Enhancing the University - Industry Collaboration in Developing Countries through Best Practices

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Abstract: *University-Industry Collaboration (UIC) creates highly skilled and productive graduates for meeting demand of industry. Such collaborations contribute positively to address innovation market failures and help to realise the full social returns of research and development (R&D) investments. Universities are often described as ''engines for growth'' which generate skills and research results that are significant sources of innovation for firms, especially in some industrial fields. Through the existing publications, this paper provides review on University-Industrial Collaboration. It gives the effects of the linkage and indicates how different countries practice UIC. Finally it presents the best practices that can be applied by developing countries in order to accelerate the economic growth.*

Keywords: *University, Industry, Technology transfer, University-Industry collaboration, Effects of collaboration, Best practices.*

I. INTRODUCTION

The term "University-Industry Collaboration" (UIC) comes with several variants such as University-Industry Linkages (UIL), University-Industry Partnership (UIP), University-Industry Alliance (UIA), and University Industry Relationship (UIR). In this paper, the University-Industry Collaboration will be used as the main term to describe the ties between university and industry although in several occasions the other terms will also be used interchangeably.

Many countries are seeking to strengthen global economic competitiveness by building a 'knowledge economy' capability. A popular approach is supporting university–industry knowledge exchange linkages [1].

Collaboration with industry is critical for academia to create scientific knowledge and obtain industrial data. In turn, collaboration with universities is crucial for organizations in joint, scientific-based research projects in order to develop solutions for production-sourced problems [2]. In a modern economy transforming scientific research into competitive advantages is essential [3].

Many scholars have argued that, university–industry research collaborations are extremely important mechanisms for generating technological spillovers. Such collaborations contribute positively to address innovation market failures and help to realise the full social returns of research and development (R&D) investments [4]. Moreover, there is a burgeoning empirical literature showing an increasing level of academic commercial activities, such as patenting and licensing, and generation of spin-out companies. This has been accompanied by an increase in research joint ventures and joint scientific publications. At the same time many governments have introduced an increasing range of policies encouraging the involvement of universities in technology transfer [4]. The capacity of a nation to produce wealth depends increasingly on the investment it undertakes in strengthening the so-called ''triangle of knowledge'', which is composed of research, education and innovation [5].

The university-industry collaboration brings new prospects of research funds, real world problems and research challenges and new ingredients in curricula development. The collaboration also creates innovation and provides national economic benefits [6, 22].

In today's economic environment it is crucial for businesses and public sector organisations to continuously innovate products, processes, and services. Industry-university collaborations provide the perfect foundation for innovation. By working with a university partner, businesses gain access to cutting-edge expertise and techniques that they don't have in-house, enabling the development of new approaches. Equally, working with industry enables academic institutions to test the practical applications of research on real-world problems and informs future research [7].

The impact of university-industry interactions on regional development became even more important since higher education institutions moved from a traditional role, focused on basic research and training, to a new role more involved in innovation and productive tasks. Referring to the new role of universities as one inserted in a "Triple Helix Mode" of innovation, universities will be one blade, together with firms and governments, for the development and use of new knowledge in the

economy and so for promoting competiveness and economic progress. Under this view, new functions of universities are emphasised such as technology transfer, spin-off creation, patent licensing, etc. [2, 8, 9, 10, 13].

The notion of triple helix was proposed by Etzkowitz and Leidesdorff [11, 12] in mid - 1990s to study the University, Industry and Government (UIG) collaboration at local and regional level. Three different kinds of triple helix structures were studied, with particular reference to organizations. In triple helix I, the state or government overshadows the university and industry structures. State governs over the university and industry relations. This type of weak structure was found in some Latin American countries. The triple helix II illustrates the working of university, industry and government as isolated bands and separated by strong borders. This structure represents immensely limited relation among the three actors. The most researched triple helix structure, however, is triple helix III, where all three rings overlap each other. Each ring takes part in the role of the others [12].

More recent contributions have somehow renewed the "triple helix" idea pointing to the existence of a "quadruple" and even "quintuple" helix innovation models. Thus the quadruple helix mode will incorporate media, culture and the civil society perspective into the process of knowledge creation and innovation whilst the quintuple helix mode will do the same with the natural environments of society [13].

Innovation is increasingly based on "Triple Helix" of University-Industry-Government interaction. The increased importance of knowledge and the role of the university in incubation of technology-based firms has given it a more important place in the institutional firmament. The entrepreneurial university takes in proactive stance in putting knowledge to use and in broadening the input into the creation of academic knowledge. Thus it operates according to an interactive rather than a linear model of innovation. As firms raise the technological level, they move closer to an academic mode, engaging in higher level of training and in sharing of knowledge. Government acts as public entrepreneur and venture capitalist in addition to its traditional regulatory role in setting rules of the game [9].

Third Mission activities in universities related to the generation and application of knowledge outside the academic environments are currently a topic of growing importance in the agendas of both R&D policymakers and university administrators [14, 15]. Universities are often described as ''engines for growth'' which generate skills and research results that are significant sources of innovation for firms, especially in some industrial fields. Numerous governments and research agencies are seeking ways to facilitate the interactions between industry and universities with the hope that they can improve productive processes and competitiveness in their national or regional environments. Growth of these activities has created a demand for suitable information for decision making on several managerial levels. In the public policy sphere a precise diagnosis of university relationships with their socioeconomic settings is needed in addition to useful tools for evaluating the programs aimed at fostering cooperation. On the university side, the professors' Third Mission activities must be identified in order to quantify their weight in comparison with traditional academic teaching and research tasks. However, a consensus has yet to be reached regarding the optimal indicators for evaluating activities carried out by academics and firms in collaborative endeavors. [14].

There are many different forms of university-industry collaboration. They range from interactions that are mainly informal and low-intensity, such as participation in social networks and joint meetings, workshops, or training activities, to robust and intensive partnerships, such as pursuing joint R&D projects together. It is also useful to distinguish between short- and long-term collaboration. Short-term collaboration is generally geared to on-demand problem solving and tends to involve activities such as one-off training sessions, consulting, testing, and contract R&D services. Long-term collaboration often includes joint R&D projects and is more strategic and open-ended, providing a multifaceted platform for the university and the company to develop innovation activities together [16].

Many fields of research, such as engineering, by their nature, involve considerable interaction with industrial practice. In addition, the role of the university as an educator of professionals – doctors, engineers, accountants, lawyers, etc. – means that a large proportion of their staff are focused on fields of research that engage with practical problems. For researchers working in such areas, practical problems provide a powerful stimulus to the development of new ideas [17].

Using deferent literature materials, this paper gives the general overview on University – Industry collaboration best practices which can be applied by developing countries. It highlights the experience on research collaboration done in industrialised countries and then compares with what has been conducted in developing countries on regards to research collaboration. Finally, it gives the concluding remarks and advices that will lead to improve the collaboration.

II. EFFECTS OF UNIVERSITY-INDUSTRY COLLABORATION

Collaboration with industry gives the access to industry for both fundamental and applied research and can boost academic research output for at least two reasons. First, collaboration can expand

academics' research agendas and improve the pool of research ideas. Collaboration helps academics to gain new insights for their own research and test the practical application of theories. Also substantial number of publicly sponsored research projects stem from industrial problems encountered in consulting [3, 18, 19].

University-industry collaboration can also expand the relevance of research carried out in public institutions, foster the commercialisation of public R&D outcomes, and increase the mobility of labor between public and private sectors [18, 20].

Industry collaboration can expand the available financial resources. Indeed, industry has been identified as a major source of funding for academic research in recent years. Two of the most important reasons for academics to collaborate with industry are to secure funds for graduate students and lab equipment, and to supplement funds for their own academic research [3, 7, 20, 21].

University-industry collaboration has positive and significant impact on scientific productivity. A scientific productivity is usually measured by the output of scientific products. These scientific products include publications in form of scientific literature, scientific texts, prototypes and patents. However, not all scientific products mentioned above are easily available or readily accessible. Many of them are not available or the access to them is restricted. Therefore, measuring the amount of scientific product is not an easy task. In many studies, scientific productivity is usually measured by calculating the number of publications in peer reviewed journals [22].

The University-Industry Partnership can increase the competitiveness of the industry partners. The manufacturing and construction industry is continuously striving to improve its products. Through, university and industry partnership programs, the university can play an important role to solve the industry problems in designing a new and innovative products. Further, the knowledge extracted from the collaboration with university can be used to manage and run the company better. This also means that how the company makes use of the knowledge and insights from academia to the benefit of the companies. For example: the possibility to create new innovative products, optimising the production time, upgrading new hardware and software, or to increase managerial efficiency [22].

The collaboration creates the partnership known as Industry-based learning (IBL) program where universities send their students to industry partners to learn and gain some important skills and work experiences. The industry partners can also benefit from this IBL program by assisting universities to prepare better equipped graduates to enter the workforce. They are the potential employers. In some cases, as a trade-off by providing access to the students under the IBL programs industries can leverage universities research capacity offer solutions and innovative ideas that can be utilised by business community [22]. It provides a chance to work on an intellectually challenging research program which may be of immediate importance to society [19].

Industry collaboration also brings brand names and prestige to institutions and Industry obtains employment-ready graduates from collaborative links with universities [6]. In this regard, university has contributed to the growth of industrial and business sectors and its contribution will in turn strengthen nation economy [22].

Industry collaboration, however, can also be costly in terms of academic output. First, spending time interacting with industry partners reduces the time devoted to pure academic research activities. Industry research and development (R&D) is directed at commercial success, while university research generally focuses on solving fundamental scientific questions [3]. Further, an excessive University's orientation towards the industrial environment has been also addressed as negative, since it may imply the engagement in too much consultancy-based research and the pursuit of short-term goals as well as problems related to knowledge disclosure [23, 24, 25].

Fig. 1 University offerings to businesses in collaboration [6]

III. UNIVERSITY-INDUSTRY COLLABORATION IN DIFFERENT COUNTRIES

Since the 1980s, many countries implemented policies to promote and sustain university–industry partnerships [26].

A. United States of America (USA)

The United States (U.S.) research university and the organized pursuit of R & D in industry both originated roughly 125 years ago and have grown in parallel throughout the 20th century [27]. According to Financial World, "the late nineteenth and early

twentieth century came to be referred to as the century of the American Genesis, given that investors, industrial scientists, engineers and systems designers were said to have become the makers of modern America" [19]. Prior to 1980, commercialisation of intellectual property from universities was rare and of little interest to most universities. The enactment of the Bayh-Dole Act in 1980 by the U.S. Congress allowed universities and small businesses to own patents on research which had been federally-sponsored. This has revolutionized the relationship between academia and industry. The legislation allowed universities to license their patents to industry, exclusively or non-exclusively. Royalties, received by the universities for such licensing, are used for further research and education as well as for rewarding the inventor(s) [28, 29, 30, 31].

The lengthy and rich history of university collaboration in the United States (U.S.) is an outgrowth of some unusual structural characteristics of the U.S. system of higher education. By comparison with those of Japan, Germany, France, and the United Kingdom, the U.S. higher education system has been much larger throughout this century. Almost any international comparative analysis shows that the number of students and the number of institutions are much greater than in these other industrial economies. The U.S. system also is characterized by a more diverse mix of institutions, including research universities, liberal arts colleges, and public and private institutions. These diverse institutions are not managed nationally or centrally, but compete fiercely with one another for prestige, for students, for faculty, and for resources. This is a very different structure from that of most other industrial economies [31].

The National Science Foundation's (NCF) engineering research centres (ERCs) are one of the U.S. government's major policy innovations of the 1980s to foster improved university–industry R&D collaboration. ERCs stand out among other university–industry R&D programs for the breadth of their objectives related to changing the conduct of academic engineering research and education as well as their emphasis on precompetitive generic research. ERCs were designed to fill a specific gap in the American national innovation system by conducting research that related to next-generation technology advances at the intersection of disciplines, the results of which were to be useful to industry without being too near-term in focus [32].

B. Canada

During the 1960s, a series of factors arose that favoured the growth of universities in Canada, in quality as well as quantity: a) the government offered tax incentives to the industry in order for it to invest in R&D projects with the universities; b) as a result of post-war baby boomers, there was a major demand to register in the universities: c) pressures towards universities for expansion into many new fields and: d) an important financial increase to the universities on behalf of the government. Consequently there has been a broad range of University-Industry Cooperative Programs (U-ICP) in research and technology exchange. During the 1970s, the boom became to an end and federal and provincial governments destined their funds to other social and economic programs consequently reducing education-related funding programs. Despite this situation, the support to Canadian universities did not stop; provincial governments continued developing programs to promote the university-industry relationship in science and technology. "As their American counterparts had done in the 1970s, Canadian universities began in the 1980s to take more interest in patenting and licensing inventions, fostering "spin-off" companies, undertaking contractual research for industry, and exploring other ways of enhancing communication and collaboration with industrial researchers". In the 1980s, the university-industry agreements were more important, involving a few large firms in important projects. It is important to point out that during the 1990s federal and provincial agencies were introduced to meet the needs of high-technology for small and medium enterprises, marking a reference that the support would not only be for major industries [19, 33].

Contemporary debates around university–industry collaborations in Canada are rooted in the longstanding perception that Canadian industry lacks in innovation, and fails to exploit the country's scientific achievements. Such concerns have become a recurring theme in federal science and technology policy since the 1980s. Although the participation of business in the national R&D effort has expanded since the 1980s, it is still regarded as weak in comparison with other leading economies such as the USA, Japan, South Korea, and the UK. Overall, business investments in R&D represent a lower portion of the GDP in Canada than in other major economies. Canadian industry supports less than half of total R&D performed in the country. In comparison, the corporate sector is responsible for two-thirds or more of the national R&D expenditures in the USA ($\approx$ 67%), Japan ($\approx$ 78%) and the OECD average ($\approx$ 65%). Corporate Canada performs a smaller share of national R&D ($\approx$ 54%) than other leading economies [34].

C. European Union

In response to the productivity slowdowns in most industrialised nations in the early-1970s and then again in the late-1970s and early-1980s, a new innovation paradigm began to be adopted by the European Commission. The focus of economic policies moved from an industry policy perspective to one that embraced the long-term benefits of high

technology. This redirection manifested itself in 1984 through the design and implementation of the first Research and Technology Development (RTD) programme. The overall aim of this and subsequent programmes was to increase the competitiveness of the EU, to build a strong scientific and technology base, and to support R&D collaborations [35].

In 2010 and 2011, the Science-to-Business Marketing Research Centre of Germany (S2BMRC) undertook for the European Commission a systematic study of cooperation among Higher Education Institutions (HEIs) in European Union (EU) countries and public and private organizations in Europe. As part of their study, all registered European HEIs in 33 countries were surveyed about, among other things, their cooperative activities with industrial businesses [35].

As such, the EU might have recognized these synergistic relationships as being a form of entrepreneurial activity through which all parties broaden their networks and thus realize an enhanced likelihood of perceiving new opportunities and reacting to them. During 2013, 14 EU country reports were published, each presenting aggregate information about the country's state of university-business collaboration as quantified through the S2BMRC survey. Of particular importance are the aggregate findings about the extent to which HEIs are involved with businesses in collaboration in research and development (R&D). Figure 1 shows country mean responses by HEIs to the survey question: Please indicate to what extent your university cooperates with business in respect to collaboration in R&D. Likert Response scale: 1 = "Not at all" to 10 = "To a large extent" [35].

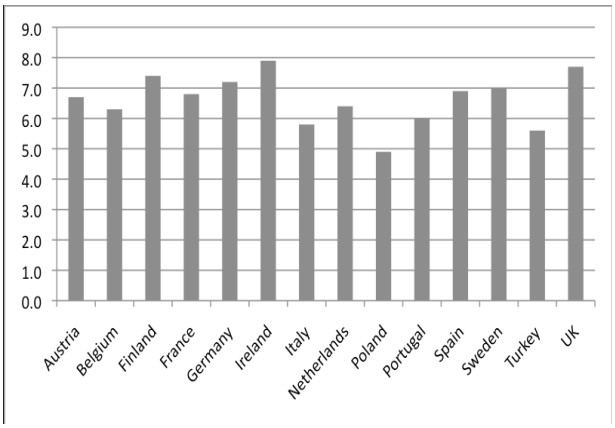

Fig. 2 Extent of Industry-Business Collaboration in R&D, by Country [35] in EU

The average responses show that most of the countries were above 50% excerpt Poland. Hence, European universities and research institutions are realising their role in the globalised economy and have undertaken interesting initiatives [36].

D. United Kingdom (UK)

UK research-intensive universities have become increasingly 'enterprising' in terms of research commercialisation, technology licensing and transfer, and other ways of engaging with the business enterprises and industry. University-industry interactions (UII) have become an important feature of the UK higher education system [37, 38].

World class university systems, especially those within competitive countries like the UK, are characterised by productive 'impact pathways' that translate science-based knowledge and know-how to commercial exploitation of research results or other societal applications. Both university teaching and academic science are increasingly designed to create socioeconomic impacts and benefits. Recent UK surveys indicate that the contributions from UK university researchers to problem solving and socioeconomic impact are indeed significant. The intent and ability to create such impacts is increasingly seen as a key performance measure of individuals, teams or organisations – witness the importance within the UK's research Excellence framework (REF) and university funding system, where the assessment scores on impact case studies contribute 20 per cent of the government research funding allocation formula [37]. Official statistics show that of the £27bn cash invested in R&D in the UK in 2012, nearly half (£12bn) came from business and almost two thirds (£15bn) was for R&D in business too [39].

Theoretical models of university-industry interactions provide ways to understanding the economic rationales to engage in joint R&D. Here the 'knowledge filter' model is used (Fig. 3) [37].

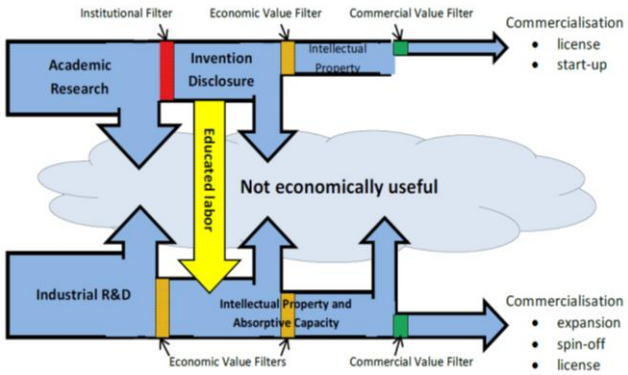

Fig. 3 Knowledge filter model of university-industry commercialisation processes

The model presents a simplified picture of university-industry interconnections in terms of how knowledge utilisation spaces and impact pathways may interact from a research commercialisation perspective. A series of decision-making processes filter out promising ideas and results, determine what gets through university/industry boundaries, and ultimately what may become economically useful innovation. This model comprises a wide

range of 'boundary spanning activities' where academic researchers and industrial R&D staff may interact and collaborate either on joint research activities or working towards achieving research commercialisation objectives [37].

The shown interactive model on fig. 4 emphasises the role of university human resources, academic career perspectives, and university-industry knowledge flows within the context of labour market dynamics affecting large firms in high-technology sectors. The inflow from industry into the university may vary from non-academic staff bringing 'practitioner' corporate-developed skills and experience into the university (for research and/or education) to prior academics (PhD student and postdocs) who spent time in corporate R&D units doing research. Some UI job hoppers may switch between two sectors (once or more regularly); others may have several part-time positions simultaneously, either temporary or permanent. At the level of professor one would expect to find a concentration of multiple affiliations where academics are part-time advisers or business consultants, or senior corporate R&D staff hold part-time professorships [37].

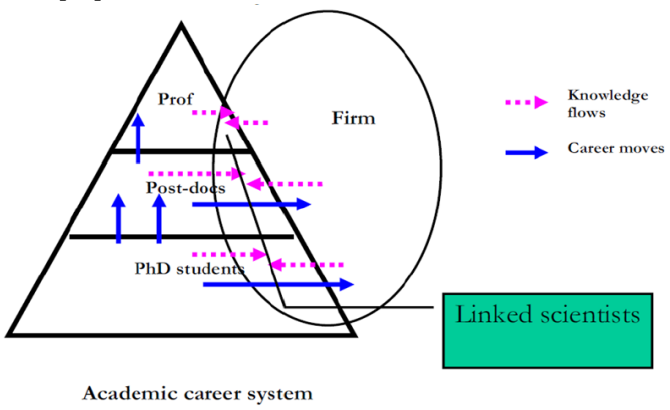

Fig. 4 University-industry interactions: collaboration, knowledge flows, human resource mobility and academic careers

E. Japan

Though university-industry partnerships were not active in the 1960s and 1970s, there is a long-standing tradition of cooperation in Japan. In this section two cases of good university-industry relation are discussed: the establishment of the world's first Department of Engineering at the University of Tokyo and the work of the Institute of Physical and Chemical Research (RIKEN) in leading a large industrial group before World War II [40].

Department of Engineering, Tokyo University:

At the start of Japan's modernization, Japan imported technologies from the West. In addition to importing machines and documents, the government hired many foreigners. These engineers were needed to construct infrastructure, such as railways and telegraph line networks, and to build and operate modern factories. However, it was too costly to hire for a long time. The government decided to foster Japanese engineers to replace these foreigners. The government sent a certain number of young Japanese to study overseas and established an engineering school at home. The Imperial College of Engineering was established under the Ministry of Engineering in 1873, and became the College of Engineering of Imperial University (now the University of Tokyo) in 1886. Then the graduates from the College worked in the industry, government, and academia. The engineering departments of Japanese universities were application-oriented from birth [40, 33].

RIKEN (Institute of Physical and Chemical Research):

RIKEN was a first research institute in the world formed an industrial concern and enabled it to be profitable and to support the institute itself. RIKEN of Japan, created the RIKEN Industrial Group. Many companies belonged to this group, and some of them became very successful. Since many of principal researchers of RIKEN held joint appointments as university professors, RIKEN can be considered as an example of university-industry partnership. RIKEN was established in 1917 at the initial stage of Japan's industrialisation as the first full-scale national research institute with government support. It excelled in a wide range of R&D activities from basic research to commercial product development [40].

Though Japanese universities, especially engineering schools, have a pragmatic tradition, university-industry partnerships were not encouraged and were not active in the late 1960s and 1970s due to the student political movement and campus disturbances. However, the environment changed in the 1980s, and the government formulated and implemented various policies to promote university-industry partnerships. For joint knowledge creation, the government established a formal scheme of joint research in 1983. In addition, the government helped to establish Collaborative Research Centres in national universities beginning in 1987. In 1999, the government began to provide research grants to encourage university-industry joint research [15, 40, 41].

Drastic change occurred in April 2004, when the government changed national universities into national university agencies. Each national university agency has an independent legal status and can make its own management decisions and make contracts with other parties. Its employees are not civil servants anymore [40].

Newly industrialised country (NIC) governments are increasingly focused on fostering science–industry interactions and developing high-technology sectors. Policy-makers in both developed

economies and NICs have been concentrating on designing policies aimed at raising the quality of Public Research and Education Organizations (PREOs) research and training programmes, to make their role more entrepreneurial and of more benefit to national economic development, and to support the growth of high-technology activities. As the economies and indigenous technological capabilities of NICs improve, national PREOs are expected to become increasingly important for supporting indigenous firms to move into more dynamic and high-opportunity industries [42].

F. Brazil

The growing support of the Brazilian government in the last decades is recognised as one of the major reasons for the country to gain importance as an emergent economy. Over the last years, Brazil has seen an improvement in the university- industry relationship, with approximately 80% of research projects being developed in public universities and research institutes, while the private sector is one of the strongest in the world. [29].

Among the incentives, R&D has been strongly promoted by Brazilian government. Some industries, such as Oil and Energy, are forced to devote a percentage of revenue towards R&D. Other governmental initiatives have also focused on strengthening the partnership. For instance, in 2005 the 'Portal Inovacao – PI' was officially launched as a result of a university-industry partnership among the Federal University of Santa Catarina and the Brazilian Ministry of Science and Technology. The PI aims at improving the visibility of experts and competencies in the country by extracting data from the Lattes Database – a large government-funded curriculum vitae database. It also aims at assisting the private sector in finding experts in specific areas of research at universities, research centres and also in other firms in order to create partnerships that may result in new technologies and innovations [29].

When Brazil is analysed in the context of Latin America as a whole, the whole region has been increasingly invested more on R&D, Brazil being one of the few countries in the region that has maintained a steady growth in government support for strengthening university-industry partnerships. This continuous support is illustrated by a doubling in government investment between 2000 and 2007. In fact, Brazil is responsible for more than half of all R&D funding in Latin America and the Caribbean [29].

G. China

University-industry partnership in China began as early as 1950's [41]. China's R&D expenditure has been growing steadily in the last decade despite their yet strong use of imported technologies. This has led to an improvement on their university and research systems, producing around 350,000 engineers every year. The patenting system is, however, still lacking in a number of areas, which might prevent further investment [29, 41, 43].

H. India

India's innovation on the other hand, is not driven by government initiatives, large firms or government-funded R&D programs, but instead by the high-quality engineers and scientists which are estimated to be around 2.5 million students/year graduating in the fields of information technology, engineering, and life sciences. India, however, still has challenges overcoming the split higher education system, where universities are primarily focused on teaching and where government laboratories are focused exclusively on research [29].

Joseph [44] reports that, in manufacturing sector, it has been found that the incidence of interaction of industry with universities as reflected by the respondents to the survey is very low. Of the 462 firms that undertook the survey only 11.27 percent claimed that they had any form of collaboration with a university or a PRI. However, there are considerable regional variations on this regard. Even when the total figures were very low, the interaction levels were high in Mumbai, with more than 31 percent of the firms collaborating with research institutes or universities. Here it needs to be noted that Mumbai is the traditional industrial capital of the country and that industrial development has a longer history than other cities. It appears that similar to innovation, the university-industry interaction is also an evolutionary process and it takes time for the institutional arrangements to emerge that facilitate the interaction. Fig. 5 indicates the results of the survey conducted on the suggested sources of information and knowledge of firms in India.

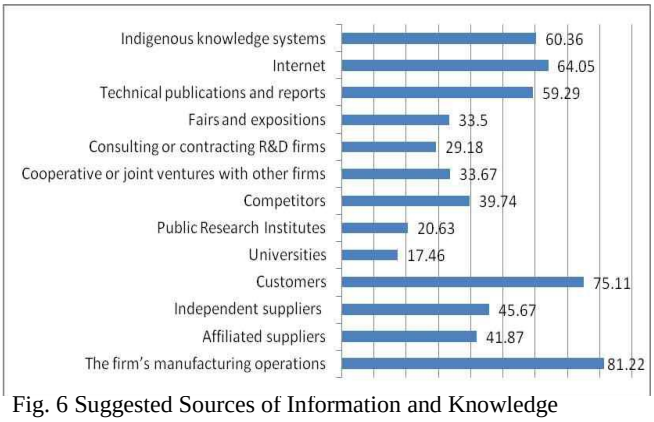

Fig. 6 Suggested Sources of Information and Knowledge for Firms

From the survey it was transpired that more than 81 percent of the firms considered their own manufacturing operations as an important source of knowledge for suggesting innovations (Fig. 5). The customers of the firm were the next important source of knowledge and information. Universities and public research institutes were reported to be less important source of knowledge. Only 17 percent

mentioned universities as important sources of knowledge, while only 21 percent claimed PRIs to be important sources of knowledge [41, 44].

I. Russia

Similar to China, Russia's growth in the past years has also been strongly dependent of imported technologies. After the economic opening of the former Soviet Union, there are only a few cases of university-industry partnerships, despite the strong position on industries such as the Oil and Gas ones [29].

Fig. 6 shows the expenditure in R&D activities for selected countries as % GDP.

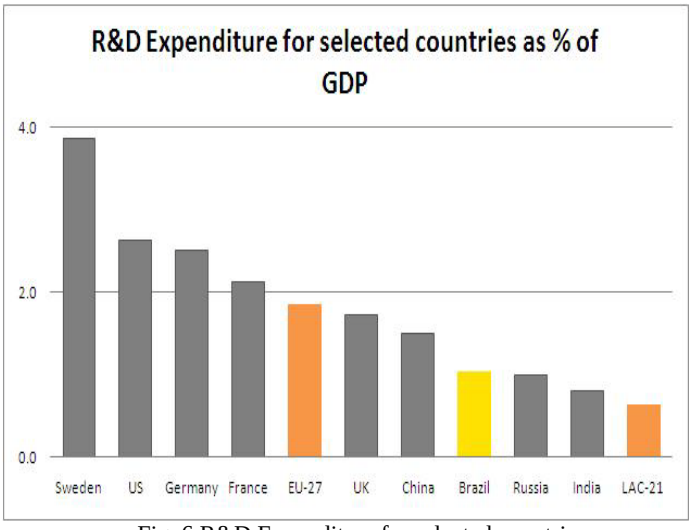

Fig. 6 R&D Expenditure for selected countries

Europe presents a greater degree of heterogeneity in R&D expenditures. Although their average expenditure is close to 2% of the GDP, three countries (Germany, France and UK) account for around three quarters of total R&D investment. The relationship between university and industry has increased in the last few years [29].

J. Africa

In general, little is known about the relationships between universities and industry in Africa. So far, empirical studies of university-industry linkages have mainly focused their attention on technologically developed countries. Because these linkages usually involve sophisticated research and innovation. Universities in developing countries, and Africa in particular, are thought to lack the ability to engage more actively with firms [45].

The analysis conducted by Sá [45] has revealed the factors that facilitate or inhibit stronger university-industry partnerships, as well as the potential opportunities for future partnerships. Informants from university and industry acknowledge the cultural divide between both sectors, which generates a lack of confidence on the part of industry on universities as potential partners. In addition, past economic crisis have led to significant reductions in state funding to higher education, which has affected their research capacity and infrastructure. The development of a robust research mission in African universities remains constrained by a number of governance and funding issues. In many cases there has been an absence of clear policies to encourage linkages between universities and industry. All of these issues contribute to the underdevelopment of the ability of universities to respond to industry needs.

A recent report on the state of university-industry linkages in Africa revealed relevant findings that serve as a cautionary warning [44]: University research output is limited by the low percentage of academic staff with PhD training and qualifications, and brain drain of qualified scientists; Many African universities have attempted to foster linkages with firms through the creation of offices and staff positions in charge of such affairs. However, such offices lack the material resources and expertise to handle industry partnerships and technology transfer effectively; There is a low number of science parks and technology incubators in academic institutions. Only a small percentage of universities surveyed reported being involved in managing science parks and engaging in technology transfer; The study suggests that support for establishing and managing business incubators and science parks would respond to the needs and priorities of African universities.

In developing countries, a major concern is the poor quality of education and the lack of financing available to universities, which often indicate insufficient capacity to join industry in innovation-related projects [18].

IV. UNIVERSITY-INDUSTRY LINKAGE BEST PRACTICES

According to Abraham [46] and Julio et al [47], best practices related with commercialisation researches and collaboration internal to the university and how it interfaces with the external community are the following**: T**he leadership of the university is strongly supportive of technology commercialisation and student/researcher entrepreneurship. In addition to the willingness to embrace collaboration with industry leadership, universities can put in place policies that encourage entrepreneurial activity, ranging from promotion and tenure policies**; E**ntrepreneur in Residences are experienced business advisors from outside of the university who work with faculty interested in commercialising their research. They provide valuable coaching and mentoring to faculty and students, help align the expectations of what can be realistically commercialised, bring with them and entrepreneurial culture, and lastly serve as a vehicle for bridging the university-industry divide**; T**here is little disagreement that people are the most important form of knowledge transfer. Leading

regions have multiple methods to link their students to work experience and job opportunities in the private sector. These include mentorship programs, internships and business plan competitions**; E**stablishing and promoting centres or institutes that have a mandate to perform collaborative research with industry and cut across two or more academic disciplines**; T**he sharing of information can foster a collaborative atmosphere within the university and between the university and the outside community**; I**ndustry-University collaboration must be aligned with the company's research and development strategy and address a tangible need of the company**; I**n every organisation, there are certain individuals who naturally engage in networking activities, maintaining relationships that cross organisational lines. These "boundary spanners" are the main conduits by which knowledge is acquired from external sources and disseminated inside the organisation, and they play an essential role in how any organisation benefits from and adapts to its environment**; T**he data show that academic research is more likely to have positive impact on a company if the university researchers have a strong knowledge of the business setting, company practices, and how the research fits the company strategy**; T**he investment in long-term relationship is advised. Industry and academia do research on markedly different time frames. Industry is driven by economic and product cycles, while academic research projects duration depends largely on the time required for a graduate degree programme (a year and a half to two years for a Master's degree, three to four years for a Doctorate). Both parties thus need to be upfront, and realistic, about the time expectations**; I**t is beneficial to have the university researchers visit the company and interact with company personnel. The more often these visits occur, the better the outcome and impact of the project [48]**; C**ontact between university researchers and individual in the company over and above the project manager increases the research's impact of the company**; S**uccessful management of the industry-university collaborations implies a wider view than deliverables and contract fulfilment, because creating and sustaining a peer-to-peer relationship is central to success [49].

V. CONCLUSIONS

The information necessary to be observed for the purpose of enhancing the university-industry collaboration in developing countries has been presented. Through review, it has been revealed that Universities and industries are dependent on each other for mutual benefits in the process of creating opportunities in competitive market.

Universities play a key role to socio-economic transformation and development of the nation through; innovation of new technology, upgrading the existing low-level technology to medium or high technology, devising a better or new and effective management techniques and formulating and suggesting economic and other relevant policies.

Further, if universities and industries work together one after the other, they can turn out to be a powerful engine for innovation and socio-economic development of the nation.

The developing countries are advised to use best practices in order to improve the nations' economy.

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