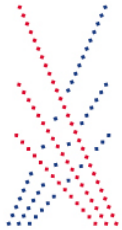

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Research Interest

The main concern of this research was to check the practical implications of Triple Helix in Peshawar, Pakistan, which is a developing country and this model has not been tested in the Peshawar region. In order to check the implications for Peshawar, I intended to empirically explore how the Triple Helix model has been applied worldwide and what the results are. Results of these articles can then enable a conclusion to be drawn on how to implement the Triple Helix model in Peshawar. For this purpose, seventy-two papers were chosen for the review. However, topics and findings of these research articles were so overlapping that themes could not be drawn easily. Finally, four themes were derived from 62 articles while 11 articles were chosen for general discussion that can guide developing regions for adopting the Triple Helix model. Based on the Triple Helix's contribution to research fields, the entire research was categorized as such: twenty articles are chosen on the Triple Helix model and R&D; seventeen articles were selected under Triple Helix and the innovation theme; a total of twelve articles covered Triple Helix and economic development; thirteen papers were chosen for Triple Helix and industrial growth and ten were selected for general discussion which is provided at the end of the chapter. Each theme, sample size, research approach and findings are discussed in detail in their respective sections. At the end of each theme, two research articles, one on a developed or newly developed country and one on a developing country, is critically evaluated and then, in the light of these articles results, the implications for Peshawar, Pakistan are discussed in detail. Finally, a conclusion is given at the end of the essay. The criteria for selecting two articles for detailed evaluation under each theme is their research relevance and findings based on measured results. Articles whose results and findings were derived from library researches or secondary data only are generally discussed.

Introduction

As the universities' role in the Triple Helix model is to generate a knowledge economy (Etzkovitz and Zhou, 2017), I investigated the empirical evidence by which it is sustained. To make it more pragmatic, I adopted systematic review method (Tranfield et al., 2003). The purpose is to generate collective insights through critical review of the findings. A total of 72 research papers on Triple Helix were reviewed and details of these research papers were then listed in table form. During the review process of these tables, four research themes were identified that were frequently used by researchers. The themes identified during the review process were R&D and Triple Helix; economic development and Triple Helix; innovation and Triple Helix, and the role of Triple Helix in the industrial growth of a country. Here it is worth mentioning that the majority of the research is significantly influenced by the legacy of Etzkowitz. As such, knowledge in the studies chosen for review is treated as an asset that can easily be re-used. Finally, conclusions are drawn by identifying research future trends.

Mapping the Research

This review was restricted to publish peer reviews; academic articles held within the following databases: ISI Web of Knowledge; Business Source Premier; Science Direct; Scopus and Google scholar. These were chosen from amongst others as providing the largest number of returns using a basic keyword search of the Triple Helix model and developed* Developing* Newly industrialised countries* and empirical studies. Each database was interrogated by the search strings listed above. Research interest was limited from the years 2000 to 2013. Titles, keywords and abstracts that were published during year 2000 to 2017 were searched, where more than 150 studies were retrieved and exclusion criteria were included in order to refine the search. For example, studies on Medical Sciences were not included since the concept of Triple Helix carries other meaning in Medical Sciences. Therefore, inclusion criteria were limited to Social Sciences, Business Studies, and Computer Science. The total number of potentially relevant studies retrieved using search strings was 150. These were exported to Refworks, a referencing database where they were further reviewed against the inclusion and exclusion criteria in using key word, searches, year of publication and title analysis. Also, duplicate studies were removed. At this stage, a thorough review of the abstracts alone was conducted and the articles that were relevant

to the year of publication, title, search strings were selected for review (Macpherson and Holt, 2007). It should be noted that the selection criteria at this stage was not the study quality alone but its fit within the literature review, which is empirical research conducted on the Triple Helix model worldwide. Abstract selection of the empirical studies on the Triple Helix model was made on the basis of methodology, sample size, main findings, country, and title of the paper, journal and year of publication.

All the abstracts that were exported to the Refworks data base did not outline the methodology; the main findings and sample size and therefore a second option was to read the full text of the articles. At this stage, the need for more coherent, succinct abstracts was felt that could enable its audience to judge the desired criteria of the topic without reviewing the whole article (Macpherson and Holt, 2007). Whilst many of the studies about developed economies could be found in high impact journals, research articles published in top ranking journals were explored in the first stage. Locus of the study primarily falls in three types of countries: developed, developing and newly developed countries. Research articles about developing countries published in less-established journals were identified in the second stage, since many articles about developing countries could not be found in top-ranking journals.

The total number of articles chosen on the basis of relevance was seventy-two. Twenty-four studies were based on comparative analysis of two or more countries. In these comparative analyses, fourteen articles were comparatively analysed from developed countries; seven studies were analysed in developed and developing countries. Three researches were on a general discussion about many countries. Individual studies on developed countries amounted to twenty-eight in number, where the research article recorded on the US was highest in number, which is seven. Other developed countries researched were as such: Canada was researched three times; Australia, Germany, Denmark, Japan and Portugal were researched twice and the UK was researched twice. The remaining developing countries reported in the table were studied only once. African regions, as a whole, were researched twice. The total twelve developing countries were explored; out of which, Thailand and China were studied twice, while the remaining developing countries in the tables list were studied once. Research articles on newly industrialised countries (NIC's) amounted to ten; out of which Mexico and Brazil were studied three times, while articles on South Korea and Malaysia were two in number.

Triple Helix and R&D

Research articles that are selected for evaluation in this section are twenty in number. These articles are organised in table form (Table 1, appendices). Findings of eighteen articles are generally discussed in this section that recommends research has a central role in the regional innovation system. Two papers are selected for detailed discussion whose research topics and findings have direct implication for Peshawar, Pakistan. Justification for selecting these two papers is given in the beginning of the discussion section.

The Etzkowitz model emphasises strong research collaboration among the three spheres of the Triple Helix. The model suggests that university R&D plays a central role in regional innovation. Therefore, governments should encourage entrepreneurial universities and support R&D activities in their region. This concept of the Triple Helix model is empirically researched by many researchers in the developed and developing world to test the impact of the university and other public research organisations on regional economic growth and innovation. These studies are discussed in this section. Results of these studies identified many issues that affect research practices, such as research evaluation and performance (Cooke, 2004). For example, in the USA where research is funded from external sources, universities have to compete for these funds. High competition among universities to access research funds in return influences research groups' behaviour formed within academia. Therefore, these groups develop firm-like characteristics as, hence, quasi-firms are formed within academia prior to their engagement in entrepreneurial activities (Etzkowitz, 2003). Pressure on research organisation is also found by Banner and Sandstrom's (2000) study in Sweden. While analysing the research performance of three research councils in Sweden, their findings confirmed that external funds change the norms system of the research councils and, thus, influences research on the whole. Moreover, conditions for academic research in Danish universities have also changed and, therefore, Ernø-Kjølhede et al. (2001) suggest a more conscious approach on part of the universities to manage the routine research practice. Similarly, recommendation for conscious approach is echoed in Langford et al.'s (2006) case study of Calgary University Canada. Langford et al.'s (2006) results supported a conscious approach towards research with the reason that with such approach universities and firms can avoid counterproductive activities and the true nature of innovation, based on Triple Helix ideals can be determined.

Research articles that supported strong research collaboration among university-industry-government, as envisaged by Etzkowtz, recommended certain policy level measures in this regard. Hence, Boardman and Corley (2008) and Boardman (2009), recommended the establishment of research centres by the government; while Wiltz (2000,) who studied 23 non-university and 17 university researchers in Germany, observed that research organisations should organise large scale research activities on the Triple Helix principle and suggested routine alliance between academic-industry researchers to ensure U-I-G research collaboration. Dietze and Bozemanb's (2005) study of 1200 CVs of academic research scientists and engineers in US; Boardman and Corley (2008) and Boardman (2009) in their analysis based on a national survey of US university scientists, agreed on the crucial role of research centres in developing university-industry linkages on the one hand, and their contribution to different academic careers on the other hand. Therefore, they suggested policy level support for the establishment of research centres. A policy level measure to facilitate public-private research collaboration is again supported in the study of Shapiro (2007). In his comparative analysis of 108 directors of research centres and managers of funded projects in Korea, he stated that new forms of capital based on the Triple Helix model can only be materialised if government facilitates public-private research collaboration. Mueller et al. (2005) while studying 326 districts in West Germany found that technological progress and new firm formation activity is higher in regions where university-industry research collaboration exists.

The above discussion touches upon research issues in Triple Helix more holistically, while the following articles explore the role of the research university in the Triple Helix model. Articles that focused on universities' roles in firm formation and cluster development found different patterns in different countries. Nishimura and Okamura (2011) surveyed 13 different technological clusters in Japan. The study supported the positive role of the R&D consortium in biotechnology and found that the university has a significant role in invention and commercial success of this cluster. This effect was not found in the overall results covering all technological clusters that were different in budget size, technological fields and support programmes. University importance until 2000 is also found in Japan by Sun and Negishi (2010). This study revealed that until 2000 not only university-industry-academia had strong ties, academia also enjoyed an inevitable role in national publication system. Since the centre of Japanese research network and members of U-I-G have become more foreign-oriented by seeking foreign

collaboration, now the university role and the U-I-G network have grown weaker. Network importance is also emphasised by Park and Leydesdorff (2010) in their longitudinal study of South Korea. They concluded that the reason why Korean national research capacity could not be improved was because of new Korean national science and technology research policy. Since the policy neglected the network effects in science, technology and industry; inter-institutional collaboration among academic private and public domain could not be strengthened.

As tri-lateral research collaboration is essential to boost national research capacity, there are still certain barriers to overcome. For instance, Tijssen (2006), analysing European universities' role in the field of immunology research, suggests that the nature of university–industry interactions and (the potential for) entrepreneurial orientation is determined by many factors. One important factor found by Acosta et al. (2009) is industry's willingness to collaborate with universities to produce new technological knowledge. Regions where industry does not encourage collaboration with academia, no average ties can be developed between the two. The same views are reflected in Inzelt's (2004) study on Hungary, who found that along with the government's support for linking public sector research with private sector expectations, the interest of industry in establishing an innovation network is also required. Thus, the knowledge economy is generated if industry's hunger for innovation exists. Cooke (2004) linked the weak nature of research collaboration between the two sectors to the cumbersome, bureaucratic procedures and the lack of entrepreneurial innovation links from research to commercialisation.

As research commercialisation is one of the outcomes of the Triple Helix, certain studies observed that confusion over patent rights exist among research partners and demanded for proper procedures to overcome patents issues. For instance, Tuunainen (2002) critically reviewed a case study of a plant-biotechnology research group of Finnish universities. Critical analysis of the case study reveals that research commercialisation of public-funded universities is controversial due to three main reasons. Firstly, Intellectual Property rights policy is not very clearly designed which led to confusion about ownership of the group's invention exist. Secondly, the university-industry relationships are not strongly developed because consumers are reluctant to use agri-biotechnological product. Finally, hybrid entities and spin-off companies created by academic research were not feasible. Research commercialisation is not free from controversies in other regions. This is proven and supported by the study of Arza and Lopaz

(2011) as they concluded that firm linkages with public research organisations in Argentina do not exploit their knowledge potentials. Despite the fact that firms in Argentina do benefit from public research organisations' (PRO's) research output, linked firms have a tendency towards patenting. Acosta et al. (2009) found that patents are determined by regional R&D funds.

Detailed Analysis of Two Papers

The two papers selected for detail analyses are Acosta et al.'s (2009) and Razak and Saad (2007). As mentioned above, these two articles are chosen on the basis of relevancy of these research studies for the Peshawar region. Acosta et al.'s research focus is European universities, while Razak and Saad's research interest is the Malaysian university. Both the articles explore the role of university in producing technological knowledge in the region. Both the papers attempt to identify issues that are related to R&D funds and patents in their concerned regions. Since Razak and Saad's (2007) article is on the developing country and Acosta et al.'s (2009) paper is on developed countries, these studies can guide my research on how to link university R&D with the industry in the Peshawar region and motivate government to help support industry-academic linkages. Firstly Acosta et al.'s (2009) research interest, methodology and findings are discussed and then Razak and Saad's (2007) is touched upon.

Acosta et al.'s (2009) paper is an attempt to understand the distribution of technological knowledge generated in universities, measured by patent counts, at a regional level in Europe. The study used panel data set of 4,580 European university patents from 1998 to 2004, to collect information. The results of the study are based on three main findings. Firstly, the data collected confirmed that institutional links are important for university to generate patents; furthermore, universities' role in producing market pull technological knowledge (patents) in European regions was supported. The study recommended that European institutions and national governments should foster entrepreneurial university to strengthen the regional innovation system.

Razak and Saad's (2007) research interest was to identify the challenges that aroused the evolution of the Triple Helix institutional system in the context of the Malaysian socio-economic environment. The research methodology used in the paper is a qualitative case study approach.

Eighteen semi-structured interviews were used to gather information. Samples for the interviews were taken from the three spheres of Triple Helix: seven respondents were taken from the government (government ministries and agencies); seven from universities (from researchers, deputy vice-chancellors and staff of research management centres) and four sample interviews were taken from industries (managers and executives). Analysis of the interviews revealed seven main issues which influence the development of the Triple Helix culture in Malaysia and the role of universities in this context. The issues were technological factors, procedures and processes within universities; commercialisation issues; relationship/interaction issues; work culture; IP issues, and government policies (Razak and Saad, 2007).

Implication for Peshawar, Pakistan

Findings and recommendations of the two articles can be used as guidelines for the implantation of the Triple Helix model in a developing region like Peshawar. Firstly, an entrepreneurial university as recommended in Acosta et al.'s (2009) article is required in Peshawar which can only be established with the support of the government. Secondly, the local industry links with the university should be established and for that purpose government should provide enough grants to academia for R&D that can provide a practical solution to industrial problems. Government should initiate academic-industry friendly policies to develop a Triple Helix culture in Peshawar, Pakistan.

Triple Helix Model and Innovation

A total of seventeen articles from the Triple Helix Model and the Innovation Table (Table 2, Appendices) have focused on Triple Helix's role in the regional innovation process. Initially, fifteen articles are generally discussed and recommendations of these articles in the light of their findings are touched upon. Finally, two articles are selected for detailed analysis due to their research techniques and measured results. On the basis of their findings, practical options for the Triple Helix model in the Peshawar, Pakistan, region are discussed. In this regard, methodologies, findings and recommendation of the two selected papers are discussed in depth.

The Triple Helix and R&D section confirms the undeniable role of entrepreneurial university in knowledge-creation and science-based regional development. Etzkowitz et al. (2008), using

secondary sources, identified the same trend in US, Sweden, Japan, and Brazil State universities. The study found that the global trend is towards the emergence of entrepreneurial universities. Almeida's (2008) research on Brazilian universities stated that development of an entrepreneurial university is not an easy task, especially in the case of Brazil where differences exist between universities and institutions. As the entrepreneurial university is emerging worldwide as an essential source of knowledge economy, Etzkowitz and Dzisah's (2008) study which is based on library research, suggests that government and international agencies should facilitate the growth of entrepreneurial universities with a broad inter-disciplinary scope and mission, and support the birth of an entrepreneurial scientist who integrates knowledge and innovation. Moreover, Etzkowitz et al. (2000) from the comparative analysis (based on library sources of US, Japan, Italy, Germany, UK, Brazil and Asia) found that the future role of the entrepreneurial university is getting more challenging; therefore, it has to be more proactive.

Moreover, academic willingness for institutional collaboration is also required. As evident from the US case, where universities' contributions in the knowledge economy is highly facilitated by the government, therefore the USA enjoys a leading position in innovation especially in biotechnology, information technology and new media sectors. To be on a par with the US innovation level, Leydesdorff et al. (2005) suggest that the European Union should also utilise its university capabilities to generate new knowledge economy. Whereas, Nwagwu (2008) observed in the case study of a Nigerian University that such ideals are not practiced in that country.

As academic will is the essential factor for a Triple Helix culture to take roots, Etzkowitz and Dzisah (2008) suggest that universities should complement the industrial enterprise as a source of new economic activity both in the developed and developing world. Whereas there was no such willingness on the part of Australian universities (Gunasekara, 2006), due to the reluctant behaviour of the Australian universities, the innovation process could not take off. Coenen (2007), while studying the regional innovation system (RIS) problems in UK and Sweden, used semi-structured interviews for Scania and secondary sources for the north east, found that the regional innovation system (RIS) is strengthened due to the constructive contribution of the university.

Etzkowitz and Dzisah's (2007) study based on library research, suggests that the African quest for innovation and development can only be achieved if the Triple Helix of university-industry-

government interactions are established. Moreover, Saad's (2004) study of an Algerian incubation centre, Henry Etzkowitz's (2002) article on science, technology and industrial policies worldwide; Marques et al. (2006), based on a discussion of case study of the University of Cambria, Portugal; Gunasekara's (2004) (102 semi-structured interviews) analysis of three non-metropolitan universities in Australia; Etzkowitz's (2007) study on USA, Europe, Canada, China, Soviet union; Leydesdorff and Deakin (2011) Canada and Montreal, emphasized the implantation of the Triple Helix model worldwide for innovation and growth. Furthermore, Etzkowitz (2007) added that university-industry-government interaction not only helps in the development of knowledge-based industry but also facilitates the expansion of such industry.

Analysis of Two Papers

Two papers chosen for detailed analysis about the role of Triple Helix in the innovation process, are by Asheim and Coenen (2005) and Li, X (2009). The first paper is about the developed European regions of Sweden, Denmark and Norway. Asheim and Coenen (2005) studied five Nordic projects on SMEs in these countries. Their results suggested that regional innovation requires a full understanding of region's industrial structure; institutional set up and knowledge base. To accomplish such understanding, region specific innovation policies are needed. Similar findings are reflected in a study by Li, X. (2009), using secondary data of thirty provincial level regions in China. His research confirmed that government support; the establishment of R&D institutes and the regional industry-specific innovation environment significantly determines innovation performance.

Implication for Peshawar, Pakistan

Peshawar, which is a developing region, while setting up institutional set-up, needs to follow the guidelines provided by the results of the two papers. Firstly, it has to establish knowledge base and develop strong ties among all the spheres of Triple Helix. Government support in this regard is highly essential not only to ensure the Triple Helix and entrepreneurial culture in the region but also to understand the needs of the SME sector, on the basis of which R&D institutes can address industry specific problems.

Triple Helix and Economic Development

To promote innovation in the region, entrepreneurial activities on the part of the university help promote regional economic development (Etzkowitz and Zhou, 2007). To achieve mutually agreed motives of economic development and promote innovation, academia, industry and government need to cooperate by eliminating their differences (Eriksson et al., 2002).

Twelve research articles from THM and the Economic Development table (Table 3, Appendices) are reported here, that focused on such tendency and highlighted the significant contribution of Triple Helix in regional development. Etzkowitz and de Mello's (2003) study, based on discussion of conference and library paper, observed that Brazil is transforming from a top-down innovation system, as perceived by Sabato triangle, to an innovation system. Hence, the transition towards innovation in Brazil has taken place over the last two decades. Therefore, the Triple Helix format is practiced at municipal, regional, national and multinational level in Brazil. As university-industry-government collaboration is gradually acknowledged worldwide, the significant role of an intermediary organisation in Triple Helix cannot be ignored. Yuwawutto et al. (2010), from a case study on dried banana enterprise in Thailand, highlighted the active role of an intermediary agency such as the industrial technology assistance programme (ITAP) in the development of the said enterprise. Emphasis on an intermediary organisation in Triple Helix is again reflected in Eun et al.'s (2006) research on Chinese university-run enterprises. The study, using the theoretical framework, states that Chinese market reforms were announced to encourage universities to form their own start-up firms (URE's) for economic benefits.

The Triple Helix contribution in regional development is highlighted in Smith et al.'s (2010) research on the UK Oxfordshire's biotech sector. Results of the study derived from secondary data, found that the university role as compared to government's, along with other national organisations, is secondary in the development of science and technology especially in the biotech sector in Oxfordshire. However, the university's role is indirectly acknowledged by the industry because of the fact that industry talent is produced by the university. Due to special abilities in integrating organisational teaching, group research and collective entrepreneurship, university as an eminent source of firm formation is agreed by Etzkowitz and Klofsten (2005) in the comparative analysis of Sweden, USA and European universities.

The importance of the Triple Helix model is further reinforced by de Castro et al. (2000) in Portugal for the creative use of telematics. The same institutional level relations are essential for the high-tech development in other parts of the world, such as in the case of Lithuania, where Chlivickas et al. (2009) observed that the most successful Triple Helix model for high technologies development is the one where the highest degree of cooperation between authorities, industry and academic public is indicated. Brundin et al.'s (2008) research, employed surveys, interviews and questionnaires to study Triple Helix networks in a multicultural context in South Africa's Cape region, found that no planned cooperation is found among all the helixes of the Triple Helix and a focus on the entrepreneur is missing. Therefore, the study recommended planned and structured cooperation among the three parties.

Moreover, Leydesdorff et al. (2006), in comparison of 438 districts of Germany with Netherlands, found that medium-tech industry equally contribute to local knowledge-based economy of West Germany; therefore, a more holistic industrial policy is recommended that focuses on the development of both high-tech and medium-tech industry. Another essential element in the promotion of the technical industry is the presence of entrepreneurial culture in the country. This has been identified by Ramos-Maltés and Lorena (2010) in a comparative analysis of two case studies in Puerto Rico; the Techno Economic Corridor (PRTEC) and the Eastern Central Technological Initiative (INTECO). The study stated that the entrepreneurial culture and transparent local grant seeking process are the essential factors in the development of new knowledge-based economy in a country.

Analysis of Two Papers

The first paper selected for critical evaluation here is by Mayer (2006). The study used 30 key informant interviews and a genealogy survey of a high-technology firm, which proposed that future studies should examine degrees of university-region engagement. The case of Portland and Washington DC, confirm the theory of the Triple Helix of university–industry–government partnerships. The study found increased dependence among universities-government and industry. Such dependence was found due to universities' desire to integrate with industry by addressing industrial needs in the region. Therefore, such integration is further encouraged by

state and local government by creating research centres to ensure firms competitiveness and develop a viable economic environment in Portland and Washington DC region.

In the second paper, Liefner and Schiller (2008) analysed five public sector universities in Thailand. Primary data are based on interviews with professors and administrators and secondary data is derived from Bureau of Budget and Higher Education. The study found that although Thailand has successfully achieved quantitative economic development, it is still behind in technological progress made at this level by the 1st generation of newly industrialised countries at a similar stage of economic development. Results found weak or less contribution of universities' capabilities into qualitative growth of Thailand. This is due to the fact that the Thai economy depends more on MNC subsidiaries' knowledge input rather than from local universities' knowledge.

Implication for Peshawar, Pakistan

From the two papers, I propose that policy makers in developing region like Peshawar promote the rise of academic capabilities in accordance with the changing needs of its industry. Higher education institutions should provide knowledge input in the form of graduates and publications; direct consultancy services and establish research centres that cater to needs of local SME's need. In this way, academia in the Peshawar region along with teaching and management will also be integrated within economic development research.

Triple Helix and Industry

An article search in this section touched upon the theme of how the Triple Helix contributes to industrial growth worldwide (Table 4, Appendices). In the case of the electronic industry of Mexico, Guadalajara region, Vargas (2010), using interviews found that not only the specific Triple Helix model has addressed electronics cluster issues of Jalisco, it has transformed the entire region into a competitive electronic design niche. Godin and Gingras's (2000) research on university, industry, government and hospitals' collaboration in Canada, found that over 15 years except from hospitals - each sector has increased its collaboration with universities.

As industry is faced with international competitiveness, Butcher and David (2007) and Coenen and Asheim (2006), used both using secondary data in their respective research; agreed to the view that a dynamic Triple Helix set up is crucial to construct regional innovation system. The same network ties are demanded by Papagiannidis et al. (2009) on the 'Skill brokerage business model'. In the case of Brazil, where meta-innovation has resulted through hybrid institutions, Etzkowitz et al. (2005) feel the role of tri-lateral network cannot be ignored. Another country where the tri-lateral network has performed well in the process of innovation is South Korea. Park et al. (2005) provides a comparative analysis of South Korea and the Netherlands derived from secondary sources; they found that South Korea enjoys the lead over Netherlands in knowledge-based dynamics, scientific and technological fields. Such development is possible due to the links that exist among all the spheres of Triple Helix.

Metcalfe (2010) further acknowledged the concept of intermediary organisations and Malo (2009) highlighted the role of public research organisation within the area of Triple Helix culture. Moreover, Frenken (2000) in his study on the post-war aircraft industry of thirty-one countries, 8 markets, 9 technologies and 863 aircraft innovations supported transnational networks. Such networks enable these countries to retain their competitive position in the international market on the one hand and make collective effort towards specific product development and innovation on the other hand.

The need for international networks is also found in Cantu (2010). The study reported that technological and cognitive proximities have emerged due to academic spin-off inclination towards extra-local and international firm linkages. Moreover, such international firm ties are formed to share technological experiences, interest, knowledge and profession. However, international linkages if faced with cultural and organisational barriers cannot be established easily. As in the case of Israel and Turkey, Goktepe (2003) found such barriers in Israel's and Turkey's magnet consortium. The reason why Turkey's innovation network could not be formed at national and international level was due to the lack of systematic and stable management strategies. Therefore, to form a successful international network, the collaborating partners must address these barriers first.

Fain et al. (2010), on new product development, suggested inter-institutional strategies in this regard. As Fain et al. (2010) reported after studying five European countries Academic Virtual Enterprise that the success of new product is determined by market demand.

Analysis of Two Papers

Etzkowitz et al. (2005) was selected because of the research's relevance and the country where the research was conducted. To examine the role of the Triple Helix in Brazil, the study was based on an extensive analysis of Brazilian Incubator Association databases, documents and interviews. Interviews were conducted with incubator and industrial association officials; government science and technology Policy officials at the Federal, State and Municipal levels and Public and Private Venture Capitalists in Brazil. Focus groups were also conducted with faculty members involved in entrepreneurial education. The findings acknowledged that creation of hybrid entities are required in the process of meta-innovation; secondly, a democratic decentralized regime, with an organised civil society, is essential (Etzkowitz et al., 2005). In a third stage of development, joint ventures from multiple actors, belonging to different spheres are required. This is evident from the example of Science Park in Brazil that was initiated 30 years ago, being an isolated project failed to achieve its objectives. Now it is more like a cooperative project which is connected with non-linear heterogeneous networks, such as incubators, research, entrepreneurship programs, branches of multi-national firms and local industry. Hence, the transformation of Brazilian incubators from high-tech focus to institutions formation at various technological levels is possible because of the Triple Helix model (Etzkowitz et al., 2005).

The second paper chosen for this was a case study of the Java Region (Irawati, 2007). This study examined six industrial clusters in the Java Region of Indonesia by employing semi-structured interviews, supported by the Triple Helix and the cluster approach. His results found that as the industrial clusters in Indonesia are scattered in various areas, universities and other institutions can help develop theses clusters by providing technical assistance to these clusters.

Implication for Peshawar, Pakistan

For incubators and science parks to take roots in Peshawar, Pakistan, academia has to get involved in industrial research; establish joint ventures with the industry and the government needs to support and initiate such science and technology policies which can help in the development of the incubation industry in the region. Cluster development and the incubation industry both depend on the active role of academia and government-friendly policies.

General Discussion

Studies by Etzkowitz and Zhou (2017); Ranga and Etzkowitz (2013); Steiber and Alänge (2013); Todeva (2013) can be used as a policy guideline for developing regions while adopting the Triple Helix model in their areas. Firstly, Ranga and Etzkowitz's (2013) concept of knowledge, innovation and consensus spaces are helpful in designing innovation strategies. While Steiber and Alänge's (2013) article of the Google case study is a guiding strategy in firm formation and growth stages involving U-I-G as key actors. Furthermore, Todeva's (2013) research on intermediaries in Triple Helix broadens the scope of the model. Relevant policy recommendations for developing regions are discussed in this section.

Ranga and Etzkowitz (2013) acknowledge the importance of innovation organisers, entrepreneurial scientists and creation of spaces in the regional innovation process. The authors suggested that Triple Helix policies in US or Europe cannot be copied or imitated exactly in the developing world due to their different cultural and environment settings. Therefore, worldwide attempts to copy Silicon Valley as a role model for sustainable growth and innovation is likely to fail because the model that worked in the greater Boston area cannot be replicated elsewhere. However, transforming the existing innovation and economic model according to region specific needs is an alternate option. Hence, developing regions need to design a policy framework for innovation and economic growth that seeks guidance from foreign experiences but are very much relevant to their cultural needs. These innovation organisers (individual or institution) with their knowledge-based vision convince the concerned institutions to collaborate for new economic model (Ranga and Etzkowitz, 2013). Instances of an innovation organiser are that of

MIT President Compton who in 1930's New England successfully not only introduced Venture Capital but also gained supports for technologies produced by MIT for local development (Etzkowitz, 2002). Entrepreneurial scientists come from both academia and industry and are the ones who are constantly involved in knowledge creation that can be used for commercial purposes. It can either be published or for practical use such as the latest technology. Academic entrepreneurs can contribute by getting involved in firm formation or being involved in industry research. Business entrepreneurs are then involved in providing their expertise to new firms started by the academic entrepreneur. Hence, the innovation organiser and the entrepreneurial scientist can make developing regions' dreams of innovation and technological development a reality.

However, developing countries' technological development largely depends how well they develop their R&D and human resource potential. In this regards, they need to establish their own knowledge-base; develop innovative businesses and lower their dependence on MNCs and exogenous R&D practices. Therefore, to develop regional specific innovation strategies these regions should adopt Triple Helix systems' approach, i.e. the developing of knowledge, innovation and consensus spaces relevant to their environmental settings. For example, knowledge space can be created by relocating R&D resources to areas that are lacking in such facilities. Thus, the success of the relocation policy of research centres to less-research intensive area can help adopt an initial framework for national innovation policy for regional development (Casas et al., 2000; Hamilton, 1966). Government-level support for research consortium/centres country-wide can help develop such research proposals that not only develop new high growth industries in the region but also give new life to ailing industries (Svensson et al., 2011).

Innovation space can be created by establishing technological universities in areas where no such higher education existed before. Such universities can help improve existing technological levels or develop new technologies based in the region. For example, MIT, founded in 1862, not only helped Boston textile, leather and mechanical clusters with its technological breakthrough but also formed venture capital industry to finance new firms in the region (Etzkowitz, 2002). Furthermore, an integrated approach towards regional innovation network should be adopted, such as the hybrid organisations of U-I-G should be linked with each other. For example, a

country-wide network of incubators, science parks, R&D, Venture Capitalist, spin-off firms should be formed (Debackere, 2000; Debackere and Veugelers, 2002). Attempts should be made to revitalise the ailing industry by establishing knowledge-based industries that attract local and international investors alike (Ranga and Etzkowitz, 2013).

Consensus can best be created through brainstorming, discussion forums and problem analysis forums through university-industry-government interaction sessions. In this regards, precedents of Pittsburgh High-Tech Council; the Petropolis Technopole in Rio de Janeiro state (Mello and Rocha, 2004) that after-hour New York clubs (Currid, 2007) are recommended guidelines for the developing regions. Moreover, support for new start-ups through access to financial and technical resources (Etzkowitz, 2002); timely and alternate solution for social-economic crises created by industrial failure (Etzkowitz et al., 2008) helps in consensus space creation.

Moreover, creation of each space is subject to individual regional cases (Ranga and Etzkowitz, 2013). Innovation space created in the US might not work in developing region or a crises situation that created consensus space in Europe or Japan might not work in developing region. This is because crises of each country are different as well as the knowledge and innovation level of a developed country is different from that of a developing world. Therefore, Ranga and Etzkowitz (2013) suggest the comparative analysis of past and present circumstances under which these spaces were created in the US or in other parts of develop world (Etzkowitz, 2002). Solutions then derived from such analysis can help formulate regional specific policy guidelines for space creation.

Steiber and Alänge's (2013) research on the formation and growth of Google highlighted the specific roles played by industry-academia and government. The case study of Google can be used as a guiding strategy for developing countries in firm formation and growth stages. The study, adopting the case study and qualitative approach, confirmed that university not only provided talent to the industry but also assisted Silicon Valley and Google in the early stages of firm formation. While industry provided research funds to Stanford University, the computer science department helped Google to access funds in its early stages. The government role is that of facilitating U-I-G linkages and early start-up firms by making friendly regulations and funding

academic start-up. Hence, U-I-G's formal and informal interaction provided a base for Google start-up and growth stages. As an inspiration for developing regions, there is a conscious need to encourage industry to provide research funds to universities. The government enact friendly policies; not only encourage U-I-G linkages but to accommodate hybrid organisations emerging due to such interaction. Todeva's (2013) study recommends the role of intermediaries such as financial or institutional in strengthening Triple Helix interaction. Hence, the intermediary role in Triple Helix in developing regions not only adds value to Triple Helix's performance but will also integrate the innovation process at different levels.

Conclusion

From the above discussion, one point is very clear that institutionalising the Triple Helix model in Peshawar, Pakistan, is not an easy task. As the concept is new to this developing region, activating Triple Helix and establishing industry-government and academia ties on one side and chalking out a proper mechanism for it to function will be a very complex process. Lessons from developed countries are very encouraging since they have almost overcome the barriers that came with the successful implementation of the Triple Helix model. Newly industrialised countries like Brazil and Mexico present a blend of success and failure pictures, while developing countries like Indonesia, Malaysia and China - though lagging far behind the developed and newly developed countries - are trying to address the barriers and make Triple Helix successful in their region. The reason for all three blocks of countries depending on the Triple Helix model for development and innovation is because all the three spheres, if working together towards the common goal of industrial growth, can achieve far-reaching results. However, the Triple Helix process in developing regions is different from that of the developed world; therefore, the recommended strategy is to adopt a region specific framework for innovation. Hence, Ranga and Etzkowitz's (2013) idea of space creation; innovation organiser and entrepreneurial scientists can initiate the process of innovation in these regions. While U-I-G interaction in the Google case can help in firm formation and growth stages (Steiber and Alänge, 2013). Weak communication and interaction among the three Helixes can be overcome by adding the role of intermediaries in the Triple Helix model (Todeva, 2013). However, a mere insight into the literature review cannot determine recommendations for U-I-G linkages in

Peshawar, Pakistan. Instead, a detailed study of these linkages in the regions needs to be explored by adopting an effective research methodology.

Appendices 1: Triple Helix and R&D Table

Paper	Author	Journal /year	Country	Sample Size	Research Approach	Main Findings
1.The Triple Helix Paradigm in Korea: A test for new forms of capital.	Shapiro R&D	IJTM & SD/2007	Korea	108-Directors research centres and managers of funded projects	Questionnaire and KORTAI R&D DATA SET	new forms of capital based on Triple Helix model can only be materialised if Government facilitate public-private research collaboration.

2. Subsidy and networking: The effects of direct and indirect support programs of the cluster policy	Nishimura and Okamura	Research Policy ,2011	Japan	Industrial Cluster Project (ICP) in Japan. 13 clusters of Japan	Survey; Questionnaires	Their findings reported that not only clusters belong to different technological fields; they also differ in numbers, size and support programmes. The study supported the positive role of R&D consortium in biotechnology and found that the University has a significant role in invention and commercial success of this cluster. While this effect was not found in the overall results covering all technological clusters that were different in budget size, technological fields and support programmes

3. Exploring the Knowledge Filter: How Entrepreneurship and University-Industry Relations Drive Economic Growth	Muller et al.	2005 Research policy	Germany	326 west Germany districts	Secondary Sources	technological progress and new firm formation activity is higher in regions where University-Industry research collaboration exists. Therefore, findings of the study emphasized upon research partnership between Academia and industry in order to generate new knowledge and ensure higher growth rates
4. The role of research in regional innovation systems: new models meeting knowledge economy demands	Philip Cooke	Int. J. Technology Management, 2004	Denmark, UK, Ireland, Sweden Finland, Germany	6 European regions/ countries	Library sources	linked the weak nature of research collaboration between the two sectors to the cumbersome bureaucratic procedures and lack of Entrepreneurial innovation links from research to commercialisation

5. Government centrality to university–industry interactions: University research centers and the industry involvement of academic researcher	P.Craig Boardman	Research Policy 2009	US	Scientific and Technical human capital	Secondary data collected from National Survey of academic researchers in the US	agreed on the crucial role of research centres in developing University-Industry linkages on one hand, and their contribution to different academic careers on the other hand. Therefore suggested policy level support for the establishment of research centres
6. Universities and industrially relevant science: Towards measurement models and indicators of entrepreneurial orientation	Tijssen	Research policy 2006	European Universities	University – industry interaction	Research papers	Analysing European universities' role in the field of immunology research, suggest that nature of University–industry interactions and (the potential for) entrepreneurial orientation is determined by many factors
7.Academic careers, patents, and productivity: industry experience as scientific and technical human capital	Dietz and Bozeman b	Research policy 2005	USA	1200 CVS of research scientists and engineers	Secondary sources. patent and CV data	Research centres has resulted in strong ties between industry and academia.

8. University research centers and the composition of research collaborations	Boardman and Corley	Research Policy 2008	US	Individual level and Center level data of US universities	national survey of university scientists	Suggested areas for future research and implications for the design and management of university research centers.

9. The evolution of university–industry–government relationships during transition	Inzelt	Research Policy 2004	Hungary	Innovation survey, R&D statistics ,administrative sources	4 pilot innovation servey	found that along with the Government support for linking public sector research with private sector expectations, the interest of Industry in establishing an innovation network is also required. As in the case of Hungarian business, where the lack of interest in innovation has made progress mainly in experimental development and design, in trials and in the tooling-up process only. Although Government programmes tries to promote interaction in national innovation system, however, such interaction is still limited in the move towards a knowledge-based economy. Thus the Knowledge Economy is generated if industry hunger for innovation exists

10. Indicators and outcomes of Canadian university research: Proxies becoming goals?	LangFord et al	Research Policy 2006	Canada	Case study of university of Calgary	Secondary	Results supported a conscious approach towards research with the reason that with such approach Universities and firms can avoid counterproductive activities and true nature of innovation, based on Triple Helix ideals can be determined.

11. Reconsidering the Mode 2 and the Triple Helix**:** A Critical Comment Based on a Case Study	Tuunainen	Science Studies 2/2002	Finland	acase study of a plant-biotechnology research group, which operated in a major Finnish university	Critical review	Critical analysis of the case study reveals that research commercialisation of public funded Universities is controversial due to three main reasons. First Intellectual Property rights policy is not very clearly designed which led to confusion about ownership of the group invention exist. Secondly, the University-Industry relationships are not strongly developed because of which consumers are reluctant to use agri-biotechnological product. Finally hybrid entities and spin-off company created by academic research was not feasible

12. Longitudinal trends in networks of university–industry–government relations in South Korea: The role of programmatic incentives	Han Woo Park, Loet Leydesdorff	Research policy ,2010	South Korea	*Science Citation Index* (SCI) and its counter parts in the social sciences (SSCI) and the arts and humanities (A&HCI)	Longitudinal study, research papers data base	They concluded that the reason why Korean national research capacity could not be improved was because of new Korean national science and technology research policy. Since the policy neglected the network effects in science, technology and industry, inter-institutional collaboration among academic, private and public domain could not be strengthened. Therefore, a country's national research capacity can only be improved if strong networks are developed among academic, industry and government.

13. Institutionalizing the triple helix: research funding and norms in the academic system	Mats Benner, Ulf Sandstro¨	Research Policy .2000	Sweden	3 research councils of Sweden i.e NUTEK, TFRSSF	Empirical analysis	While analysing the research performance of three research councils in Sweden, their findings confirmed that external funds change the norms system of the research councils and thus influences research on the whole
14. The production of university technological knowledge in European regions: evidence from patent data	Acosta et al	Regional studies 2009	European regions	panel data set of 4,580 European university patents from 1998 to 2004	Research papers and secondary sources	The study added that patent activities in the region are affected by variations in regional research and development (R&D). results stated that every country legal framework is different from others which create differences in University patents. Therefore, all European regions should adopt a homogeneous legal system for industrial property in the University

15. Forms of research organisation and their responsiveness to external goal setting	Wilts	Research policy 2000	Germany	23 non university researchers, 17 university professors	Interviews	observed that research organisations should organise large scale research activities on Triple Helix principle and suggested routine alliance between Academic-Industry researchers to ensures U-I-G research collaboration

16. Research groups as 'quasi-firms': the invention of the entrepreneurial university	Henry Etzkowitz	Research Policy 2003	USA, Europe, Latin America	USA, European and Latin American universities	Secondary data from Archival research at Stanford university ,interviews conducted during 1980-1990, and case studies of Latin American and European universities	USA where research is funded from external sources, universities have to compete for these funds. High competition among universities to access research funds in return influences research groups' behaviour formed within academia. Therefore, these groups develop firm like characteristics as hence quasi-firms are formed within academia prior to their engagement in entrepreneurial activities
17. Managing university research in the triple helix	Ernø-Kjølhede et al	Science and Policy 2001	Denmark	Research management at Danish universities	Library research	suggest a more conscious approach on part of the Universities to manage the routine research practice

18. Firms' linkages with public research organisations in Argentina: Drivers, perceptions and behaviours	Arza, V (Arza, Valeria)[1]; Lopez, A (Lopez, Andres) R&D	TECHNOVATION Volume. 2011	Argentina	Argentinean manufacturing sector (2055 firms	original firm database constructed from a representative survey with information for linked and unlinked firms for year 2005 in Argentina	firm linkages with public research organisations in Argentina do not exploit their knowledge potentials. Despite the fact that firms in Argentina do benefit from public research organisations (PRO's) research output, linked firms have tendency towards patenting.

19. Measuring the relationships among university, industry and other sectors in Japan's national innovation system: a comparison of new approaches with mutual information indicators	Sun, Y (Sun, Yuan)[1]; Negishi, M (Negishi, Masamitsu)	SCIENTOMETRICS ,2010	Japan	1,277,823 articles (research papers	Secondary	This study revealed that until 2000 not only University-Industry-Academia had strong ties, Academia also enjoyed inevitable role in national publication system. The University not only bridged Industry and Government but also linked foreign researchers with these national sectors. Since centre of Japanese research network and members of U-I-G have become more foreign oriented by seeking foreign collaboration, now the University role and U-I-G network have grown weaker

20. The role of universities in the evolution of the Triple Helix culture of innovation network: The case of Malaysia	Razak, Azley Abd Saad, Mohammed.	International Journal of Technology Management & Sustainable Development; 2007, Vol. 6 Issue 3, p211-225, 15p, 1 Diagram, 1 Chart	Malysia	case study Malysian universities-Industry-Academia	Qualitative: 18 Semi-structured interviews	The issues identified were technological factors, procedures and processes within Universities, Commercialisation issues, Relationship/interaction issues, Work culture, IP issues, and Government policies.

Appendices 2: Triple Helix and Innovation Table

Paper	Author	Journal /year	Country	Sample Size	Research Approach	Main Findings
1.Pathways to the entrepreneurial university: towards a global convergence	Henry Etzkowitz et al	Science and Public policy 2008	US, Sweden, Japan and Brazil	State Universities of US, Sweden, Japan and Brazil	Secondary sources	The study found that global trend is towards the emergence of Entrepreneurial Universities. These Universities have taken a central position in knowledge based economy that moves beyond etatism and pure market relations to an intermediate position within a Triple Helix regime.

2, Rethinking development: circulation in the triple helix	Henry Etzkowitz* and James Dzisah	*Technology Analysis & Strategic Management* 2008	Developed and developing regions	Discussion on Entrepreneurial Universities of developed and developing countries	Library research: research papers	suggest that Government and international agencies should facilitate the growth of Entrepreneurial Universities with a broad inter-disciplinary scope and mission, and support the birth of an entrepreneurial scientist who integrates knowledge and innovation
3. The role of universities in the regional innovation systems of the North East of England and Scania, Sweden: providing missing links?	Lars Coenen	Environment and Planning C: Government and Policy 2007,	UK and Sweden	Comparative analysis of Scania Sweden and North East region of UK regarding RIS Problems	Emperical Study: secondary data for North East, primary data,semi structured interviews for Scania	found that regional innovation system (RIS) is strengthened due to the constructive contribution of the University.

4.Technology Transfer in European Regions Introduction to the Theme Issue	Leydesdorff et al	The Journal of Technology, 2005	European union and US	Review of papers about US and European regions	Library sources	US A Universities contributions in the knowledge economy is highly facilitated by the Government, therefore USA enjoys leading position in innovation especially in biotechnology, Information Technology and new media sectors. To be a par with US innovation level, suggest that the European Union should also utilise its university capabilities to generate new knowledge economy

5. How can university–industry–government interactions change the innovation scenario in Portugal?—the case of the University of Coimbra.	Marques ,J.P. C.[1] Caraça, J.M. G.[2] Diz, H.[3]	Technovation; Apr2006	Portugal	Case study of University of Coimbra, Portugal	Discussion on results of case study	Analysis of this case confirms that the model is relevant to the region and university can play an important role in establishing networks and linkages.
6..The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm	Etzkowitz et al	Research Policy 2000	USA,UK Latin America, Asia, Europe	Case studies of US, Japan, Italy, Germany, UK, Brazil	Comparative analysis from library sources.	Comparative analysis of US, European, Latin American and Asian regions found that a common trend towards entrepreneurial university is emerging due to increased demand of knowledge production.

7. Reframing the Role of Universities in the Development of Regional Innovation Systems .	Gunasekara, Chrys	The Journal of Technology Transfer (2006	Australia	Case studies of three metropolitan universities, Comparative analysis	Over 100 semistructured interviews and document reviews	Results revealed that although senior management modified their institutions to meet the regional needs, Universities were reluctant to act like the state and industry. Due to the reluctant behaviour of the Australian Universities innovation process could not take off
8. Knowledge bases and regional innovation systems: Comparing Nordic clusters	**Asheim & Coenen**	Research policy 2005	Sweden, Denmark ,Norwey	5 Nordic comparative projects on SME's	Comparative analysis of five case studies	Their results suggested that regional innovation requires full understanding of region's industrial structure, institutional set up and knowledge base. To accomplish such understanding region specific innovation policies are needed

9.The Third Role of Australian Universities in Human Capital Formation	Chrys Gunasekara	Journal of Higher Education Policy and Management. 2004	Australia	Three case studies of non core-metropolitan universities peri-urban region (University of Westem Sydney (UWS)), a provincial city (University of Wollongong (UOW)) and a rural region (Charles Sturt University, Riverina campus).	Secondary data and primary data:102 semi-structured interviws	The study found that universities are playing effective role in developing human capital in the region.

10. The Triple Helix of Innovation: Towards a University-Led Development Strategy for Africa	Henry Etzkowitz and Dzisah	ATDF Journal 2007	Africa	African Universities	Library research	suggest that African quest for innovation and development can only be achieved if Triple Helix of University-Industry-Government interactions are established
11. The triple helix model of innovation(NF)	Etzkowitz	TECH MONITOR 2007	USA, Europe ,Canada, China and Soviet union	US, European, Canadian, China and Soviet models	Library and secondary data	Triple helix of university-industry-government can help in the development and expansion of knowledge-industry in the region.
12. China's regional innovation capacity in transition: An empirical approach	Xiao Li	Research Policy 2009	China	30 provincial level regions	secondary	His research confirmed that Government support, establishment of R&D institutes, and the regional industry-specific innovation environment significantly determines innovation performance.

13.The Nigerian university and the triple helix model of innovation systems: adjusting the wellhead *	Nwa gwu	Techn ology Analy sis & Strate gic Mana geme nt, 2008	African region	Case study of Unive rsity of Nigeri a	Research papers	Triple helix ideals are not practiced in that country. This is because Inter-institutional collaboration in Nigerian economy is not encouraged by the economic and political circumstances of the country. Therefore academia's significant presence in economy is not found in Nigeria.
14.The Triple-Helix Model of Smart Cities: A Neo-Evolutionar y Perspective	Loet Ley desd orff & Mar k Dea kin	Journ al of Urban Techn ology. 2011	Canada, Glasgow	Montr eal, Edinb urgh	Secondar y	The study found that smart cities can be created due to intellectual capital of academia, industry and democratic government

15. Issues and challenges arising from the application of innovation strategies based on the triple helix culture.	Saad, Mohammed[1]	International Journal of Technology Management & Sustainable Development; 2004,	Algeria	Algerian incubation system	Library sources: discussion	The study suggested strong and effective cctriple helix linkages in Algeria to promote learning and innovation.
16. Networks of Innovation: Science, Technology and Development in the Triple Helix Era	Henry Etzkowitz	International Journal of Technology Management & Sustainable Development , 2002	Several countries	1st ,2nd,,3rd worlds analaysis	Library sources	First, Second, and Third Worlds, have formulated innovation strategies based upon the deliberate elaboration of university – industry relations through reflexive science, technology, and industrial policies
17. Innovation and entrepreneurship in Brazilian universities	Almeida	International Journal of Technology Management & Sustai	Brazil	*Three university case studies*	Exploratory: Semi-structured interviews, Discussions, and secondary data	found that different structures have emerged in Brazilian Universities in order to stimulate innovation and entrepreneurial activities. It

		nable Development ,2008				further observed that although Brazilian Government does support these initiatives at the federal, regional and local levels, but due to differences that exist among the three spheres of the Triple Helix, the dream of Entrepreneurial University in Brazil cannot be materialised.

Appendices 3: Triple Helix Model and Economic Development

paper	Author	Journal/Year	Country	Sample Size	Research Approach	Main Findings
1.A Triple Helix Strategy for Promoting SME Development: The Case of a	Yuwawutto et al	Industry and Higher Education,2010	Thailand	Case study of community enterprise of dreied bananas	exploratory	intermediary agency role in SME's sector in developing countries is strongly recommended by the study

Dried Banana Community Enterprise in Thailand						
2.What is the Role of Universities in High-tech Economic Development? The Case of Portland, Oregon, and Washington, DC	HEIKE MAYER	Local Economy, 2006	USA	High-tech manufacturing industry Portland's Silicon Forest is compared to IT service Washington, DC.	empirical study 30 key informant interviews Geneal ogy survey of high-technol ogy firms. Second ary data	The study found increase dependence among Universities - Government and Industry. Such dependence was found due to Universities desire to integrate with industry by addressing industrial needs in the region.
3.Explaining the "University-run enterprises" in China: A theoretical framework for university–industry relationship in	Eun et al	Research Policy 2006	China	University run entriprises(U-R-E)	Theorotical frame work	states that Chinese market reforms were announced to encourage Universities to form their own start-up firms (URE's) for

developing countries and its application to China						economic benefits. Since intermediary agencies in China were not fully developed, therefore Chinese Universities were not inclined towards firm formation and economic gains.
4.TRIPLE HELIX NETWORKS IN A MULTICULTURAL CONTEXT:: TRIGGERS AND BARRIERS FOR FOSTERING GROWTH AND SUSTAINABILITY	Brundin *et al*	Journal of Developmental Entrepreneurship; Mar2008	Western Cape region South Africa	three longitudinal case studies in cape region	survey , questionnaires and interview	Results of the study found that no planned cooperation is found among all the Helixes of Triple helix and a focus on the entrepreneur is missing. Therefore, the study recommended for planned and structured cooperation among the three

						parties.
5. The rise of a triple helix culture Innovation in Brazilian economic and social development	Henry Etzkowitz and Jose Manoel Carvalho de Mello	International Journal of Technology Management & Sustainable Development 2003	Brazil	Research articles	Discussion on conference papers and library research	Brazil is transforming from a top-down innovation system, as perceived by Sa'bato triangle, to an innovation system. Hence, transition towards innovation in Brazil is taking place for the last two decades. Therefore, Triple Helix format is practiced at municipal, regional, national and multinational level in Brazil. As such, new actors, especially Universities and industrial associations are coming up with initiatives to strengthen innovation process in Brazil.

6. The triple helix model as a motor for the creative use of telematics	Castro et al	Research Policy,2000	Portugal	Portugues economy	Theoretical framework and secondary data	found that Portuguese traditional economic sector, with low technological content, creates significant barriers both to the circulation of information and to the promotion of learning processes. In order to overcome barriers to the creative use of technology, the study recommended policy level measures to strengthen University-Industry-Academic relations, at national and local level in Portugal.
7. The innovating region: toward a theory of knowledge-based regional	Henry Etzkowitz1 and Magnus Klofsten	R & D management 2005	Sweden ,Euorpe and USA	Comparative analysis of the case study	Semi structured interviews and research papers	Due to special abilities in integrating organizational teaching, group research

development				of Swedish universities, Europe and USA		and collective entrepreneurship, University as an eminent source of firm formation is agreed
8.The implementation of the triple helix model of industry-university-government relations in Puerto Rico to promote knowledge-based regional economic development	Ramos-Maltés, Ana Lorena	Massachusetts Institute of Technology, 2010	Puerto Rico	Comparative analysis of two case studies: Puerto Rico TechnoEconomic Corridor (PRTEC) and the Eastern Central Technological Initiative (INTECO)	Secondary and primary data	The study stated that entrepreneurial culture and transparent local grant seeking process are the essential factors in the development of new knowledge-base economy in a country. As these factors were not developed in the country, the above two initiatives failed to developed knowledge-base economy in

						Puerto Rico despite the fact that these initiatives did make progress in firm formation through incubators and community outreach program.
9.Academic capabilities in developing countries—A conceptual framework with empirical illustrations from Thailand	Liefner and Schiller	Research Policy 2008	Thailand	5 public sector universities	Primary data: interviews and secondary data:Bureau of budget and Hgher education	. The study found that although Thailand has successfully achieved quantitative economic development, it is still behind in technological progress made at this level by 1st generation of Newly Industrialised Countries at a similar stage of economic development. Results found weak or less

						contribution of Universities capabilities into qualitative growth of Thailand.
10. LEADING PRIORITIES FOR DEVELOPMENT OF THE HIGH TECHNOLOGIES MARKET	Chlivickas et al	Journal of Business Economics and Management. 2009	Lithuania.	High technologies in Lithuania	Qualitative analysis and scientific literature	observed that the most successful 'Triple Helix' model for high technologies development is the one where the highest degree of cooperation between authorities, industry and academic public is indicated. Therefore, the article establishes the implementation of the 'Triple Helix' as a leading priority for high technologies development in Lithuania.

11.Triple helix and regional development: a perspective from Oxfordshire in the UK	Smith, Helen Lawton; Bagchi-Sen, Sharmistha	Technology Analysis & Strategic Management; 2010	UK	biotechnology sector in Oxfordshire (UK)	Secondary data: published reports, primary data: Three surveys by Oxfordshire Bioscience network (OBN)	found that the University role as compare to Government's along with other national organisations is secondary in the development of science and technology especially in the biotech sector in Oxfordshire. However, the University's role is indirectly acknowledged by the industry because of the fact that industry talent is produced by the University
12. Measuring the knowledge base of regional innovation	Loet Leydesdorff et al.	Research Policy/2006	Germany/ Netherland	438 districts of Germany/ Netherland	Secondary sources	found that Medium-tech industry equally contribute to local knowledge-base

systems in Germany in terms of a Triple Helix dynamics						economy of West Germany , therefore a more holistic industrial policy is recommended that focuses on the development of both high-tech and medium-tech industry. Another essential element in the promotion of technical industry is the presence of entrepreneurial culture in the country

Appendices 4: Triple Helix and Industry Table

Article	Author	Journal And year of publication	Countries	Sample size	Research Approach	Findings
1.A complexity approach to innovatio	**Koen Frenken**	Research Policy 2000	31 countries	8 markets, 31 countries,9 technol	secondary	He reported that pattern of specialization is emerging

n networks. The case of the aircraft industry (1909–1997)				ogies,863 aircrafts innovation		among these countries where focus is on particular technology and market. Such networks enable these countries to retain their competitive position in the international market on one hand and make collective effort towards specific product development and innovation on the other hand. Henceforth, trans-national networks might become the new model of technology transfer worldwide.
2.Exami	Amy	Critical	Nort	Ottawa	Secondar	acknowledge

ning the Trilateral Networks of the Triple Helix: Intermediating Organizations and Academy-Industry-Government Relations	Scott Metcalfe	Sociology.2010	h America and Canada	Centre for Research and Innovation (OCRI) and the Canada Arizona Business Council (CABC	y data	d the concept of intermediary organisations
3. Government Influence and Foreign Direct Investment: Organizational Learning in an Electronics Cluster	María Isabel Rivera Vargas	Critical Sociology. 2010	Mexico	9 engineering dept and 13 foriegn corporation in electronics industry in Guadalajara, 3 indeginious firms	Qualitative,exploratorycase study, interviews	found that not only specific Triple Helix model have addressed electronics cluster issues of Jalisco, it has transformed the entire region into competitive electronic design niche
4.The contribution of (not so) public research to commercial innovations in the field of	Stéphane Malo **(Malo,S)**	Reseach policy; 2009	US and EU-15 countries	Data of 57 companies	Secondary and primary data; Survey questionnaires	highlighted the role of public research organisation within the area of Triple Helix culture

combinatorial chemistry						
4. Exploring the role of spatial relationships to transform knowledge in a business idea - Beyond a geographic proximity	Cantu, C (Cantu, Chiara) [1]	INDUSTRIAL MARKETING MANAGEMEN 2010	Italy	Case study; Petroceramics, POINT, Kilometro Rosso and R&D orgn Delta Moulds, Elchi, CNR-IDPA, Milan University	Secondry and primary data;60 indedepth semi-structured interviwes	The study reported that technological and cognitive proximities have emerged due to academic spin-off inclination towards extra-local and international firm linkages. Moreover, such international firm ties are formed to share technological experiences, interest, knowledge and profession
5.Entrepreneurial networks: A Triple Helix approach for brokering human and social capital	Papagiannidis et al	J INT ENTR 2009	general	Skill brokerage business model and e-business	library	. research suggested, to boost innovation and commercialisation beyond geographic boundaries, Triple Helix of University–Government–Industry

						interactions must be established
6. A comparison of the knowledge-based innovation systems in the economies of South Korea and the Netherlands using Triple Helix indicators	PARK et al	Scientometrics, 2005	South Korea, Netherland	Comparative analysis of knowledge base of U-I-G in S.Korea and Netherlands	Secondary	found that South Korea enjoys lead over Netherlands in knowledge-base Dynamics, scientific and technological fields. Such development is possible due to the links that exist among all the spheres of Triple Helix.
7.Towards "meta-innovation" in Brazil: The evolution of the incubator and the emergence of a triple helix	Etzkowitz et al	Research policy, 2005	brazil	Brazilian Incubator Association databases, documents and interviews	Extensive analysis: interviews and focus groups	Findings from extensive interviews and focus group discussions acknowledged that the transformation of Brazilian incubators from high-tech focus to institutions formation at various technological levels is

						possible because of Triple Helix model
8.The Triple Helix as a model to analyze Israeli Magnet Program and lessons for late-developing countries like Turkey	DEVRIM GOKTEPE	Scientometrics 2003	Israel , Turkey	ninety-two magnet Consortium Board of Managers	Survey: Questionnaire secondary data	found that such barriers in Israel and Turkey magnet consortium. The reason why Turkey innovation network could not be formed at national and international level was due to the lack of systematic and stable management strategies. Therefore, to form successful international network, the collaborating partners must address these barriers first.

9.A review of triple helix linkages in New Zealand earthquake engineering networks and comparison with the Australian cooperative research centre model	Butcher, Peter and Thorpe, David	Triple Helix VI (2007	New Zeal and and Australia	Case study and Comparative analysis of earthquake engineering industry Newzealand. Cooperative Research Centres (CRC) in Australia	Secondary sources	agreed to the view that a dynamic Triple Helix set up is crucial to construct regional innovation system
10.The Role of the User and the Society in New Product Development	Nusa Fain" - Niels Moes" - Joze Duhovnik	Journal of Mechanical Engineering.2010	5 European countries	Case study of Academic Virtual Enterpriseinvolving five *European universities*	"quasijudicial" method	reported after studying five European countries Academic Virtual Enterprise that the success of new product is determined by market demand. Therefore, institutions in the process of new product development

						should consider technology-push and market-pull strategies in order to make the product successful.
11.The place of universities in the system of knowledge production	Godin and Gingras	Research Policy 2000	Canada	Four sectors, university, government, industry and hospitals	Canadian bibliograghic data base:1980-97. Articles, notes and reviews	found that over 15 years except from Hospitals, each sector has increased its collaboration with Universities. Therefore Governments emphasised more on University-Industry ties and Industry now is involving academia in its R&D programs.
12.Strengthening Cluster Building in Developing	DESSYIRAWATI	2007	Indonessia	Case study of 6 industrial cluster in Java	Qualitative/primary and secondary data	results found that as the industrial clusters in Indonesia are scattered in various areas.

Country alongside the Triple Helix: Challenge for Indonesian Clusters - A Case Study of the Java Region				region, semi structured interviews with the employees of the selected industrial clusters and 6 universities		Universities and other institutions can help develop theses clusters by providing technical assistance to these clusters.
13.Constructing regional advantage at the northern edge	Coenen and Asheim	2006		Regional development in the knowledge economy	Secondary data	dynamic Triple Helix set up is crucial to construct regional innovation system

Appendices 5: General discussion Table

Article	Author	Journal/ Year	General discussion
1.Triple Helix systems: an analytical framework for	Ranga and Etzkowitz	Industry and Higher education/ 2013	Generally discussed

innovation policy and practice in the Knowledge Society			
2. Industry and Higher education/ 2013	Steiber and Alanga	Industry and Higher education/ 2013	Generally discussed
3. Governance of innovation and intermediation in Triple Helix interaction 4. The triple helix: University–industry–government innovation and entrepreneurship	Todeva Etzkowitz and Zhou 2017	Industry and Higher education/ 2013 Routledge	Generally discussed Generally discussed

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