

Faculty-Industry R&D Joint Ventures: Barriers VS Incentives for Developing Nations

Muhammad Fiaz, Baseerat Rizwan, Naqvi Najam Abbas, Yang Naiding

Abstract—The aspiration of this research article is to target and focus the gains of university-Industry (U-I) collaborations and exploring those hurdles which are the obstacles for attaining these gains. University-Industry collaborations have attained great importance since 1980 in USA due to its application in all fields of life. U-I collaboration is a bilateral process where academia is a proactive member to make such alliances. Universities want to ameliorate their academic-base with the technicalities of technobabbles. U-I collaboration is becoming an essential lane for achieving innovative goals in this century. Many developed nations have set successful examples to prove this phenomenon as a catalyst to reduce costs, efforts and personnel for R&D projects. This study exploits amplitudes of UI collaboration incentives in the light of success stories of developed countries. Many universities in USA, UK, Canada and various European Countries have been engaged with enterprises for numerous collaborative agreements. A long list of strategic and short term R&D projects has been executed in developed countries to accomplish their intended purposes. Due to the lack of intentions, genuine research and research-oriented environment, the mentioned field could not grow very well in developing countries. During last decade, a new wave of research has induced the institutes of developing countries to promote R&D culture especially in Pakistan. Higher Education Commission (HEC) has initiated many projects and funding supports for universities which have collaborative intentions with industry.

Findings show that rapid innovation, overwhelm the technological complexities and articulated intellectual-base are major incentives which steer both partners to establish faculty-industry alliances. Ever-changing technologies, concerned about intellectual property, different research environment and culture, research relevancy (Basic or applied), exposure differences and diversity of knowledge (bookish or practical) are main barriers to establish and retain joint ventures. Findings also concluded that, it is dire need to support and enhance cooperation among academia and industry to promote highly coordinated research behaviors. Author has proposed a roadmap for developing countries to promote R&D clusters among faculty and industry to deal the technological challenges and innovation complexities. Based on our research findings, Model for R&D Collaboration for developing countries also have been proposed to promote articulated R&D environment. If developing countries follow this phenomenon, rapid innovations can be achieved with limited R&D budget heads.

Muhammad Fiaz is with the Northwestern Polytechnical University, Xi'an, Shaanxi, China (phone: 0086-15129299670; fax: 86-29-88491544; e-mail: fiaz_42@yahoo.com).

Baseerat Rizwan is with Hazara University, Mansehra, Pakistan (e-mail: Baseerat_khan@hotmail.com).

Naqvi Najam Abbas is with the Northwestern Polytechnical University, Xi'an, Shaanxi, China (phone: 0086-15129299607; fax: 86-29-88491544; e-mail: najm_naqvi@yahoo.com).

Prof. Yang Naiding is with the Northwestern Polytechnical University, Xi'an, Shaanxi, China, fax: 86-29-88491544; e-mail: naidingy@nwpu.edu.cn.

Keywords—University-Industry Collaboration, Academia, Innovation, R&D Barriers

I. INTRODUCTION

UNIVERSITY-INDUSTRY (U-I) collaboration has played a significant role in boosting up the economies of developed states. Academic engagement with industry or commercial activities can have complementarities with research performance [1] by reducing the R&D development cost and activities [2]. Academia is considered to create reliable public knowledge and state supports for research to expand useful knowledge economically [3] and industry raise practical problems that stimulate to develop new ideas [4]. Even though Give-and Take relationship exists among partners [5], but still there exists lack of attitudinal alignments among coordinating pillars. Reason is that academics wish to create 'leaky' knowledge while industry desires to create a sticky knowledge [6].

After Second World War, American academic science is not only considered as leadership in basic research, but also has mount up an immense reservoir of talents in both science and technology [5]. Collaboration with academe has different shapes and magnitudes based on the relationships. Recurrent cooperation [7], infrequent and intermittent relations and partnership with universities [8; 9] are major forms of collaborations [1]. U-I collaboration has been discussed in literature due to its momentous impact on local development [10] and its contribution to innovation [11].

Academic institutes are considered as the best R&D collaboration partners due to open innovation paradigm policy. Enormous reservoirs of intellectual knowledge-base, latest equipped labs, up-to-dated research materials in the form of students reports, dissertations and scientific research publications and professors are adorned with the novel ideas of research and innovative knowledge force the local and foreign enterprises to establish collaborations with these institutes to reduce R&D cost, associated risk and personnel. Collaboration between universities and companies can involve several benefits. According to [12], creative breakthroughs, academic freedom, social change, getting outsider's perspective and flexibility of research facilitate to become R&D partners with academe.

The nuclear concept of this study is to discuss the main barriers encountering U-I Collaborations in developing countries. Taking into consideration success stories of university-industry collaboration of developed countries, a roadmap and a model for the developing countries have been proposed by author to get the advantages from this collaborative coalition.

This research contribution is organized in a manner to highlight the need for university-industry alliance in section II while the success stories of developed countries and the milestones achieved by Pakistan are addressed in Section III and IV respectively. Section V defines the modus operandi for the developing nations like Pakistan to achieve the University-Industry R&D alliance. The paper concludes with some recommendations in the last section.

II. NECESSITATION OF UNIVERSITY-INDUSTRY COLLABORATION

The current economies are increasingly based on knowledge and information. The abilities of public and private institutions, managers and workers play a major role in growth of nations and economies by discovering and utilizing knowledge-based assets and capabilities. The utilization of knowledge and human has been emphasized. Organizations are introducing and reinforcing policies that facilitate innovations, and collaboration with other academic institutions and universities is one among them. Universities not only provide a platform of highly skilled and knowledgeable human and advanced technological resources but also offer equipped laboratories and precious reservoirs of knowledge that can be better exploited by industries. Another major benefit of this collaboration is inexpensive research students that are considered highly skilled and outfitted with profound knowledge. They can contribute miraculously in the field of innovation and technology. The technological development and empirical contributions have made universities major appealing economic agents for industry. The current technological pace, ever-changing trends, market demands and multidimensional research activities are the tough challenges for industry to cope with it. In spite of the fact that academic institutions provide updated information and knowledge capital to companies, but it may not always yield immediate or tangible benefits. In order to develop a win-win situation, industry is looking for the associations with universities for innovation and market growth that bring capital, knowledge, talent, technology, research and innovations together. University-Industry research collaboration is like an incubator that generates co-creation and sharing of knowledge among the collaborating partners. Industry always looks for those research activities and experiments that highlight different perspectives of problems and provide immediate and novel solutions to them. New knowledge, and updated & useful information are the most important contribution of university-industry collaboration, and due to their non-competitiveness and non-excludability, both actors can have the opportunity of gaining advantages as compared to those that do not. In addition to the R&D collaboration, seminars, trade shows, business alliances and startups can also be used as a way to facilitate knowledge sharing between academia and industry [13]. R&D activities conducting internally is considered important for a firm as it indicates its absorptive capacity [14] but emphasis is also laid on developing contacts outside the organizations [15] as firms are increasingly relying on R&D alliances and combined research projects with other entities while academia is also getting engaged into these partnerships [16] because R&D collaborations generate technological

opportunities and appropriate returns for firms as well as enhance the ability to identify, absorb and exploit knowledge and information[17].

III. COLLABORATION TRIUMPHS OF DEVELOPED COUNTRIES

R&D alliances are widely exercised in the economy of developed countries. Research investigations indicate that large number of agreements has led the firms to combined R&D projects in USA.

Collaboration of firms with academia is an emerging theme and USA is one of the developed countries which got the benefit of this cooperation. Since early 1980s, arrangements have been made to enhance collaboration among these two mainstays and to establish articulated research centers. This action led the USA to increase the industrial support for university researches. Industrial support currently accounts for 5% of total academic R&D expenditures [18]. Government-university-industry research Roundtable (GUIRR) data shows the tendency of different multinational and international firms to collaborate with universities in United States as exhibited in Table-1. [19].

Likewise, Empirical data on KNOW survey [20], conducted in Europe shows that SMEs are more interested to cooperate with universities due to short R&D budget and high tendency towards R&D activities. More than seven European countries participated in this survey.

The Chinese government has been advocating a use-driven science policy since its establishment, encouraging universities to serve the national economy by solving practical problems for industry [12].

IV. BARRIERS VS INCENTIVES OF U-I COLLABORATION: FACULTY AND INDUSTRY PERSPECTIVES FOR DEVELOPING COUNTRIES

A. *Barriers of university-industry alliance in developed nations*

Strategic Partnership and collaborations are always exposed to several challenges such as knowledge capital protection and patenting etc. The diversity of working environments of partners; University and Industry is also a drawback of such relationships. University-industry alliances usually face variety of barriers and hurdles. Cultural, institutional and operational barriers are identified as three categories of barriers to collaborate [21]. Industry is mainly concerned with efficiency in production, quality enhancement, turnover and timelines while universities majorly emphasized on pure research and publications. The researchers at research institutions also have different approaches from the business professionals of firms. Intellectual property protection, privacy, technological copyrights, secrecy, and knowledge transfer are the basic challenges and threats related to such alliances.

Another issue is that academia and researchers are interested in publishing their research outcomes while firms try to conceal research novelty and findings to get competitive advantage over competing firms. In addition to that, Industrial sector is focused on dealing with uncertainties, environmental

changes, and firms' extension such as mergers and acquisitions however, this less likely to happen at academia side. Such differences between the academic and industrial approaches and their mutually exclusive preferences and working environment may cause discrepancies among the partners. Therefore, a common platform is needed to overcome or reduce the gap between collaborating allies and to align the strategies for mutual benefits and appropriate gains [22; 23]. The basic purpose of academia behind their research efforts is to generate theoretical outputs, discover and explain natural realities while Business endeavors are focused on creating workable and useful artifacts [24].

B. Incentives Of U-I Collaboration For Developed Nations

In other words, the Core theme of Universities and academic institutes is to create and educate new knowledge, whereas enterprises and firms focus on reusing and implication of this knowledge to get competitive advantages [25]. There are several positive and negative perspectives of University-Industry alliances [26;27] and many studies have been conducted to highlight the barriers and benefits related to such associations [28].

Whereas, the difference in the culture and working environment of the partners, U-I collaboration faces many barriers and hurdles but a few researchers emphasized to investigate those barriers and the factors that might mitigate UI convergence [15]. Johan and colleagues [1] have classified these barriers in two categories: 'orientation-related barriers and 'transaction-related barriers. While Institutional norms, public and private knowledge [25], uncertainty, information asymmetries, transaction costs [28], research focuses, lack of insight in the specific research area and ever-changing technological complexities are also hinder the project execution in such clusters. Instead of all the above mentioned barriers, still there are countless incentives acting as stimuli for both partners to push them for R&D convergence. Innovative behavior [29], knowledge creation [30] and its implementation for new innovation, reducing R&D costs [2], dealing with innovation related risks, sharing strategic information for gaining competitive advantages [31] and attaining the collaboration experience based benefits are among the foremost inducements. Universities primarily focus on basic research instead of emphasizing on getting immediate results due to academic freedom and environment. On the other hand, enterprises prefer applied research and require immediate results due to tough competency trends in the market. Due to small lever and tendency of collaborations among these two sectors, the gradient of scientific research outcomes is also limited in developed countries.

TABLE I
U-I PARTNERSHIP IN USA-SOURCE: GOVERNMENT-UNIVERSITY-INDUSTRY
RESEARCH ROUND TABLE

Industry Partner	University Partner
AGLLENT TECHNOLOGY	UNIVERSITY MICHIGAN
BATELLE	OHIO STATE U
BOEING	GEORGIA TECHNOLOGY
CORNING	PENN. STATE
ELSEVIER	PURDUE

NOBLIS	GEORGE WASHINGTON
HEWLETT-PACKARD	UCLA
IBM	STANFORD
INTEL	UC BERKELEY
DEERE	IOWA STATE
LOCKHEED MARTIN	MARYLAND
MARS	UC DAVIS
TEXTRON	NORTHEASTERN
NORTHROP GRUMMAN	CAL TECH
NORTHROP GRUMMAN ELECTRONICS	MIT
PACIFIC NORTHWEST	WASHINGTON STATE
NAT LAB	
SEIMENS	PRINCETON
RAYTHEON	UMASS
SEMICONDUCTOR RES CORP.	U. TEXAS AUSTIN
SOUTHWEST RESEARCH INSTITUTE	U. TEXAS SAN ANTONIO

V. U-I COLLABORATION ROLE MODEL FOR DEVELOPING COUNTRIES

A long list of successful collaborations among world's leading industries and institutes in USA (Table-1), effective(National Science Board, 2008) UK Engineering and Physical Sciences Council – EPSRC's programs for promoting collaboration with universities [32], Empirical data on KNOW survey [33] for R&D Collaboration and National Program for medium and long term scientific and technological Development 2006–2020 in China [34] has instigated the author to establish a model for developing countries for successful execution of R&D Projects. R&D Collaboration model for developing countries is depicted in fig-1 where research oriented universities and industries jointly makes articulated R&D environment for combined Knowledge-base and this organized body of related information is used for future research and more rapid innovations in the time yet to come. State supports encourage for sustaining this relationship and liaison office facilitates process of Transfer of Technology (TOT) through proper and positive communication to avoid break ups. Due to technological and market competition, all stakeholders can have ambiguities in their minds. Role of liaison officer is becoming more challenging to manage all stakeholders. Sharing the mental states with synchronized contracts, motivational negotiations, and positive communications help to reduce the collaboration barriers among the partners of developing countries [35]. To minimize cultural differences, liaison office will make possible the exchange of applied and technological knowledge among partners.

Academic institutes are the major source for creating the fundamental and applied knowledge. In an opposing direction, practitioners at industry are involved with practicalities with the real life problems and mount the technological knowledge reserves. Due to the lack of collaborations among both partners, rapid innovations remain the question. Articulated R&D environment supported by state provides a platform for firms and faculty to share their innovations and discoveries and vigorous growth can be made in ever-changing technology which is not possible to be achieved discretely. Dotted line for technological knowledge from articulated environment to

universities shows that sharing the practical knowledge is important, but still other factors are considered more important as research funding, students' placements and business opportunities.

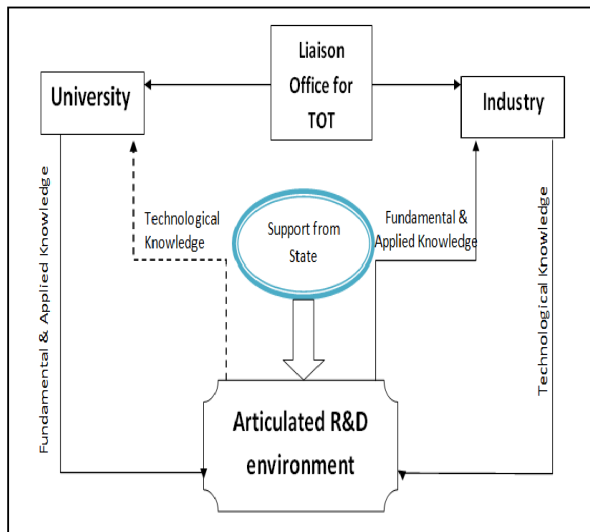


Fig 1 Model for R&D Collaboration for developing countries

VI. GUIDING STEPS FOR DEVELOPING COUNTRIES

University-Industry collaboration paradigms have contributed a lot in the economies of Developed countries and they have set some standard guidelines. Authors have jotted down the following steps for the successful collaboration ventures.

1. Faculty and Industry should design policies in a way that can protect privacy, maintain and enhance quality and support technology transfer effectively.
2. Proper articulation of current and potential risk may prevent the dissolutions of alliances.
3. Establish the units/cell of excellence in academic institutions.
4. Faculty members along with their research oriented senior students must visit industry to get new insights and analyze practicality of their research findings by establishing the environment of mutual understanding and sharing.
5. Academia must offer / facilitate the consultancy and training services to the firms for identifying different perspectives of their problems and provide them immediate, effective and novel solutions.
6. Public and private sector universities should emphasize on developing relationships with both industrial sectors; public and private.
7. In U-I collaboration, Research institutions should align their research objective and projects with the need of (the collaborating) industry.
8. Universities should plan and arrange the seminars, workshops and conferences according to the requirement of collaborative partner that may provide them a platform to share their knowledge and technology.

9. University-Industry collaboration should support and facilitate knowledge learning, knowledge management, knowledge utilization, and knowledge sharing.
10. In U-I alliances, Human resource should be developed in a way that it could meet the needs of industry and market.
11. Universities and industries should collaborate in way that it could identify and work on real life issues resulting in positive contributions to the society by creating employment opportunities for graduates, improving reputation and image of universities.
12. Companies may choose to delegate some studying problems to universities, and concentrate their efforts on more secure fields.
13. By collaborating with universities, firms may reduce the cost and risks related to the development and innovation by transferring its attestation and validation to academia. Proper documentation of such alliances between the partners can lead effective and secure knowledge sharing and technology transfer.

VII. CONCLUSION

This research contribution has been drafted to pave the way for developed countries to divert their intentions for enjoying the bountifullnesses of academic research. Easy access to the genuine literature coinciding with reality, research funding, validation of textual literature with practical real life practitioners and availability of skilled human resources are the major incentives which attracts developing countries for promoting joint R&D ventures. Results of this research show that variety of barriers has hindered this process of cooperation. Lack of interest, different culture, social norms, and research priorities are serious problems to be considered otherwise collaborations may come to an end without achieving its goals.

ACKNOWLEDGEMENT

Authors are thankful to China Scholarship council and Northwestern Polytechnical University, NPU, Xian, China for the research support and guidance.

REFERENCES

- [1] Johan Bruneela,b, Pablo D'Esteb, Ammon Salter a ,2010, "Investigating the factors that diminish the barriers to university-industry collaboration", *Research Policy* 39, 858-868
- [2] von Hippel, E., von Krogh, G., 2003. Open source software and the "Private- Collective" innovation model. *Organization Science* 14, 208-223.
- [3] Geuna, A., Steinmeuller, W., Salter, A.J. (Eds.), 2003. *Science and Innovation: Changing Rationales for the Public Funding of Research*. Edward Elgar, Cheltenham, UK.
- [4] Rosenberg, N., 2002. *America's University/Industry Interfaces 1945-2000*. Working paper, Department of Economics, Stanford University.
- [5] Yong S. Lee, 2000, "The Sustainability of University-Industry Research Collaboration: An Empirical Assessment ", *Journal of Technology Transfer*, 25: 111-133
- [6] Brown, J.S., Duguid, P., 2000. *The Social Life of Information*. Harvard Business School Press, Boston, Massachusetts.
- [7] Bishop, K., D'Este, P., Neely, A., 2011. Gaining from interactions with universities: multiple methods for nurturing absorptive capacity. *Research Policy*, 40, 1, pp. 30-40.
- [8] Hall, B.H., Link, A.N., Scott, J.T., 2003. Universities as research partners. *Review of Economics and Statistics* 85, 485-491.

- [9] Hertzfeld, H.R., Link, A.N., Vonortas, N.S., 2006. Intellectual property protection mechanisms in research partnerships. *Research Policy* 35, 825–838.
- [10] Gunasekara, A., 2006, "Reaffirming the role of universities in the development of regional innovation systems", *Journal of Technology Transfer*, 31, 101–113.
- [11] Abramo, G., D'Angelo, C. A., & Di Costa, F., 2011, "University–industry research collaboration. A model to assess university capability", *Higher Education*, 62(2), 163–181.
- [12] Nissani, M. (1997), Ten cheers for interdisciplinary: The case for interdisciplinary knowledge and research. *Social Science Journal*, 34, 2, 201-216
- [13] Teece, D. (2000), *Managing Intellectual Capital*, New York: Oxford University Press
- [14] Chesbrough, H. (2003), The logic of open innovation: Managing intellectual property, *California Management Review*. 2003. 45 (3): 33–58.
- [15] Hall, B.H., Link, A.N. and Scott, J.T. (2001), Barriers inhibiting industry from partnering with universities: Evidence from the advanced technology program. *Journal of Technology Transfer*, 26, 1-2, 87-97.
- [16] Cohen, W.M. and Levinthal, D.A. (1990), Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35, 1, 128-152.
- [17] Van Dierdonck, R. and Debackere, K. (1988), Academic entrepreneurship at Belgian Universities. *R&D Management*, 18, 4, 341-353.
- [18] USA National Science Board, 2008
- [19] Roberto Fontana, Aldo Geunab, Mireille Matt (2006), Factors affecting university–industry R&D projects: The importance of searching, screening and signaling, *Research Policy* Vol. 35(2006), Page 309–323
- [20] Hong, W., (2006), Technology transfer in Chinese universities: is 'mode 2' sufficient for a developing country? In: *New Technologies in Global Societies*. World Scientific Publishers, New Jersey, pp.21–50
- [21] Bruhn, J.G. (1995), Beyond discipline: Creating a culture for interdisciplinary research. *Integrative Physiological & Behavioral Science*, 30, 4, 331-341.
- [22] Cyert, R.M. and Goodman, P.S. (1997), Creating effective university–industry alliances: An organizational learning perspective. *Organizational Dynamics*, 25, 4, 45-57.
- [23] Pavitt, K. (1998), The social shaping of the national science base. *Research Policy*, 27, 8, 793- 805.
- [24] Lopez-Martinez, R.E, Medellin, E., Scanlon, A.P. and Solleiro, J.L. (1994), Motivations and obstacles to university industry cooperation (UIC): A Mexican case. *R&D Management*, 24,1, 17-31
- [25] Dasgupta, P. and P. David, 1994, Towards a New Economics of Science, *Research Policy* 23, 487-522.
- [26] Robert W. Gracy (2011), "Enhancing International Research Collaborations: A University Perspective" Asia Pacific Research Executive Forum 2011, Strategic Collaboration to further strengthen Universities in Asia Pacific, June 8th, 2011
- [27] Lindholm Dahlstrand, A. (1999), Technology-based SMEs in the Göteborg region: Their origin and interaction with universities and large firms. *Regional Studies*, 33, 4, 379-389.
- [28] Behrens, T.R. and Gray, D.O. (2001), Unintended consequences of cooperative research: Impact of industry sponsorship of climate for academic freedom and other graduate student outcome. *Research Policy*, 30, 2, 179-199.
- [29] Veugelers, R., Cassiman, B., 2005. R&D cooperation between firms and universities. Some empirical evidence from Belgian manufacturing. *International Journal of Industrial Organization* 23, 355–379.
- [30] Allen, J.T., 1984. *Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information within the R&D Organization*. MIT, Press, Cambridge (MA).
- [31] von Hippel, E., 1987. Cooperation between rivals: informal know-how trading. *Research Policy* 16, 291–302.
- [32] Durrani, T.S. and Forbes, S.M. (2004) The three-legged stool : new modes of university–industry–government collaboration. In: 13th International Conference on Management of Technology, 2004-04-03 - 2004-04-07, Washington
- [33] Hong, W., (2006), Technology Hippel, E., 1987. Cooperation between rivals: informal know-how trading. *Research Policy* 16, 291–302.
- [34] Paul C. Irwin Crookes, 2009, "China's embrace of the market economy: understanding its innovation strategy", *European View* 8:133–141
- [35] Freeman, R. E., The Stakeholder Approach Revisited, *Zeitschrift für Wirtschafts- und Unternehmensethik*, Vol. 5, No. 3, 2004, pp. 228-241.