Systematic View of Innovation: Role of Universities in National Innovation System of Sri Lanka

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Abstract

In latter part of the 1980s, the systematic view of innovation at the national level has attracted much attention. This systematic view has become a popular research theme all around the world at present. Freeman (1987) and Nelson (1993) are important contributors to the perspective of National Innovation System (NIS). The concept is mainly focused on the inter-relationship and inter-dependencies among the major actors of NIS. The S&T Research Institutions, the Universities and the Firms representing industries are considered as the main three contributors of NIS. The inter-relationships and interactions among those actors are crucial for triggering innovation towards the socio-economic development of a country as a whole. This study aims to identify the role of Universities of Sri Lanka in NIS, to determine the existence of networking relationships with other main actors of NIS, to identify problems encountered by the University sector in terms of their presence or absence in NIS and to suggest required policy implications needed for strengthening the university sector as an effective player in NIS of Sri Lanka. The survey methodology was employed in the study and the entire population was to collect the data from the university sector mainly representing deans of the faculties and heads of the departments. Data was collected through a self-designed questionnaire after testing its reliability and ensuring validity. Supplementary to the survey and in-depth interviews were conducted with seven vice-chancellors to collect qualitative data and justify findings of the survey. 104 survey questionnaires were successfully collected from the whole population. Social Network Analysis (SNA) was employed to determine the strength of the networking relationship among the Universities, the S&T Research Institutions, and the Firms representing industries. Further, collected data were presented through descriptive and summary statistics. Qualitative data collected through interviews were analyzed through content analysis to draw a conclusion. The study revealed that there is a positive trend in the higher education sector towards performing an effective role in the future though there are minimum innovative activities and performance recorded at present.

Keywords: Innovation, Role of Universities, Networking, National Innovation System

INTRODUCTION

Innovation climates in developing countries have attracted much attention from recent. The reasons for lack of innovativeness in those countries were accounted to poor business and governance conditions, inadequate infrastructure and lower level of education. This raises significance and particular challenges to the development and promotion of innovation within the nation (OECD 1997). The flow of technology and information among people, institutions and enterprises can be identified as key to the innovative process based on the national innovation systems approach. Further, the complexity of relationships among actors in the system which includes universities, enterprises, and government research institutions is contributing to the development of innovation and technology (Feinson 2003). As the primary purpose of this research study aims to identify networking relationships maintained by the university sector among other actors of NIS of Sri Lanka. This is essential to the policy makers to understand the leveraging points for enhancing innovative performance and overall competitiveness of the country. The measurement and assessment of NIS has been based on four types of knowledge or information flows. The first flow is '*interactions among enterprises'* and it is primarily determined with joint research activities and other technical collaborations. Second flow defines as '*interactions among enterprises, universities and public research institutes'* that are including joint research, co-patenting, co-publications and more informal linkages. Third flow has been identified as '*diffusion of knowledge and technology to enterprises'.* This includes new technologies adoption rates by the industry through machinery and equipment. Fourth flow is '*personnel mobility'* that focuses on the technical personnel movement within and between the private and public sectors (OECD 1997). It is expected to improve innovative capacity of enterprises in terms of new products, patents and productivity through these flows accompanied with high levels of collaborations, technology transfers and personnel mobility. Hence, this research study is mainly addressing main research problem 'what is the role of national universities to strengthen the NIS of Sri Lanka?'. It will be addressed with three other specific research questions;1) what is the strength of networking relationships maintained by the departments and faculties among other universities, faculties and academic departments?2) what is the strength of relationships maintained by the university sector among the firms in industry? and 4) what is the strength of relationships maintained between the university and the research institutions?. Addressing the above research problem and questions of the study, it is expected to make important policy implication for improving the effectiveness of NIS of Sri Lanka.

SIGNIFICANCE OF THE STUDY

The attempt in producing innovative products and services is crucial function for the development of a country. Innovation is considered as an essential component or the engine of modern economies to survive within the global competition through introduction of new products, services and processes. In this NIS approach, it stresses the importance of the interrelationship among the major actors to create and diffuse new knowledge and technology for the commercial benefits. Among the major actors, the universities are now moving to play an essential role that contrasting from traditional teaching roles to more complex and active engagements with industry and other S&T institutions (public and private), in terms of research works, sharing infrastructure, technology transfer through skilled technical personnel etcetera. Therefore, the understanding of the significant strength of the existing relationships between university and other actors is a key to contribute to better performance of the NIS. The main purpose of this study is to understand network relationships established among the actors from the universities point of view. Result of this study has a significance value to enhance the effectiveness of NIS within the country through proposing required policy implications.

UNIVERSITY SYSTEM IN SRI LANKA

The university system in Sri Lanka has been restructured with the No. 16 University Act of 1978, vesting the power to the University Grants Commission (UGC) as an apex body of the university system to plan and coordinate university education, allocate funds to Higher Educational Institutions (HEIs), maintain academic standards, regulate and administer HEIs and handle admission of students to HEIs. There are 15 national universities and three campuses directly governed and funded by the UGC and Sri Lankan government. Several private higher education institutions have also been incorporated and started their operations in the recent past with the support with the new policy of Sri Lankan government.

As presented in the UGC statistics book (2014), the expenditure in university education as a percentage of government expenditure was 1.42 in 2012 and it had been raised up to 1.66 in 2013. The average student's per capita cost in university education was 246,663 in 2012, and it had been increased to 288,175 in 2013. The total expenditure on education was Rs.150, 274 Million in 2013. Out of this total expenditure on university education was Rs.27,838 Million, which included Rs. 21,655 Million in recurrent expenditure and the Rs. 6183 Million in

capital expenditure. The spending on the recurrent expenditure in percentage was 77.57% and on the capital expenditure was 22.43% in 2013. As a result the grand total of capital expenditure in higher educational institutions was Rs. 6,183,474,000 in 2013. The income of university education consists from other income and the government grants. The total income received to the higher educational institutions was Rs. 28,064,075,000 in 2013. The amount of government grant was Rs. 23,130,198 while the other income amount (self-earned) was Rs. 4,934,777. The percentage of other income was 17.58% in 2013 while government grants as a percentage 82.42%.

LITERATURE REVIEW

The Role of Universities in NIS

The attention on the role of universities in the NIS of a country has been continuously increased. This is a result popularization of findings of university research activities in the processes of development of new products, services and technologies introduced by the industry. This has led to increase the importance of multi- and inter-disciplinary research and development. Further, it has strengthened interrelations for the purpose of industrial applications of basic research activities. The early research on NIS concerned technological innovation process as the core on firm activities in the beginning of 1990s. According to Lundvall (2010) early research models attempted to measure firms' innovation performance in terms of new products developed, linkages maintained between firms and other actors in the NIS. This also includes the capability of a firm to absorb technologies developed by knowledge creators. In recent scholarly works, the specific role played by other actors, such as governments and universities is also emphasized. Government role is defined in relation with creating policy incentives while the universities role has been linked in conducting research. Therefore, the triple actors' model named "Triple Helix" emerged to give a deeper understanding on the relationships among these actors (Etzkowitz and Leydesdorff 2000). This model opened up an alternative avenue for NIS studies by addressing knowledge commercialization though licensing or through starting spinoff companies linked to the universities. The traditional role in teaching and research of the universities was considered as their first priority. Transferring the knowledge to industries and society began to be considered as the next priority. The third priority was the stream combination of first and

second priorities. These three modes of streams require specific policies and resources to ensure the effective functioning for a strong NIS.

As a part university role, it needs to develop models, marketable ideas and also transfer those effectively to the industry for commercialization. Triple – Helix concept emphasized the necessity of university-industry-government interactions for these fruitful modes of streams. Identifying the role of universities in the process is a bit difficult task. However, it can be identified as engagement in joint research activities together with industry firms, transferring new products to industry, sharing infrastructure, mobility of high trained research and development personnel and visiting lecturing for industry etc. Universities distribute knowledge via teaching and improve the stock of human capital. Apart from that university broaden the knowledge via researching. Without satisfying from above, they need to transfer the generated knowledge to society by collaborating with industry. This category of activities is the results of the first two functions that are education and research. Third stream has not yet been a core function in the same way as the first two streams but it seems increasing attention on this. Today, universities have to play an active role in transferring knowledge, science and technology development to useful innovations all the times. In the global context, all national, regional and local levels are motivating the "third stream" which is describing the collaborative role of universities industries. Currently, university involvement for the innovation based development is greatly appreciated than earlier (Geuna and Muscio 2009).

Eminent universities in the world have shown three missions to be accomplished. They are trying to excel as well as to exploit and create strong connection among those missions that are teaching, conducting research and technology transfers (Van Looy et al 2004). Role of modern universities have been recognized as create and introduce potential innovations for the requests of the societies. This requires engaging in basic research activities mainly since those are characterized by high uncertainties in market and technological successes and the long-term visibility of impact. Hence, there is a tendency that private investors are trying to stay away from basic research. It has become a key function of the universities and public research institutes generating science-based knowledge as a result of the reluctance of the private sector firms. In addition to the formal relationships which can be recognized easily, there is a countless of informal relationships lies on innovation processes, skill transferring and science based industry networks either on personal or organizational levels. The way of knowledge exchange among firms and research institutes emphasizes the importance of

informal relationships and flows of human capital. According to Chesbourgh (2003), science and technology laboratories at universities need to make available for open innovation projects which are closely monitored by companies who engaged in those research and development activities. Researches with more academic orientation reveal appropriate methodologies required frameworks that can be utilized in applied researches engaged by firms in their own R&D facilities. Depending on the findings of scientific researches, firms can develop a better foundation for their technological landscapes in search of inventions for the future. Based on this foundation they are allowed to foresee future innovations, evaluate those from different aspects and transform those to successful commercialized innovation (Rosenberg, 1990; Fleming and Sorenson 2004).

Many countries are searching for better policies to create strong and fruitful collaborations among universities and industry. This policy formations and applications have created a value for university-based research and hence, transferred those to successful innovation boosting economic performances (Cohen and Noll 1994). Accordingly, those policy initiatives have created sharing premises that universities can help to the innovation initiated by the industry. Triggering potential deliverable innovations for commercialization through this support and sharing mechanism is the main focus in this research paper.

NIS in Developing Countries

The condition of NISs in developing countries has been addressed by the recent studies. Accordingly, there is a limited presence of required institutions in many developing countries (Intarakumnerd et al 2002). Further, they have pointed out that industrial innovation in many developing countries is highly informal and unsystematic. Innovations in those countries are not the results of formally articulated through conscious engagements in R & D activities. Subsequently, it has been emphasized that the dominant cultural patterns of these developing countries do not appreciate the importance of scientific knowledge and technological innovation. Hence, it is concluded that NISs of developing countries are less developed by order. These systems have not much contributed for the institutional and technological properties required for modern economic growth. It is necessary to understand the way that innovation process is operating with current economic position and the changes expected within the country. This are should be studied in line with the context of economic development. The studies in NISs should be interconnected with the country's economic and

institutional development and growth. Newly industrialized countries such as South Korea, Taiwan have paid attention on strengthening their NIS and were able to acquire a great economic growth. The developing countries need to pay considerable attention on enhancing their strategic capacity for innovation in the government level, institutional level, educational level etc. Comparing major inputs of the NISs in developing countries with those of developed countries, it is noted that capital accumulation which facilitates knowledge creation and learning is significantly higher in developed context resulting strong NISs. It can be concluded that innovation is the results of the collaboration between societal activities and findings of the science and technology initiatives. However, innovation does not count only as a result of technology creativeness. Most of the specific regional, social, economic factors affect to the effective innovations to be developed within countries. Therefore, the understanding of the innovation and NIS diverges from place to place. The more the developing countries need to fill this gap exist in the NISs learning from developed and newly industrialized countries and thereby to grasp the benefits of increased economic performances.

METHODOLOGY

Research Method

The mix methodology applies in the study combining quantitative and qualitative approaches for data collection and analysis. This study has been employed the survey methodology and in-depth interviews as data collection methods.

Sampling Procedure

Population: The entire population of the representative from universities, faculties, study departments or units were considered as unit of analysis of the study. All the vice chancellors were selected to conduct in-depth interviews. The deans of faculties and heads of the departments in the government universities in Sri Lanka were included in the population for the survey.

Sample size: All the departments and faculties in the Sri Lankan state university sector; 15 national universities with 80 faculties, 3 campuses and 494 academic departments were taken for the assessment. And the entire population was taken as the sample.

Sample unit of analysis: the unit of analysis is individual academics held administrative positions (vice chancellors, faculty deans and department heads) in the state universities of Sri Lanka.

Data Collection Approach

In order to achieve the objective of the study both primary and secondary data were collected. Survey method and in depth interviews used as main primary data gathering approach and official university records and documents were retrieved for secondary data collection. At the initial stage, a questionnaire was sent to all the deans of the faculties and heads of the departments both by mail and e-mail and was followed by extensive assistance and guidance given by the data collection team either having telephone discussions, appointments or meeting et cetera. Amidst time limitations and non-responsiveness, there were 104 responses at the response rate of 18 per cent from 24 Deans of faculties, 77 heads of departments it was sufficient to the analysis. Two responses were remained unidentified due to insufficient information.

Methods of Data Analysis

Both quantitative and qualitative methods were used to analyze the collected data. Qualitative data collected from in-depth interviews were analyzed with narrative analysis and content analysis. For the purpose analyzing quantitative data it was used SPSS 21.0 version and descriptive statistics were calculated to summarize and average the research data and to describe main characteristics of the sample. Data from the Faculties and Departments in the Sri Lankan university system were analyzed to reveal their existing relationships with other universities, science and technology research institutions and the firms in the industry and also to illustrate and measure the strength of relationships using Social Network Analysis (SNA), a powerful method to image social reality. For the purpose of summery calculations and drawing graphs with the SNA, NodeXL version 1.0.1.350, user friendly software was used.

Instrument validity and reliability

Validity of the dimensions used to measure the strengths of the relationships was ensured through extensive literature survey as discussed in previous sections. It is urged to measure

the reliability of the data collected, the reliability of the questionnaire was tested under main categories. According to the research model presented in Figure 1, three major types of relationships were identified. They are the type -1 relationships that exist among academic faculties/departments and the other universities. The type-2 relationships which are maintained by faculties/departments with science and technology research institutions and the type-3 relationships are the relationships that exist among faculties/departments with firms in the industry.

The above three types of relationships are measured on five dimensions and they are;

1. The frequency of conducting joint research activities;
2. The frequency related to the inviting of personnel for visiting lecturing for the faculty/departments;
3. The degree of conducting the mutual joint research conference;
4. The frequency of the conducting and engagement in workshops, meetings, training, and consultancies for the improvement of skills and knowledge sharing;
5. The frequency of sharing research and development infrastructure with each other.

Before moving to the reliability testing of the main three relationship types the sample adequacy was measured using the factor analysis. As the benchmark for this "KMO and Bartlett's Test" was used. The outcome indicated a value of 0.752 which was greater than 0.5, thus considered as the sample is adequate to represent the whole population of the research study. After that, the reliability analysis was conducted separately for the main three types of relationships. The overall reliability value was 0.776 which exceeds 0.7 Cronbach's alpha value. This satisfies the reliability of the measurements. The questions included regarding the first type of relationship which is relationships exist among academic faculties/departments and the other universities. The overall reliability value calculated as 0.880 and it is above 0.7 Cronbach's alpha value. This proves the reliability of the measurements used. The questions included regarding the type-2 relationships that is relationships maintained by faculties/departments with S&T research institutions. The reliability is proven with Cronbach score of 0.846 which is greater than 0.7. The questions included covers the type-3 relationships that are the relationships exist among faculties/departments with firms representing the industry.

RESULTS AND DISCUSSION

This research study tries to explore the networking relationships exist among the three main actors of the national innovation system of Sri Lanka under the umbrella topic of role of universities in NIS in developing countries. Following the survey methodology, the data were collected on the network relationships among the universities, the science and technology institutions and the firms in the industries. It was succeeded in collecting 104 completed questionnaires to reveal the relationships maintained by each the departments and the faculties over five dimensions identified and used SNA methodology to graph and measure the collected data. There were three main analyses completed to reveal university-university relationships (type 1), university- S&T institutions relationships (type 2) and university-industry relationships (type 3) as explained in Figure 1.

These partnerships analyzed with the strength of relationships across each dimension. Summary statistics and standard drawings were used to identify and measure strength of the relationships using NodeXL application software. The data showed that there is considerable number of relationships maintained among the departments and the faculties in the university system (Figure 2). However, there is no sufficient number of relationships found between the departments/ faculties with other actors namely the S&T institutions (Figure 3) and the firms in the industry (Figure 4). There is a clear division between the faculties and the departments in established universities and the faculties and the departments attached to newly established universities. Most of the edges are directed to the established universities since other remote and newly established universities seek the assistance from established universities for the purpose of facing the challenges inherited with their remoteness and low level of maturity. The University of Colombo, the University of Peradeniya, the University of Sri Jayewardenepura, the University of Kelaniya, the University of Moratuwa and the University of Ruhuna work as centers of making bridges among different departments and the faculties located in different provinces of Sri Lanka.

There were a number of network relationships between the Departments or the Faculties of university system and S&T institutions as revealed in this study (Figure 3). Respondents were asked to rank the relationships based on the strength of the ties with the suggested ten S&T institutions. Based on the responses, it was identified that NSF is the mostly linked S&T institution in all five dimensions with the university departments and faculties that responded

to the survey. NERDC, ITI, CRI and Arthur C. Clerk center are maintaining the relationships with the university sector after the NSF. However, the number of edges and betweenness centrality is not strong enough to show tight relationship between the two sectors. Networking relationships between the university sector and the firms in the industry were tested as the third part of the study. The departments or the faculties were requested to name the institutions and indicate the strength of such ties. There were limited networks which revealed. A few numbers of firms were suggested by the responded faculties/ departments in the university system. Hence, it can conclude that there is a limited networking relationships that exist between university sector and the firms in the industry. This finding is the confirmation based on the limited relationships revealed in the survey conducted for identifying the innovative behavior of SMEs and large firms in the industries (Weerasinghe et.al 2014).

These results are confirmed with the interview data obtained through interviewing Vice Chancellors. Further it was found that there is a good tendency in allocation of resources towards innovation infrastructure and trend in establishing effective networking relationships. The weak relationships found among the universities, the S&T Institutions and the firms were justified with the limited resources available in the university sector, restricted to mode one mission, prevailing culture among university staff and students and lack of consistency of the government policies on education system of the country. Most of universities are still define their role is primarily facilitation of knowledge sharing and learning, hence tagged as teaching universities. It was emphasized the importance of active engagement of the university sector by deploying more resources for innovation, encouraging academic members to engage in collaborative research activities which will address the practical issues of the industries to bridge the gap between the expected innovative performance of the university sector and the actual performance. This study indicates the importance of establishing strong partnerships among universities, S&T institutions and the firms representing industries, Universities are requested to play leading role to connect the knowledge creation process and facilitating firms to commercialize created knowledge collaboratively.

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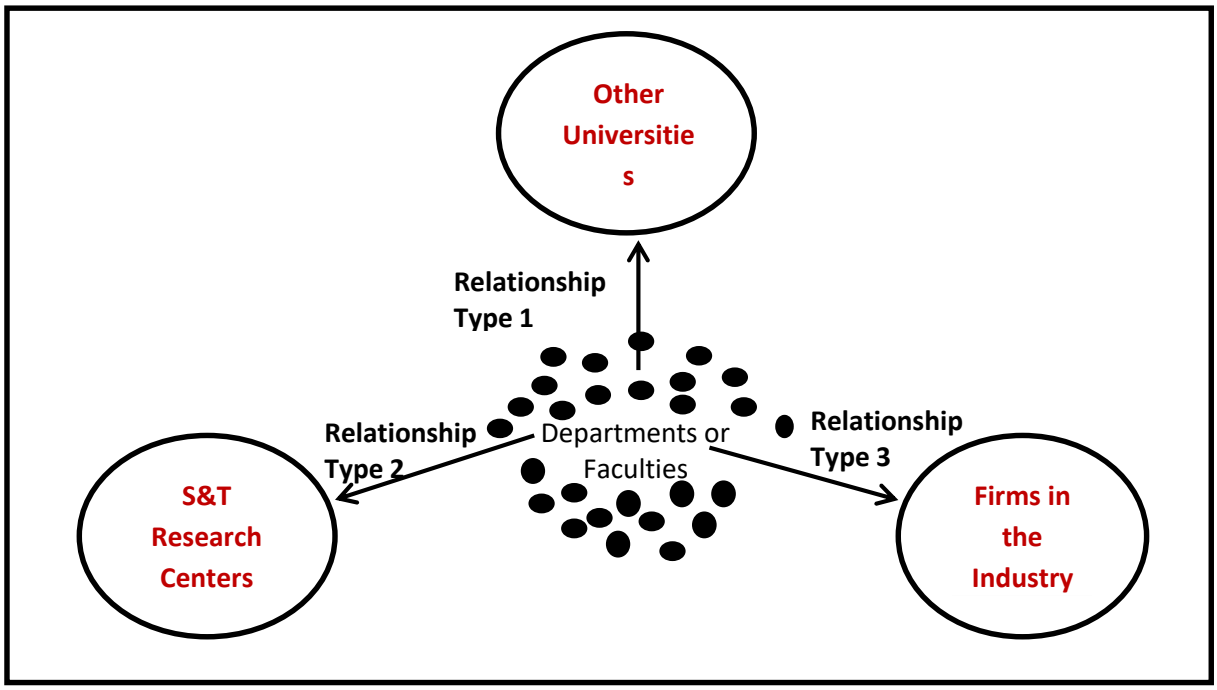
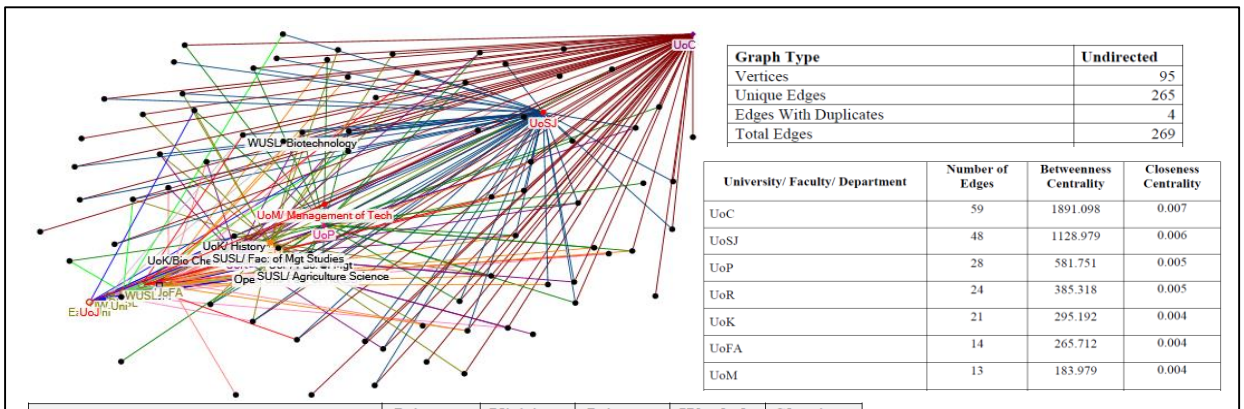


Figure 1: Networking relationships among faculties/departments and other actors of NIS

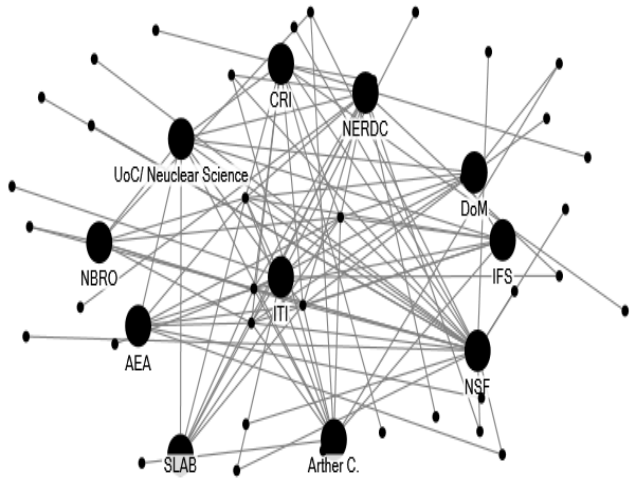


Graph Type	Undirected
Vertices	95
Unique Edges	265
Edges With Duplicates	4
Total Edges	269

University/ Faculty/ Department	Number of Edges	Betweenness Centrality	Closeness Centrality
UoC	59	1891.098	0.007
UoSJ	48	1128.979	0.006
UoP	28	581.751	0.005
UoR	24	385.318	0.005
UoK	21	295.192	0.004
UoFA	14	265.712	0.004
UoM	13	183.979	0.004

Characteristics	Joint Research	Visiting Lect.	Joint Confer.	Workshops & train.	Sharing R&D Faci.
Graph Type	Undirected				
Vertices	63	90	65	86	42
Unique Edges	142	233	163	204	99
Edges With Duplicates	0	4	2	4	0
Total Edges	142	237	165	208	99

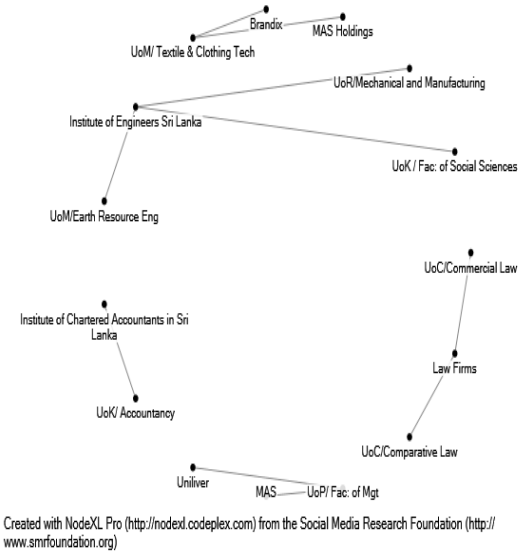
Figure 2: Illustration of relationships among Faculties/Departments with other Universities



Graph Type	Undirected
Vertices	49
Unique Edges	104
Edges With Duplicates	0
Total Edges	104
Self-Loops	0

Label	Degree	Betweenness Centrality	Closeness Centrality
NSF	22	518.101	0.011
NERDC	11	138.574	0.009
ITI	11	172.045	0.009
CRI	11	204.500	0.009
Arther C.	10	90.673	0.008
IFS	8	94.500	0.008
AEA	8	62.824	0.008
NBRO	8	25.931	0.008

Figure 3: Network relationship among Departments/Faculties in the University sector and National R&D Institutes



	Any kind of links	Joint research	Visiting lecturing	Joint Conferences	worksh ops, training	Sharing R&D infra
Graph Type	Undirected					
Vertices	15	12	15	13	15	10
Unique Edges	10	8	10	8	10	7
Edges With Duplicates	0	0	0	0	0	0
Total Edges	10	8	10	8	10	7

Firms	Degree	Betweenness Centrality	Closeness Centrality
Institute of Engineers Sri Lanka	3	3.000	0.333
Law Firms	2	1.000	0.500
UoP/ Fac: of Mgt	2	1.000	0.500
UoM/ Textile & Clothing Tech	2	1.000	0.500
UoC/Commercial Law	1	0.000	0.333
UoC/Comparative Law	1	0.000	0.333

Figure 4: University Industry relationships in terms of any kind of relationship for innovation

List of Abbreviations:

Name of the S&TResearch Institute	**Abbreviation**
Institute of Fundamental Studies	IFS
National Engineering Research and Development Center	NERDC
National Science Foundation	NSF
Arthur C. Clarke Institute for Modern Technologies	Arthur C.
Atomic Energy Authority	Atomic
Sri Lanka Accreditation Board for Conformity Assessment	SL Acc
Industrial Technology Institute	ITI
National Building Research Organization	NBRO
Department of Meteorology	METEO
Coconut Research Institute	Coconut Re
Name of the University	
University of Colombo	UoC
University of Peradeniya	UoP
University of Sri Jayewardenepura	UoSJ
University of Kelaniya	UoK
University of Moratuwa	UoM
University of Ruhuna	UoR
Open University of Sri Lanka	OUSL
Eastern University of Sri Lanka	EUSL
South Eastern University of Sri Lanka	SEUSL
Rajarata University of Sri Lanka	RUSL
Sabaragamuwa University of Sri Lanka	SUSL
Wayamba University of Sri Lanka	WUSL
UvaWellassa University	UW Uni.
University of the Visual and Performing Arts	UoFA