phone
Signature :	Fax :

NSF –Study on University –Industry- Research Institutes Linkages

Scope of the study:

The survey will cover six sectors of the economy namely Rubber and plastics, Food and beverages, Information science, Fisheries, Textile and Construction. Universities other than three universities, which are situated in the war prone areas, will be included in the study. The relevant research institutions, which are established under he act of the Parliament to carry out specific research and development activities and industries (The public and private sector manufacturing and service enterprises including non-profit organisations in the country will be considered as industries) will also be included in the study.

Guidelines for Ranking:

You can give a rank to each of the item given in each question by circling the relevant number (5- Very high, 4- High, 3- average, 2- low 1- very low, 0- Not at all).

e.g. If the Government funds that you receive for collaborative work is low, you will have to mark Rank as "2" as follows;

Source of funds	**Rank**
Government funds	0 1 (2) 3 4 5

If there is an item that you think relevant and not listed in the form, you can add that item under "Other " and give a rank.

Thank you for your kind cooperation.

Appendix four – List of interviews

Confidential Page

Decision makers

Interview number	Name	Type of institution	Position	Institution
IN17	Fonseka, T.S.	U	Dean/Fac of Agriculture	Wayanmba Univ
IN21	Amarasekera, P.	U	Dean Fac of Science	Kelaniya Univ
IN27	Ratnayake, R.	G	Vice chairman	UGC
IN60	Ranasinghe, M.	U	Dean/fac of Engineering	UOM
IN62	Vitharana, T	G	Advisor	Min 0f S&T
IN63	Ranjan Rodrigo	R	Chairman	NERD
IN64	Weerasinghe,	U	Dean Fac of Agriculture	UOR
IN65	Nilaweera, D.	G	Consultant	Ministry of Policy implementation
IN66	Jayasuriya, N.	G	Executive officer	NASTEC
IN67	Subasinghe, P.	G	Secretary	Ministry of S&T
IN68	Gunasekera, P.	U	VC	UOP
IN69	Senaratne, R.	U	VC	UOR
IN73	Liyanage, K.	BI	Director	Ruhuna Business Incubator
IN74	Perera, S.	U	Head/ Dept of BM	UOR
IN75	Tilakeratne, L.	R	Director	RRI
IN76	Wickremasinghe	R	Director	VRI
IN77	Rangala, L.	IA	Consultant	Chamber of Exporters
IN78	Palipana, K.B.	R	Director	IPHT

Case Studies

Interview number	Name	Type of institution	Position	Insitution
IN39	Kodituwakku, S.	U	Director	UOP
IN61	Dias, S.	U	Director/UIIC	UOM
IN71	Karunathilake, K. E.	R	Director/AgEDIS	DOA
IN72	Albert, W.V.D.	IA	Consultant	PAEA

Sample of respondents

Interview number	Name	Type of institution	Position	Insitution
IN13	Fernando, N.	I	NA	Loadstar
IN14	Deerasekera, K.	I	NA	Auqa pack Ltd
IN31	Thiruchelvam	I	NA	Esjay
IN32	Nishantha	I	NA	Kins food
IN33	Fernando,	I	NA	Dipped products
IN43	Wijetunga	I	NA	Agro food
IN46	Pryadharsane	I	NA	MSP
IN47	Kahaduwa	I	NA	Mr Hop
IN48	Abeysinghe	I	NA	Polymer products
IN50	Tissera	I	NA	Orna fish
IN51	Alahakone, W.D.	I	NA	Country style
IN01	Jeevika	R	NA	NARA
IN03	Anton Fernando	R	NA	NERD
IN04	Vithanage	R	NA	NERD
IN10	Ranatunga	R	NA	NBRO
IN11	Samarakody	R	NA	NBRO
IN16-A	Thilakeratne	R	NA	IPHTI
IN44	Siriwardena	R	NA	DOA
IN49	Nandala	R	NA	RRI
IN55	Gunaratne, J.	R	NA	ITI
IN08	Gunasekera	U	NA	UOM
IN06	S.Perera	U	NA	UOM
IN07	Manatunga	U	NA	UOM
IN18	Bamunuarachchi, A.	U	NA	UOSJ
IN19	Wijesighe, N.	U	NA	UOP
IN23	Jinadasa, J.	U	NA	UOSJ
IN34	Wickramanayake	U	NA	UOC
IN35	Dilrukshi	U	NA	UOC
IN36	Jayasinghe	U	NA	UOP
IN45	Samarajeewa, U.	U	NA	UOP
IN52	Pallewatte, T.M.	U	NA	OU

Snowball sample

Interview number	Name	Type of institution	Position	Insitution
IN02	*Ananda Lal*	*R*	*Publicity officer*	*NARA*
IN05	*Piyasiri*	*R*	*Researcher*	*NERD*
IN09	*Samarasinghe*	*P*	*Diretor*	*ADB/UOM*
IN15	Motha	R	NA	ITI
IN16-B	*Fernando*	*R*	*NA*	*IPHTI*
IN22	*Jerry Jayasinghe*	*I*	*Owner*	*Jerry electronics*
IN24-A	*Shaheed*	*O*	*NA*	*CITI*
IN24-B	*Jayaweera*	*G*	*Deputy Director*	*CITI*
IN25	*Karunaratne*	*G*	*Secretary*	*UGC*
IN26	*John Silva*	*G*	*Secretary*	*IFF*
IN28	*Rashmi*	*I*		*Rashmi bakery oven*
IN29	Liyanage	U	NA	UOP
IN30	*Gamage*	*O*	*NA*	*SLIIT*
IN37	*Alwis*	*O*	*NA*	*ADB*
IN38	Karunaratne, P.	U	NA	UOP
IN41	*Laknath, P*	*P*	*Consultant*	*USAID*
IN42	Ediriweera, N.	R	NA	ITI
IN53	*Samarappuli, N.*	*G*	*Director(Research)*	*BOI*
IN54	Gunawardena	U	NA	UOC
IN56	*Peiris M.*	*I*	*General Manager*	*General motors*

Appendix five – List of codes sorted by clusters

Cluster	Issue	Sec	TOR	Target	Status	Intv no
Capability	Need to improve quality and knowledge base	R	U	I	EP	18
Central facilities	Need Adequate resources, knowledge on industrial setup and requirements	R	I	O	EP	13
Centrality/facilities	Need to have central facilities	R	I	G	EP	33
Centrality/facilities	Need service organization	SB	R	G	EP	75
Centrality/facilities	Relationships through central organizations	R	R	O	EP	4
Coordination	Need for coordinating center with PS outlook and management	R	I	UR	AT	14
Coordination	Mechanism to promote interactions	SB	R	G	EP	15
Coordination	National unit as meeting place	SB	U	G	EP	54
Coordination	No formal forum to disseminate to industry	R	U	U	EN	6
Coordination	Need separate arrangement for interaction	SB	U	U	EP	54
Coordination/ evaluation	Need mechanism for evaluation	R	R	R	EP	11
Coordination/monitoring	Monitoring mechanisms required	R	U	G	EP	35
Coordination/regulation	Private labs- need to regulate	R	R	G	EN	10
Culture	Cultural gap -depend on person	R	I	UR	EN	14
Culture	Difficult to change perception on Government Institutes	R	R	R	EN	3
Culture	Publication driven behavior of academia	SB	U	U	EN	54
Financial assistance	Need 2 years support to improve	R	I	G	EP	48
Financial assistance	Govt grant to services is needed	R	I	G	EP	43
Financial assistance	Financial facilities should be made available	R	I	G	EP	50
Financial assistance	Capital -difficult for development activities	R	I	I	EN	47
Financial assistance	Difficult to access capital for development	R	I	I	EN	32
Functional failure	Govt inst do not visit industries	R	I	G	EN	48
Functional failure	Confidentiality important	R	I	O	EP	13
Functional failure	Testing facilities not adequate	R	I	R	EN	51
Functional failure	Duplication should be avoided	R	I	R	EP	13
Functional failure	Need to focus strength and resource pool and coordinate	R	I	R	EP	13
Functional failure	Testing facilities not adequate	R	I	S	EN	48
Functional failure	Difficult to contact people	R	I	UR	EN	33

Functional failure	Test methods and facilities not adequate	R	I	UR	EN	46
Functional failure	No practical orientation	R	I	UR	EN	32
Functional failure	Services not satisfactory.	R	I	UR	EN	50
Functional failure	Long response time.	R	I	UR	EN	50
Functional failure	Capabilities is a problem	R	I	UR	EN	50
Functional failure	Reliability, timeframe, usage – not satisfactory	R	I	UR	EN	50
Functional failure	Not responding quickly	R	I	UR	EN	43
Functional failure	Retention is a problem	SB	R	R	EN	40
Functional failure	Training not adequate	SB	R	R	EN	75
Functional failure	Mobility of researchers towards Univ	SB	R	R	EN	40
Functional failure	Merit based promotions required	SB	R	R	EP	42
Functional failure	Lack facilities for pilot scale production	R	R	R	EN	55
Functional failure	Very little follow up as lack of funds	R	R	R	EN	10
Functional failure	No infrastructure, communication facilities, little flexibility not structured to market knowledge	R	R	R	EN	11
Functional failure	Researchers join higher education sector	R	R	R	EN	40
Functional failure	No infrastructure, communication facilities, little flexibility not structured to market knowledge	R	R	R	EN	11
Functional failure	Management is poor	R	U	I	EN	35
Functional failure	Need another set of top people	R	U	R	EP	45
Functional failure	Vocational training Not adequately covered	R	U	S	EN	45
Functional failure	Need trained committed people	R	U	S	EP	45
Functional failure	Speed is very important	R	U	S	EP	45
Functional failure	Student project duration cannot increase due to backlog	R	U	U	EN	35
Functional failure	No support from univ on industry related activities Training courses)	R	U	U	EN	18
Funds	Capital not available	SB	I	I	EN	31
Funds	Capital -difficult for development activities	R	I	I	EN	47
Funds	Need funds	R	I	U	EP	14
Funds	Funds for interactions	SB	U	G	EP	54
Incentive structure	Incentives as a BOI company	R	I	I	EN	50
incentive structure	No incentives	R	I	S	EN	48
incentive structure	No incentives to retain good staff	R	R	R	EN	16
incentive structure	No reward system	R	R	R	EN	10

incentive structure	No incentives for succeeded tech	R	R	R	EN	16
incentive structure	Should develop researchers by providing maximum opportunities	R	R	R	EP	11
incentive structure	Curiosity at a certain age	R	R	R	EP	11
incentive structure	Should support, encourage and provide incentives to execution of knowledge	R	R	R	EP	55
Incentive Structure	Incentives- not adequate	R	U	U	EN	18
Industrial dynamics	Foreign collaboration on marketing & Consultants	R	I	I	EN	33
Industrial dynamics	Import related expenditure is high	R	I	S	EN	48
Industry dynamics	Foreign collaboration on marketing & Consultants	R	I	I	EN	33
Industry dynamics	Import experts from research institutes	SB	R	I	EN	40
Industry dynamics	Lack capabilities	SB	R	I	EN	40
Industry dynamics	Lack facilities	SB	R	I	EN	75
Industry dynamics	Lack manpower	SB	R	I	EN	75
Industry dynamics	Lack understanding of basics	SB	R	I	EN	75
Industry dynamics	Industry not strong enough to address development activities	R	R	I	EN	10
Industry dynamics	Industry can influence the existence of inst	R	R	I	EN	16
Industry dynamics	Weak SMEs. Cannot accommodate extra expenditure on processing	R	R	I	EN	1
Industry dynamics	Industries-Fear to take student	R	U	I	EN	23
Industry dynamics	Ask for male students with English abilities	R	U	I	EN	19
Communication/systems	Need information about services and facilities	R	I	G	EP	50
Communication/systems	IS- What kind of support that industry can get	R	I	G	EP	51
Communication/systems	Information on service and what they can offer to industry	R	I	G	EP	33
Communication/systems	IS to know problems of the industry is needed	R	R	G	EP	3
Communication/systems	IS- May facilitate relationships	R	U	G	EP	8
Communication/systems	IS-Needed	R	U	G	EP	52
Communication/systems	IS- Need to publicize what can do and what has done	R	U	G	EP	19
Access to know how	Supplier network , visits, conferences, internet as sources	R	I	I	EN	14
Access to know how	Know how search through internet. Some from India through exhibitions	R	I	I	EN	17
Access to know how	Know how- from Australia through proprietor	R	I	I	EN	48
Access to know how	Know how_ Through internet and magazines	R	I	I	EN	50
Access to know how	Information through magazines for product development -	R	I	I	EN	51

Access to know how	Parent company support	R	I	I	EN	50
Access to know how	Suppliers useful to identify solutions	R	I	I	EN	50
Access to know how	Know how- Through journals, internet and other company	R	I	I	EN	51
Access to know how	World wide supplier buyer network. Connected through internet. Strong IT dept.	R	I	I	EN	13
Access to know how	Knowledge from reading and experience	R	I	I	EN	43
Access to know how	Univ as source of knowledge	SB	I	U	EN	31
Access to know how	Need to know the entire service process	R	I	UR	EP	47
Access to know how	Ideas through international exposure	R	R	R	EN	16
Market culture	Production- Subcontracted	R	I	I	AT	48
Market culture	Product diversity- On buyers requirement	R	I	I	EN	43
Market culture	Can not compete with imported products	R	I	I	EN	49
Market culture	Marketing- By word of mouth	R	I	I	EN	43
Market culture	Marketing difficult	SB	I	I	EN	31
Market culture	Cannot rely on farmers. Quality vary	R	I	O	EN	43
Market culture	Purchasing power of society is limited	R	R	O	EN	47
Market culture	Purchasing power matters	R	R	O	EN	51
Market culture	Low purchasing power	R	R	O	EN	32
Market culture	Local market do not need quality products	R	R	O	EN	1
Market culture	Low purchasing power of society	R	R	O	EN	1
Market culture	Industry in crisis. Scarcity of activities	R	U	I	EP	52
Market culture	Demand for agriculture reduced	R	U	O	EN	19
Modernization	Establish lab to keep quality	R	I	I	AT	43
Modernization	Go for private labs accredited	R	I	I	AT	43
Modernization	Should allow private practice	SB	R	G	EP	40
Modernization	Focus on technology rather than science	SB	R	G	EP	15
Modernization	Policies to retain generated funds	SB	R	G	EP	42
Modernization	Release researchers to work in industry	SB	R	R	EP	15
Modernization	Train researchers of RIS in industry	SB	R	R	EP	42
Modernization	Difficult regulations	SB	U	U	EN	54
Modernization	Generated income for essential work	R	U	U	AT	8

Modrnisation	System not flexible	SB	I	U	EN	31
Modrnisation	Confidentiality important	SB	U	I	EP	54
Negative perception	Low productivity. No commitment	R	I	U	EN	47
Negative perception	Technology leaks through students	R	I	U	EN	47
Negative perception	Students not creative enough	R	I	U	EN	47
Negative perception	Careful as students may spoil others	R	I	U	EN	51
Negative perception	Student come just to fulfill requirement. Commitment lacking	R	I	U	EN	13
Negative perception	Some wanted to be guided by the industry	R	I	U	EN	13
Negative perception	Take time to respond	R	I	U	EN	33
Negative perception	No practical orientation	SB	I	U	EN	31
Negative perception	No product developments done in universities	SB	I	U	EN	31
Negative perception	Overload of work for academia	SB	I	U	EN	31
Negative perception	Students low motivation, not mature enough	SB	I	U	EN	31
Negative perception	Students moral obligation lacking	SB	I	U	EN	31
Opportunity	Trend is for traditional foods	R	I	O	EN	47
Opportunity	Research institutes need for analysis testing & certificates	R	I	R	EP	13
Opportunity	Has potential for process development	R	I	U	EP	51
Opportunity	Many students are absorbed	R	I	UR	AT	13
Opportunity	New areas evolve, deeper investigation is required, plenty of fresh work, companies face tech problems regularly where assistance is needed	R	I	UR	EN	13
Opportunity	Industry is grouping up. They may address research issues	R	R	I	AT	10
Opportunity	Long term relationships with rice millers	R	R	I	AT	16
Opportunity	Confidentiality maintained	R	R	I	AT	55
Opportunity	Training- Cost recovery basis	R	R	O	AT	16
Opportunity	Testing services geared to generate income	R	R	R	AT	11
Opportunity	Training- Good demand	R	R	R	AT	3
Opportunity	Joint R&D with public sector	R	R	R	AT	16
Opportunity	Contacts over the years for testing service. Income adequate to run the division	R	R	R	EN	10
Opportunity	Testing major function	R	R	R	EN	10
Opportunity	Testing services-Framework for links exist	R	R	R	EN	11

Opportunity	Tech diffusion- ineffective	R	R	R	EN	1
Opportunity	ITI Capable of large projects	R	R	R	EN	55
Opportunity	Reorientation. Restructure to accommodate services, consultancy and technology transfer	R	R	R	EP	1
Opportunity	Need to do marketing	R	R	R	EP	4
Opportunity	Testing facilities could be improved for regular income generation	R	R	R	EP	3
Opportunity	Opportunity to improve service function	SB	R	R	EN	15
Opportunity	Personal contacts used to out reach service function	R	R	R	AT	4
Opportunity	Need to develop self image	R	R	R	EP	55
Opportunity	Service sector should support once development is proved	R	R	S	EP	55
Opportunity	Get job opportunities	R	U	I	EN	19
Opportunity	Discipline dependence	R	U	O	EN	8
Opportunity	Discipline dependence	R	U	O	EN	18
Opportunity	Personal contacts more important	R	U	O	EN	18
Opportunity	Generated income for essential work	R	U	U	AT	8
Opportunity	New forms- Good for new persons and to work as a team	R	U	U	AT	19
Opportunity	Accreditation will bring discipline to labs	R	U	U	EP	45
Opportunity	Opportunities to start up business	R	U	U	EP	19
Opportunity	Need research management for Universities	R	U	U	EP	45
Opportunity	Disciplines dependences	R	U	U	EN	11
Opportunity	Demand exist for textile graduates	R	U	U	EN	8
Org culture	Problem of accountability, transparency and general lethargy + political culture	R	U	G	EN	45
Org culture	Different time frames	R	U	P	EN	45
Org culture	System eroded. Before anything, get in house clean	R	U	U	EP	45
Orientation	Relationships with foreign univ through personal contacts	R	I	I	AT	33
Orientation	In-house training on management	R	I	I	AT	51
Orientation	Confidentiality important	R	I	O	EP	13
Orientation	New form should run as a commercial venture	R	R	R	EP	4
Orientation	Responsibilities between dealer & RI changed	R	R	R	AT	3
Orientation	Create competitive environment among dealers	R	R	R	AT	3
Orientation	Depend on motivation, personal commitment & incentives	R	U	O	EN	52

Orientation	Lobbying not performed	SB	U	U	EN	54
Perception	Intelligent, get feed back, good evaluation as neutral person	R	I	U	EN	14
Perception	Students-Good skills	R	I	U	EN	33
Perception	No commitment of researchers	SB	R	R	EN	75
Perception	Workforce not committed	SB	R	R	EN	75
Perception	Confidentiality, accuracy lacking	SB	R	U	EN	15
Perception	More relax work	SB	R	U	EN	40
Perception	Public sector not committed	SB	U	G	EN	38
Perception	OK with getting reading. Beyond that do not think.	R	U	R	EN	45
Perception	Sluggishness of University system	SB	U	U	EN	54
Perception	Student lack self-learning ability	SB	U	U	EN	54
Perception	Response time matters	SB	U	U	EP	54
Perception/culture	Govt office slow, under pressure, no facilities, not interested, lack commitment	R	I	G	EN	14
Policy culture	Policy should be consistent	R	I	G	EP	50
Policy culture	Circulars provide encouragement but does not apply.	R	I	G	EN	48
Policy culture	Incentive criteria contradictory	R	I	G	EN	51
Policy culture	Local industry not supported	R	I	G	EN	51
Policy culture	New regulations prohibit small industries	R	I	G	EN	43
Policy culture	Govt backing was negative	R	I	G	EN	48
Policy culture	Incentives- Contradictions	R	I	G	EN	47
Policy culture	Support from top	R	I	G	EN	14
Policy culture	No standards in SL	R	I	G	EN	46
Policy culture	Need special considerations for reputed exporters	R	I	G	EP	50
Policy culture	Private sector need policy directions 3-4 years in advance	R	I	G	EP	33
Policy culture	Labor laws does not promote productivity	R	I	G	EN	51
Policy culture	Govt policy do not promote local industry	R	I	G	EN	48
Policy culture	Associations strengthen the hands of industry	R	I	I	AT	51
Policy culture	Exporters forum as a channel	R	I	I	AT	50
Policy culture	Through associations and chambers and BOI/EDB forum	R	I	I	AT	33

Policy culture	Associations act on external matters	R	I	I	EN	50
Policy culture	Although policy change behavior remains	R	I	O	EN	50
Policy culture	Influenced by World Bank & influence by regional agreements	R	I	O	EN	33
Policy culture	Motivation oriented policies needed	SB	R	G	EP	42
Policy culture	Act does not allow commercial ventures	R	R	R	EN	3
Policy culture	Lack of vision & management	R	R	R	EN	55
Policy culture	Decision-makers - not committed enough	R	U	G	EN	18
Policy culture	Academia are not involved in policy formulations	R	U	G	EN	6
Policy culture	Construction bill in the shelves- as WB not accepted	R	U	G	EN	52
Policy culture	Recognition of academics is low	R	U	G	EN	6
Policy culture	Local level policy directions succeeded	R	U	O	AT	52
Research	Research- high risk	R	I	I	EN	47
Research	Research -no financial support	R	I	I	EN	43
Research	Research projects- Identified by individuals. Mostly national importance is considered	R	R	R	EN	10
R&D/funds	Funds for R&D from govt grant	R	I	G	EP	46
Recognistion	Lack recognition	SB	R	G	EN	
Recognistion	Scientists are not recognized	SB	U	G	EN	38
Research	Should allow industrialists to work in research institutes	R	I	G	EP	50
Research	Low research	SB	I	I	EN	31
Research	Want to try by self . Not by staff in research institutes	R	I	R	EP	47
Research	Researchers do not work in the filed. Interested in personal benefits	R	U	R	EN	23
Research	Lack hands on experience	R	U	R	EN	23
Research	Reliability and accuracy is questionable	R	U	R	EN	45
Research	Equipment not used properly	R	U	R	EN	18
Research	Lack committed people. Lack research culture	R	U	U	EN	45
Research	Do not look beyond the day to day work	R	U	U	EN	45
Research	Facilities adequate but much to do	R	U	U	EN	45
Research	Teaching material should be changed	R	U	U	EP	18
Research	Financial administration should be changed	R	U	U	EP	19
Research	Some equipment not properly used	R	I	R	EN	51

Responsiveness	Services should be quick as industry pays	R	I	R	EP	51
Responsiveness	Good contacts with research institutes	R	I	R	AT	48
Responsiveness	Links with research institutes on personal contacts	R	I	R	EN	51
Responsiveness	Curriculum should be practical oriented	R	I	U	EP	47
Responsiveness	Response time matters	SB	I	U	EP	54
Responsiveness	Student based relationships exist	R	I	U	AT	23
Responsiveness	Help when processing deviate from original, overcome problem with material, to challenge issues with supplier/buyers	R	I	U	AT	14
Responsiveness	Relationships through personal friend exist	R	I	U	AT	47
Responsiveness	Student projects help for analysis	R	I	U	AT	47
Responsiveness	Use students only in certain parts of the company to maintain company secrets	R	I	U	AT	33
Responsiveness	Personal contacts exist	R	I	U	AT	50
Responsiveness	Commitment important	SB	I	U	EP	54
Responsiveness	Limited to regular visits, seminars and lectures	R	I	UR	AT	51
Responsiveness	Attitudes of officers should be changed	R	I	UR	EP	48
Responsiveness	Help to establish labs	SB	R	I	AT	75
Responsiveness	Need research in industry	SB	R	I	EP	42
Responsiveness	Need to realize importance by industrialists	SB	R	I	EP	42
Responsiveness	Prioritization is needed	R	R	R	EP	3
Responsiveness	Dissemination trough seminars	R	R	R	AT	1
Responsiveness	Accommodate student projects	R	R	R	AT	16
Responsiveness	More application oriented Research is required	R	R	R	EP	3
Responsiveness	Scientific meetings are organized to meet industrialists	SB	R	R	AT	75
Responsiveness	Industry started moving, earlier blaming univ	R	U	I	AT	45
Responsiveness	Personal contacts with senior professors exist	R	U	I	AT	19
Responsiveness	Through personal contacts/student projects	R	U	I	AT	23
Responsiveness	Many activities in the sector	R	U	I	AT	45
Responsiveness	Industry come and do seminars	R	U	I	AT	34
Responsiveness	Student projects through personal contacts	R	U	I	AT	8
Responsiveness	Industry supervisor has a role	R	U	I	AT	35
Responsiveness	Associated with industry as representative from a professional body	R	U	I	EN	6

Responsiveness	Involve in postgraduate courses	SB	U	I	AT	
Responsiveness	Industry not interested	SB	U	I	EN	38
Responsiveness	Relationships only on personal contacts	R	U	I	EN	35
Responsiveness	Relationships-Very low key	R	U	I	EN	52
Responsiveness	Try to promote relationships through industrial associations	R	U	O	AT	18
Responsiveness	Visiting lectures from industry exist	R	U	U	AT	23
Responsiveness	Industry orientation	R	U	U	AT	6
Responsiveness	Industry advisory boards. Courses more liaison with professional bodies	R	U	U	AT	7
Responsiveness	Spin off company established. Not functioning well	R	U	U	AT	18
Responsiveness	New degree in industry based food science with more practical. Staff from industry and other fac. Exposed to international students	R	U	U	AT	19
Responsiveness	New curriculum. Self learning based	R	U	U	AT	45
Responsiveness	Part time Degree programme in IT	R	U	U	AT	34
Responsiveness	Semester system, new course units, industry components	R	U	U	AT	19
Responsiveness	Curriculum w.r.t industry and professional org requirements	R	U	U	AT	7
Responsiveness	Full Time/Part Time need to be balanced for Quality.	R	U	U	AT	19
Responsiveness	Industry licensing committee exist	R	U	U	AT	52
Responsiveness	Univ based service center opened	R	U	U	AT	34
Responsiveness	Representing at industrial forums	SB	U	U	AT	
Rule & Regulations	Regulations- Barrier	R	R	R	EN	11
Rule & Regulations	Need flexibility	R	R	R	EP	1
Rule & Regulations	More liberty is required by Univ	R	U	G	EP	19
Skills	Capabilities are inadequate	R	I	I	EN	48
Skills	People good but lack industrial exposure	R	I	UR	EN	33
Skills	Experience in industry is needed	R	I	UR	EP	32
Skills	Experience and training	R	I	UR	EP	48
Skills	Qualifications and experience	R	I	UR	EP	50
Skills	Skilled staff recruitment is needed	R	R	R	EP	3
Social dynamics	Social responsibility is disregarded in Sri Lanka	R	I	S	EN	48
Social dynamics	70% of income spend on food	R	R	O	EN	51

Social dynamics	Industry has sense of national benefit	R	U	I	EN	8
systemic failure	Govt structure negative	R	I	G	EN	48
systemic failure	Syatem- Pull back innovation	R	I	S	EN	46
systemic failure	No support at all	R	I	S	EN	32
systemic failure	Difficult to keep relationships continuously	R	I	UR	EN	33
systemic failure	Standards not yet established	R	R	G	EN	10
systemic failure	Not developed enough	R	R	R	EN	55
systemic failure	Not bothered commercialization as the system is not effective enough. Institute does not encourage	R	R	R	EN	55
systemic failure	No mechanism to protect knowledge. Hence do not need patent. Keep them as secrets	R	R	R	EN	55
systemic failure	Now reached by SMEs only	R	R	R	EN	55
Systemic failure	Corrupt system	SB	R	R	EN	75
Systemic failure	Human mobility -From industry & other univ	R	U	O	EN	34
systemic failure	Vocational training under review	R	U	S	AT	45
systemic failure	No technician training system	R	U	S	EN	18
systemic failure	System does not provide facilities to exposure to industry	R	U	S	EN	18
systemic failure	No help from the system	R	U	U	EN	8
systemic failure	Job opportunity soon after the exam in the past-	R	U	U	EN	34
systemic failure	Old generation failed to built up	R	U	U	EN	45
systemic failure	New generation-money and position oriented not work oriented	R	U	U	EN	45
systemic failure	Commercial basis services not possible	R	U	U	EN	19
systemic failure	Delays due to bureaucracy	R	U	U	EN	8
systemic failure	No benefit to the dept to do testing services	R	U	U	EN	19
systemic failure	No support from univ for relationships	R	U	U	EN	23
systemic failure	Lack leadership	R	U	U	EN	45
systemic failure	Management style has failed. Should come from the top	R	U	U	EN	45
Systemic failure	Mandate does not allow commercial activity	SB	U	U	EN	54
Technology culture	Machinery -Investment needed is high. Manufactured locally at low cost	R	I	I	AT	43
Technology culture	Relationships exist with importers, local experts	R	I	I	AT	46
Technology culture	Close relationships with competitors	R	I	I	AT	50
Technology culture	Product development -in-house	R	I	I	EN	51

Technology culture	Owner has engineering background and developed own machines	R	R	I	AT	55
Technology culture	No place for local tech. Banks do independent evaluations	R	R	S	EP	55
Technology culture	Links with Univ more formal. SMEs through IDB	R	R	U	EN	10
Technology culture	Univ -lab based, not practical oriented	R	R	U	EN	3
Technology culture	Cannot handle long term projects as people change	R	R	U	EN	11
Technology culture	Local firms cannot compete with foreign companies	R	U	I	EN	52
Technology culture	Capabilities of academia to handle industry problem is not adequate	R	U	S	EN	18
Technology culture	Academia has to develop their own image	R	U	S	EN	18
Technology culture	Technical knowledge of machinery	R	I	I	EN	32
Technology culture	Previous experience helped in product development	R	I	I	EN	47
Technology culture	Processing facilities should go to production sites	R	I	I	EP	51
Technology culture	Buyers assist technological solutions	R	I	O	EN	50
Technology culture	Manufacturing related designing capabilities are weak	R	I	O	EN	33
Technology culture	Tech secrets - not a problem . Tech cannot hide	R	I	U	EN	14
Technology culture	No national recognition for technologies developed locally	R	R	G	EN	10
Technology culture	Industrial products are developed with industry funds	R	R	R	AT	55
Technology culture	Technologies developed could not commercialize	R	R	R	EN	1
Technology culture	Extension arm weak in research institute	R	R	R	EN	1
External Influence	World Bank regulating economy	R	I	G	EN	14
External influence	Govt try to implement IMF recommendations	R	I	G	EN	51
External influence	Govt. not capable to negotiate with donors.	R	I	G	EN	51
External influence	External influence exist	SB	U	G	EN	54

Appendix six - Summary of India's tax incentives for innovation

Nature of tax incentive	Scope
Direct tax incentives	Under sections 35(1 and 2) of the Income Tax Act 1961, both revenue and capital expenditure on scientific research incurred by in-house R&D units on activities related to the business of the company is allowed to be fully(100%) deducted from the taxable income for that year. In the Union budget for 1997-98, the deduction for capital expenditure has been raised to 125% for a specified set of industries such as drugs and pharmaceuticals, electronic equipment , telecommunications equipment etc. Section 35(3) of the IT Act 1961 provides that 100% of expenditures made on capital equipment and related to research activities are allowed to be written off in the year in which the expenditure are incurred. A weighted tax deduction of 150% of the financial contribution made by industry on R&D projects and programs sponsored by industry in approved national labs , universities and Indian Institute of technology ..etc . the budget for 2001-02 proposed to extend this to biotechnology, for clinical trials, filing patents and obtaining regulatory approvals. It is also proposed that the entire amount paid to specified projects under the India Millennium Mission, 2020 will be eligible for 125% weighted deduction Depreciation allowance, at an accelerated scale on installed plant and machinery based on indigenous technology A five year tax holiday has been allowed to companies created exclusively for participation in R&D activities.
Indirect tax incentives - Custom duty exemptions	All recognized scientific and industrial research organizations (SIROS) are eligible for exemption on customs duty on the import of scientific equipment, instruments, spares and accessories as well as consumables for R&D activities and programs The union budget for 1996-97 introduced the provision of customs duty exemption on specific goods imported for use in R&D projects funded partly by any department of the central government and undertaken by a recognized in house R&D unit
Indirect tax incentives- Excise duty exemption	The SIROS have been exempted from excise duty on indigenous items purchased by them All recognized industrial units have been exempted from levy of excise duties for a period of three years for the goods produced by them based on domestically developed technologies and duly patented in any two countries out of India, the European Union(one country), the United States and Japan.

Sources: Mani (1997), DSIR(2000), Ministry of Finance(2001)

Appendix six- A

Correlation between type of relationship and the actual benefit obtained by the respondents - Industrialists

		Type of relationships														
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Benefite 1	Spearman correlation	0.5	0.357	0.57	0.62	0.28	0.38	0.42	0.58	0.5	0.27	0.416	0.27	0.43	0.46	0.228
	Approximate significance	0.006	0.06	0.002	0	0.13	0.051	0.026	0.002	0.009	0.17	0.028	0.16	0.024	0.014	0.26
Benefit 2	Spearman correlation	0.27	0.167	-0.018	0	-0.304	-0.169	0.296	0.025	-0.168	-0.27	-0.096	-0.23	0.009	-0.096	-0.32
	Approximate significance	0.15	0.386	0.92	0.99	0.1	0.389	0.119	0.9	0.4	0.15	0.62	0.23	0.96	0.62	0.1
Benefit 3	Spearman correlation	0.62	0.364	0.55	0.78	0.161	0.426	0.598	0.48	0.56	0.48	0.39	0.31	0.395	0.48	0.39
	Approximate significance	0	0.052	0.003	0	0.41	0.02	0.001	0.011	0.003	0.01	0.036	0.11	0.041	0.01	0.04
Benefit 4	Spearman correlation	0.36	0.58	0.46	0.52	0.178	0.4	0.41	0.172	0.23	-0.037	0.28	-0.006	0.178	0.192	0.17
	Approximate significance	0.044	0.001	0.011	0.003	0.347	0.02	0.021	0.38	0.23	0.85	0.13	0.976	0.348	0.3	0.38
Benefit 5	Spearman correlation	0.39	0.328	0.44	0.44	0.283	0.275	0.32	0.335	0.25	0.3	0.34	0.23	0.4	0.329	0.27
	Approximate significance	0.026	0.07	0.014	0.012	0.12	0.141	0.079	0.075	0.18	0.1	0.05	0.215	0.026	0.076	0.15
Benefit 6	Spearman correlation	0.39	0.234	0.26	0.34	-0.035	0.083	0.231	0.179	0.27	0.3	0.2	0.2	0.19	0.057	0.24
	Approximate significance	0.04	0.231	0.18	0.07	0.85	0.68	0.238	0.381	0.17	0.12	0.3	0.311	0.34	0.77	0.22

Appendix six - B

Correlation between type of relationship and the actual benefit obtained by the respondents - Researchers

Type of relationships

		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Benifite 1	Spearman correlation	0.2	0.065	0.18	0.16	0.247	0.21	0.056	0.253	0.49	0.56	-0.075	0.11	0.334	0.01	0.23	0.28
	Approximate significance	0.419	0.78	0.44	0.49	0.3	0.37	0.81	0.296	0.031	0.01	0.76	0.63	0.175	0.96	0.358	0.21
Benefit 2	Spearman correlation	-0.05	-0.157	0.153	0.02	0.102	-0.12	0.59	-0.124	0.33	0.45	0.1	0.2	0.21	0.21	0.191	-0.17
	Approximate significance	0.84	0.47	0.5	0.92	0.67	0.61	0.003	0.624	0.15	0.03	0.67	0.39	0.41	0.33	0.463	0.48
Benefit 3	Spearman correlation	0.078	-0.04	-0.1	-0.13	0.022	0.34	0.19	0.05	0.04	0.19	0.43	0.134	-0.254	0.03	0.066	0.1
	Approximate significance	0.75	0.85	0.66	0.57	0.93	0.14	0.397	0.84	0.86	0.4	0.072	0.58	0.32	0.88	0.802	0.68
Benefit 4	Spearman correlation	0.252	0.229	0.223	0.36	-0.014	-0.039	0.67	-0.052	0.32	0.62	0.31	0.6	-0.17	0.1	0.132	-0.19
	Approximate significance	0.31	0.332	0.374	0.12	0.955	0.873	0.001	0.84	0.19	0.004	0.226	0.007	0.53	0.68	0.626	0.42
Benefit 5	Spearman correlation	0.35	0.177	0.193	0.27	0.334	0.191	0.041	0.35	0.51	0.36	-0.119	0.133	-0.15	0.26	0.07	0.21
	Approximate significance	0.14	0.44	0.428	0.24	0.175	0.419	0.86	0.15	0.03	0.115	0.63	0.58	0.55	0.265	0.78	0.38
Benefit 6	Spearman correlation	0.25	-0.008	0.158	0.36	0.46	0.123	0.109	0.25	0.45	0.156	0.129	0.09	0.08	0.051	0.06	0.13
	Approximate significance	0.28	0.97	0.48	0.09	0.03	0.586	0.611	0.29	0.04	0.49	0.598	0.7	0.73	0.82	0.79	0.56
Benefit 7	Spearman correlation	0.19	-0.1	0.32	-0.19	0.13	0.072	0.101	0.06	0.2	0.16	-0.44	-0.194	0.052	0.55	-0.34	-0.139
	Approximate significance	0.43	0.64	0.14	0.38	0.58	0.762	0.648	0.8	0.41	0.47	0.06	0.427	0.84	0.008	0.17	0.55

Appendix six - C

Correlation between type of relationship and the actual benefit obtained by the respondents - Academia

Type of relationships

		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Benifite 1	Spearman correlation	0.252	0.286	0.376	-0.017	0.26	0.158	0.325	0.18	0.12	0.43	0.04	0.08	0.3	0.213	0.32	0.27
	Approximate significance	0.27	0.209	0.09	0.94	0.26	0.49	0.15	0.43	0.59	0.05	0.84	0.73	0.2	0.354	0.17	0.23
Benefit 2	Spearman correlation	0.45	0.272	0.422	0.376	0.29	0.3	0.6	0.25	0.31	0.23	0.12	0.035	0.059	0.104	0.236	0.156
	Approximate significance	0.02	0.198	0.04	0.07	0.16	0.16	0.002	0.22	0.13	0.27	0.57	0.87	0.79	0.63	0.289	0.46
Benefit 3	Spearman correlation	0.28	0.152	0.47	0.322	0.42	0.36	0.348	0.46	0.26	0.19	0.09	0.8	0.161	0.017	0.156	0.36
	Approximate significance	0.18	0.48	0.019	0.125	0.042	0.08	0.095	0.02	0.21	0.35	0.68	0.41	0.475	0.936	0.487	0.14
Benefit 4	Spearman correlation	-0.017	-0.052	0.315	0.013	0.247	0.32	0.217	0.15	0.095	0.35	0.34	0.3	0.407	0.383	0.616	0.21
	Approximate significance	0.94	0.81	0.154	0.956	0.28	0.14	0.33	0.5	0.672	0.1	0.12	0.19	0.075	0.078	0.004	0.34
Benefit 5	Spearman correlation	0.538	-0.029	0.038	0.154	-0.034	-0.149	0.3	-0.44	-0.117	0.17	-0.08	-0.21	-0.217	0.154	0.11	0.046
	Approximate significance	0.006	0.89	0.859	0.47	0.118	0.498	0.14	0.03	0.586	0.42	0.68	0.33	0.332	0.464	0.626	0.831
Benefit 6	Spearman correlation	0.128	-0.208	0.067	0.12	-0.105	-0.069	-0.114	-0.103	0.036	0.13	-0.26	-0.131	0.061	-0.059	-0.322	0.229
	Approximate significance	0.55	0.34	0.763	0.58	0.64	0.753	0.6	0.63	0.869	0.58	0.24	0.57	0.793	0.78	0.15	0.292
Benefit 7	Spearman correlation	0.72	0.449	0.385	0.15	0.048	0.211	0.69	-0.16	-0.135	-0.036	0.023	-0.021	-0.516	-0.039	0.013	-0.261
	Approximate significance	0	0.032	0.069	0.49	0.83	0.33	0	0.46	0.54	0.87	0.918	0.92	0.017	0.86	0.95	0.23