INNOVARE JOURNAL OF BUSINESS MANAGEMENT

Vol 8, Issue 1, 2020

ISSN- 2321-6824

Research Article

INDUSTRY AND RESEARCH COLLABORATION A MODEL FOR INDIA

ROSHANI GOEL

Sanrachna, SGT University, Gurugram, Haryana, India. Email: roshani_sanrachna@sgtuniversity.org

Received: 5 November 2020, Revised and Accepted: 16 December 2020

ABSTRACT

The purpose of this paper is to understand the technological innovation taken place in pharmaceutical industry based on institutional research and the gaps between the investment made in research the utilisation of research by the industry. Though the topic is open for argument but it will be beneficial for public policy makers concerned with science and technology and economist thriving for technological change and innovation. The paper aims at putting a discussion for a need on investment and private businesses collaboration with institutional research. This gives space and time for new knowledge to transform the existing technology for betterment of life. It critically talks in the context of pharmaceutical companies in India while getting an outline from industrially developed countries. It highlights the fact that first industry academia collaboration enhancement agenda was held on 5th March 2013, in New Delhi. This itself explains the requirement of institutional research for technological upliftment which will further be supported by literature presented by the researchers.

The international scenario showed that 1980's Bayh Dole Act of United States is the best model to strengthen the industry and research collaboration. The model has been implemented worldwide. This paper presents the analysis of countries like U.S.A, United Kingdom, China and OCED countries. The reason for this is that these countries have well developed academia industry collaboration and strategic partnership between them. Though these countries have better GDP and stable economy. However, India is a growing economy and new ideas will help it in making it stronger.

India is at a starting stage of developing the process academia research and industry collaboration, so there is a way for new strategies to make way in the bottleneck for collaboration. Even in India Bayh Dole Act has been implemented under different name. But one of the major challenges regarding its implementation that India receives is in transparency and clarity in terms of policy and lack of inputs from different organisations. In addition, different are positive about India's growth and in order to sustain such growth in coming years it is imperative to have technological advancement and innovation to accelerate to propel the economic growth of the country. Thus, research centres near firms seems to get more related to research work concerned or required by the industry. In other words, in industry research collaboration geographical proximity has main of the main role to play in it. The study bases its argument on rich literature that advocates that the collaboration is beneficial for both research and industry.

Keywords: Industry, Research, Collaboration, India

INTRODUCTION

D.B. Audretsch and M.P. Feldman [1] in their study mentioned that 'more than any other economic activity, innovation and technological change depend upon new economic knowledge. Paul Krugman (1991a, b) and Gene Grossman and Elhanan Helpman (1991) emphasised on the role that 'spillovers of economic knowledge across agents and firms paly in generating increasing returns and ultimately economic growth'. In recent years, industrially developed countries are based on the foundation of industrial and public- private research institutions. They have made it as a policy priority according to the Organisation for Economic Cooperation and Development (OCED) report 2007. Since the 1960's, researchers have identified the intensification of institutional or academic research to support technology transfer, enhancement and exploitation of research outputs. To examine innovation system, researchers on economics of innovation talked about the 'triple helix' model which talked about the interaction between public research, industry and government institutions as the ideal model for innovation system [2]

It is expected that government to finance research for institutions to attain optimal research and development investment. Due to private under investment of R&D results in failure of financial and technology markets and economies in R&D. Also, public-private funded research is used by private business firms for industrial innovation. Economics of knowledge innovation can be achieved through three basic categories, education, research and consultancy. New information and knowledge generated by research institutions can move to industry through R&D contracts, publication of research papers and R&D cooperation with private companies [3].

Whilst the economist has deliberately asserted that public funded research specifically is a fundamental key for industrial innovation and economic growth, the scope of the paper makes itself limited to significance of the contribution of public private funded research made to pharmaceutical industries. The essay determines that basic research makes primary contribution to any drug discovery for industrial research which is also known as 'drug concept' phase. The study will follow this line of research. It will begin by identifying the countries who have successfully been profitable with institutional research in innovating their pharmaceutical industries for both private and public domain. With the help of existing literature, the study will unfold the factors which have determined the collaboration like the capacity of university with excellence of researchers, the investment and geographical location. This will help in drawing an outline for India's pharmaceutical innovation through institutional research. This will establish an argument that enterprises seeking institutional research are positively innovating technology for their industries.

The analysis of the countries adapted collaboration of research and industries

Literature on public private funded research and industries is very rich in content. However, the study mainly covers U.S and European countries and their experience. Universities in these countries have a long history of collaboration with industrial ventures and industrial departments being setup around universities. One important analysis is that these countries are also industrially developed countries. Recently, Asian countries have also started collaboration between universities and industrial ventures and R&D units. In addition, they are also collaborating with government funded research institutions. This section of the paper will present a comparative analysis of countries who have performed better through collaboration of institutional research and pharmaceutical industries particularly.

According to 2019 Global Innovation Index, U.S has been ranked on 3rd position out of 129 countries. Having improvement in quality of health, R&D global companies and having good number of scientific publication and universities. In 2004, the United States invested $26.1 billion in basic research [4] and $476.5 billion in 2017. "In the life

sciences, the U.S. National Institutes of Health (NIH) is the world's largest public enterprise supporting basic research. In 2004, NIH obligations for basic research were $14.8 billion, which represents about 83% of total federal obligations for basic research in the life sciences" [4]. The explanation for economic development is related the fact that

institution like universities, non- profit organisation does federal funded research and then is transferred to industries. Micro level data on NIH research development allows pharmaceutical innovation and R&D units to align according to medical defined areas. The regulatory formulation imposed by U.S Food and Drug Administration (FDA) allows pharmaceutical companies to formulative innovative process which is common across the firms. This further makes it simpler to apply any research at larger expertise.

Another on the list is United Kingdom which was ranked 5th on Global Innovation Index which was marked by the growth in human capital and research. In 2017, 34.8 Billion pounds were invested in R&D in U.K from 33.1 billion pounds in 2016 [5]. In U.K NESTA (National Endowment for Science, Technology and the Arts) is a major innovation foundation in the country. it was originally funded by
25 million pounds endowment from UK National Lottery which is managed by a Trust. Through policy innovation and research, it helps developing an advanced healthcare system. NESTA embarked on research and innovation programmes and work to transform them into practical applications.

In terms of Asian countries, China consider universities research crucial for development of technological products and making them internationally competitive. Which resulted for them to achieve 14th position in Global

Innovation Index. The paper by Hu and Mathew's (2008) highlight the role played by universities and research for building China's National Innovation Capacity (Siddharthan, p.3). In 2017, China's investment on R&D was $280 billion constituting 2.12% of country's GDP. 2.7% is current ratio of investment in R&D specifically for pharmaceutical companies.

Nevertheless, OECD countries are not behind in committed to investment for basic research. 35 members of OECD are devoted 22% of their research budget to basic research. "On average in the European Union, 52% of the government's budget appropriation for R&D went to basic research in 2013. There are wide variations from one country to another, however. Germany devotes 57% of the government appropriation for R&D to basic research, for instance, France 45% and the UK 40%. Latvia counts the lowest share (23%) and Croatia and Malta the highest (more than 90%)" [6]. Germany is moving ahead with a faster pace by constructing a research centre for Physics, Facility for Antiproton and Ion Research (FAIR). The project further involves seven European Union partners. Switzerland is a leader for innovation research because it spends its 30% of researchon basic research.

Emerging economies are also spending on research like Republic of Korea, Brazil and Russia. This indicates that institutional research helps for business and commercial outcomes. They reflect short term goals with return of investment giving new knowledge for industrial innovation.

Aligning the findings with Indian model

India is known for affordable and quality higher education. Education institution plays a vital role in social and economic development of the individual and of the nation. However, higher education becomes inoperable if it is not used to give specific output. Therefore, it is important for institutions to collaborate with industries for better results. It helps in advancement of science and technology too. But in India, there is a wide gap between industry and research institutions because of lack of initiative taken by private and public stakeholders. Unlike other Asian countries like China, Japan and South Korea the collaboration between industry and research has not resulted in any technology innovation but is confined in introducing new training programs that will help the universities to produce graduates to get absorbed by same system.

However, stakeholders and policy makers have realized the importance of industry research collaboration. The first discussion was held on 5th March 2013 in New Delhi, India. The consultation was held between the Ministry of Human Resource Development and leading representatives of industries and Indian academic institutions from all across the states. In the workshop on Academia- Industry Collaboration, Ministry of Human Resource Development of India (MHRD) [7] pointed out that-

"In India, a number of initiatives for industry-academia linkages have over years yielded positive results in research, but as these remain sporadic in nature India's share in world researchers has persisted at about 2 percent as compared to 20 percent of the USA and China's. The share of research and development (R&D) investments of the USA were 32 percent, of Japan 13 percent and China 9 percent, it was only 2.2 percent in India[1] . Significantly, an analysis of the share in R&D shows that in India, the government share is between 75-80 percent, the private sector's share is 20- 25 percent, and that of universities is 3 percent, while in OECD countries, the government share is 10 percent, the share of the private sector is 69 percent, the share of universities is 18 percent and of the non-profit organisations is 3 percent. As a share of GDP also, India's R&D spend is about 1 percent as against a target of at least four per cent if double digit GDP growth is to be achieved" (The MHRD Consultation for Greater Industry-Academia Collaboration, 2013).

The study by Joseph and Abraham (2009) used firm level data that included pharmaceutical companies. The results suggested that industries and academia did not have much interaction in fact the companies got new ideas from manufacturing operations. In India, the government sponsored research is considered as the property of government and researcher has no say in its commercialisation. "In this context the Indian Cabinet gave its nod for a bill - Protection and Utilisation of Public Funded Intellectual Property Bill 2008 (October 30, 2008) - giving scientists share in the intellectual property. This bill has been modelled on the Bayh-Dole Act in the US which spurred applied research in the US Universities" (Siddharthan, p.12).

Major provision provided by the act-

- The title to innovations developed under federally-funded research programs by non-profit institutions, including universities, and small businesses could be retained by them
- To promote the utilization of inventions arising from federal funding by encouraging universities to collaborate with commercial concerns.

Outlying the model from the perspective of pharma industry

Pharmaceutical industries live through translational research. The collaboration between pharma industries and research is considered as an era of modern therapeutics. Some of the fruitful collaboration has given a relevance of respiratory medicine the discovery and clinical application of corticosteroids, recognized with the award of a Nobel Prize to Philip Hench (Mayo Clinic), Tadeus Reichstein (Basel University), and Edward Kendall (Mayo Clinic) (Rosenblatt, 2013). There are few collaborations on earth which have repeatedly accomplished transforming knowledge of potential drug into medicine for people all around the world. During technological advancement natural molecule used for drugs were discovered. In recent times, the molecules are synthesized and drugs are invented, and then their properties are tested after which the drug is formulated and produced. It was estimated that pharma industries spend $1 billion to $2 billion for the invention of any new drug.

The first half of the process for inventing a drug begins after sending years of research in academia to identify a potential drug for invention (Rosenblatt, 2013). Nevertheless, the failure rate is high is such process. 80% of molecules that enter clinical trials do not become drugs. The total time needed from research to compound to regulatory approval is 10- 15 years and there are times that some drugs continue post approval as well. The process is economically as well intellectually challenging. But once it is organisationally successful it returns the time and money invested in it. For example, the deaths regarding cardiovascular disease were surging till 1970's in U.S. But in 1980's number of innovations and introduction of statins reversed these trends. Not only U.S but the entire world saw a decline in a cardiovascular mortality rate. Likewise, by the mid of 1990's HIV Aids became a global epidemic disease until academia research and pharmaceutical invention turned it into a chronic disease where people can live their daily life with the disease (Rosenblatt, 2013). These two-

[1] UNESCO Institute of Statistics

example set a blockbuster success of a collaboration between academia and industry.

It is important to understand the progress that biological system and sophisticated methodologies have made over a past 60 years. In 1940's drug invention was done by chemists making it a compound and testing them on animals. By 1970's and 1980's pharmaceutical industries entered into a real molecular target: enzymes, receptors and channels. Today, after three more decades we are in the era of 'omics' like genomics, proteomics, etc. Major products in the companies today will be gone in next 10 years because of patent expiry. This shows that business model for pharma industries is relentlessly challenging and thus requires the division of work between organisations.

The working condition and methodology between academia and industry is different but goal for providing a healthy life is same. Academia does the basic research to identify novel molecular targets and for trials that evaluate the safety of inventions from industry. Pharma industries do not have advanced research laboratories that exists in academia. Simultaneously academia requires industries to put their research into medicines and technologies used for patients. The part of funding is done by government and academia. As mentioned earlier, NIH fund basic research and clinical research in U.S. the amount of research in last couple of decades supported by NIH is much higher that any pharmaceutical company.

Industry research collaboration in India

As India at a beginning stage of development in terms of industry research linkages. It faces certain challenges despite being a country for top educational institutions. The problems arise in terms of higher education that requires immediate attention. There are constraints in research capacity due low enrolment rate in PhD programmes. Despite obstacles, India's share in world researchers persisted at 2% while 20% in U.S.A and China. With the recognition at the importance of industry research collaboration, there has been an increase in the pass outs at various levels as the PhD pass out has increased both in males and females (2015-2016).

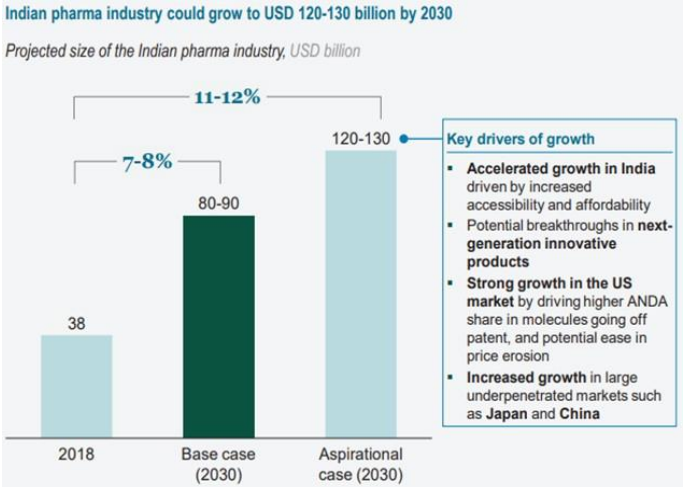
Table 1: *Pass outs at various levels*

S. No.	Description	Gender Wise	Year		
			2011-12	2015-16	Growth
1	PhD	Male	13696	14887	8.70%
		Females	7763	9284	19.59%
2	M. Phil	Male	9581	8701	-9.18%
		Females	11036	14423	30.69%
3	Post Graduate	Male	578451	665846	15.11%
		Females	535575	739150	38.01%
4	Under Graduate	Male	2757412	3128466	13.46%
		Females	2711918	3203533	18.13%
5	Integrated	Male	11826	12477	5.50%
		Females	8305	10127	21.94%
6	P G Diploma	Male	56086	95013	69.41%
		Females	32699	80340	145.70%
7	Diploma	Male	324980	500999	54.16%
		Females	232735	287323	23.46%
8	Certificate	Male	32893	37321	13.46%
		Females	36094	41467	14.89%

Source- PhD Research Bureau, Compiled with Ministry of Human Resource Development, AISHE Report 2015-2016, Ministry of Science and Technology.

India is also growing in pharmaceutical companies every decade and is expected to grow in coming years. This states that investment and collaboration with them has a brighter scope. As shown in Table 2.

Table 2: *Indian Pharma Industries to embark a growth in next ten years*



Source: Indian Pharmaceutical Alliance (IPA), 2019.

Furthermore, India has some worldwide known renowned universities like Indian Institute of Technology (IIT), Indian Institute of Management (IIM), All India Institute for Medical Sciences (AIIMS), The National Centre for Biological Sciences in Bangalore and National Centre for Biotechnology Education (NCBS) and Indian Institute of Science (IIS). These university conduct research in collaboration with state and central government with industry players involved in it. Their research including from other 1400 institutions has been published worldwide. Due to lack in policy clarity and gaps in policy implantation at ground level the collaboration between the two could not enhanced. One way to do this Public Private Partnership (PPP). "To enhance the PhD education in the country, the office of Prime Minister in 2013 launched the Prime Minister's Fellowship Scheme for Doctoral Research, which is unique for its promotion of industrial research. According to this scheme, the government provides 50% of the total cost of fellowship to students for performing research in real-time industry environment. Industry provides the rest, and any Intellectual Property Rights (IPR) once created is owned jointly by the student and the industry concerned" (Ministry of Science and Technology, 2019).

The reason for private sector for not being research oriented until recent times is that there is a lack competitiveness among firms and also most of the research were done under government domain. But this view has begun to change as private sectors has started showing interest in research as it is time saving and simultaneously academia research face funding issue which is being sponsored by private firms. There comes a mutual understanding while working in collaboration is that researchers work to get their research published and industry for patent. Both align with each other without disrupting the other in order to protect their own interests of publications and IP rights (Abuja, Carapina, Kort, Raess, Tieken and Wagstaff, 2019). And with the - Protection and Utilisation of Public Funded Intellectual Property Bill the researchers are also given certain share in the patent.

Aligning with each other helps in recognising different drivers to make the collaboration possible. The key pointers as presented by Abuja, Carapina, Kort, Raess, Tieken and Wagstaff, (2019) are:

Size and development stage of the organization: Large enterprises (pharmaceutical industry) have different dynamics vs. small and medium enterprises regarding decision making, strategy and risk-averse behaviour to maintain their reputation.

Nature of the collaboration: Research service projects are more straightforward and often follow a more linear path than joint collaborative projects and long-term strategic initiatives where thematic partnerships will generate knowledge as part of an 'extended department' of the company.

Project size and complexity: A larger number of partners brings in more complexity to align legal representatives in setting up a larger consortium. Technically demanding projects requires collaboration between different stakeholders representing different disciplines.

Indian Scenario from geographical perspective

In 2005, Indian law became compliant with the World Trade Organization (WTO) Trade Related Aspects of Intellectual Property Rights (TRIPS) agreement. "As a result, product patents are now possible on chemical molecules for new drugs introduced after 2005. This clearly represents a significant step forward for both novel drug discovery as well as the sale of therapeutics in the Indian

market" (Drug Discovery World). Howard in his study pointed out that to promote direct investment in clinical development and data management, government is providing benefits such as exemption from import duty on clinical trial samples and service tax for 10 years. In India, states with major clusters of pharmaceutical industries are Mumbai, Delhi, Bangalore and Hyderabad.

"The state of Maharashtra, where Mumbai is located, contributes about 40% of the total turnover in the pharmaceuticals sector in India. It has 4,100 registered pharmaceutical manufacturers out of a country-wide total of around 20,000. Around one-third of the country's bulk drugs are produced in and around Hyderabad in Andhra Pradesh. Infrastructure, however, continues to be an issue. In 2005, India only invested 3.6% GDP ($28 billion) on infrastructure (in contrast, China invested 9% GDP – $201 billion)"

There are some examples of Public Private Partnership in India that has helped India to develop in the idea of industry and research institutions for example- "Nicholas Piramal, an Indian pharmaceutical company headquartered in Mumbai, has a fee-based agreement with the Institute of Genomics and Integrative Biology (IGIB) and this alliance has already resulted in two joint patents. Researchers at the Center for Biotechnology at Jawaharlal Nehru University in New Delhi, in collaboration with Panacea Biotech Ltd, have completed preclinical studies on a recombinant anthrax vaccine and will start Phase I trials shortly" (Howard, Drug Discovery World).

Another example is of Merck India, for example, is active in early drug disease research through the Merck Development Centre (MDC), a new R&D unit set up at Taloja near Mumbai, with an investment of $3.9 million. The Government funding of the Indian Department of Biotechnology (DBT) has risen from $15 million to more than $125 million a year. Funding has also come through from international sources such as the US National Institutes of Health, the Bill & Melinda Gates Foundation, the European Union and the Welcome Trust. A particular focus has been to nurture industry-academia interaction.

With the ongoing research in India in companies mentioned below are now collaborating with academia and also providing support in education and funding.

Table 3: *Ongoing Research in India*

Company	Area of Research
Astrazeneca	Tuberculosis
Nicholas Piramal	Migraine, Tuberculosis, Psoriasis
lupin Pharma	Type 2 Diabetes, obesity
Dr. reddy's lab	Arteriosclerosis, Restenosis, Dyslipidaemia
aventis pharma	Metabolism, Cardiology, CNS, Arthritis, Oncology, Respiratory, Anti- Infectives
Novartis	Diabetes
Roche	Oncology, Virology, Transplantation

Source: Howard, Drug Discovery World

AstraZeneca Discovery Bangalore is part of the AstraZeneca R&D network mainly focused on tuberculosis research with an overall current and planned investment of more than $40 million. More than 100 scientists are presently employed at the site. Now they are interested in collaboration with educational institutes for speedy research. On other hand, Evolve Biotech (Switzerland), which is setting up its own discovery programme at the Indian Institute of Chemical Technology (IICT), Hyderabad (Howard, Drug Discovery World).

This shows that Indian Pharma companies have larger scope when in collaboration with academia research and similar lines if for institutes to get fund for their researches.

Challenges for the collaboration

Before focusing the attention on promoting the improving research collaboration with pharma industries, it is necessary to look at the barriers which obstruct its success. First, the interface between the pharmaceutical industries and practicing physicians has also been a matter of tension. The negative attitude in interface spill over becomes an obstacle in research collaboration and in a reliable research. Academia sometimes have a conflict of interest it is crucial for them to understand that unpredictable change creates a regulatory barrier. The long process of modification without any resolution creates uncertainty for predictability.

Secondly, every research institution has their own policy concern collaboration with the industry. However, the conditions under the policy is similar. These research centres and industries negotiate on payments, time a research will require and a royalty rates that a particular collaboration requires. The main obstacle comes in navigating the non- disclosure agreement while constructing a master research with potential intellectual property rights (R. Lutchen, 2018).

Third, not all research is productive and beneficial. There is awareness regarding high irreproducibility of academic data. This is the problem faced by academicians and scientists indulged in basic research. for example- "Scientists at Bayer recently evaluated about 70 targets that they had worked on. They observed that for almost two-thirds of the targets, the initial basic research data that prompted interest could not be replicated (Prinz, Schlange and Asadullah, 2011). A few months later, Amgen corroborated this finding with its own observations (Begley and Ellis, 2012). Venture capital firms do not start new companies until they have replicated relevant data" (Rosenblatt et al, 2013).

Fourth, problem is of 'red tape' that is, every translational research requires a strong clinical research which itself is in crisis in most part of the world. For example: in 2007 more than half of the clinical research did not go under clinical trial which were developed in United Kingdom.
Fifth, time and money spent for the training of clinical investigators drop the research almost after their first clinical trial. This results in the loss of money which is not recovered due to unreasonable act.

Sixth, another factor geographical proximity of the university to the firms. There are multiple advantages for in firms working with and keeping updates with the local colleges and universities. In other words, universities and colleges citied more often located near the firms (Mansfield, 1995).

It is crucial to our understanding that despite all of this pharmaceutical companies who are open to uncertainties and inefficiencies and barriers to practice and policy still send their research in for trials and obliged to operate in world.

Overcoming the obstacles

There is a need for collaboration between research and industry as there are disease for which there is no ideal treatment for "chronic obstructive pulmonary disease, interstitial lung disease, asthma, lung cancer, and pulmonary hypertension. Other areas of respiratory medicine having unmet needs include AIDS, multidrug resistant tuberculosis, and a variety of "orphan diseases" (Rosenblatt, 2013). With the problems mentioned above, the entire collaborative arrangements can differ if introduced with programmatic collaboration. Instead of contract based on time now money invested on the basis of milestone of research. On the other hand, academia with funding is also bringing core resources like chemical laboratories and imaging methods with them. For example- Merck has initiated a model which is California Institute for Biomedical Research (Calibr). Calibr is a non- profit organisation started in 2012 in California. Merck has made a commitment of $92 million to Calibr for over next 7 years. Calibr will provide academic collaboration with vast industry support. Another is Pfizer's Center for Therapeutic Innovation (CTI). "CTI provides investigators access to select Pfizer compound libraries, proprietary screening methods, and antibody development technologies. CTI will enable academic career advancement through research and publication, while creating significant financial opportunities through milestones and royalties" (Rosenblatt, 2013). Another example of Gilead Science and Yale school. Gilead is providing $40 million for research for initial 4 years and will provide $100 million if the time frame extents for next 10 years during 4 years' time span. Thus, support from government and public private industries will help the healthcare system to boost in innovation arena.

Funding Mechanism

In this paper one has understood that for any research public funding is a primary source of support. One of the ways of getting funds is by grants writing and pre- application deadlines covering the explorative researches that is, doctoral research and mentioning time span. Whereas pri4vate

funded research is more output driven and have more chances of delivering a successful research-based product. More effort is put in where there is more support is provided for research. But this is however, sometimes is mistaken that funding will be provide for overall project whereas funding is provided to cover the actual cost of research, like on materials, travelling, personnel and depreciation.

Often, it becomes difficult for private biomedical research institutes to keep pace with technological advancements making unfeasible for institutions to keep a contract dictating the list of services being provided at what prices like any commercial business contract. Similar situation goes with Public research institutes. Then how this will be done? For private funding small and medium enterprises have various investors behind them who want fast research in limited time. There are limited resources to fund these limited times span academic research. On the other hand, large companies have interest in long term research-based projects and have developed separate supporting capacity for academic institutions with academic liaison management. Also, large firms advertise about their requirement and interests on their sites which ease the opportunity for licensing and research collaboration. Research programs which have market opportunity can fetch capital investment from industries.

Public funding focuses on key arena working for better healthcare system like universities and pharmaceutical industries. Charities from National and International foundations help in providing the support public institutions for research. Today, research on novel drug discovery has become a focus of interest act as an opportunity for young researchers to look in new area of health system. Nevertheless, for both public and private funding the consent is based on Project Agreement which includes (Abuja, Carapina, Kort, Raess, Tieken and Wagstaff, 2019):

- Generation and sharing of knowledge.
- Access to company expertise.
- Access to high-end, high-throughput core facilities.
- Access to consumables and materials (subject to terms of MTA).
- Joint publications (with higher impact).
- Expanded professional network.
- Enhanced quality and reproducibility of research outcomes.
- More attractive terms to obtain licenses (non-exclusive or exclusive).
- Generation of joint IP, generating future income from issued licenses.
- Personnel exchange (e.g. PhD, Post-Doc, technicians).
- More opportunities for co-funding (Company Letters of Support for grant applications)

Such agreements can take time to build a report where both parties are comfortable with but later it helps in building trust and act as an efficient vehicle to keep long term partnership. It can also name as Non-Disclosure Agreement (NDA), that is having IP rights.

Framework for India

Despite facing challenges, India has been successful in tackling the problems with the realization for an industry and research collaboration. India ranked at 52nd position in 2019 in Global Innovation Index, moving up from 81st position 2015. India's growth is noted on knowledge diffusion, research and development and knowledge creation. However, there are multiple reasons due to which the model for India in the context of technological innovation is still not achievable. Industry research collaboration requires systematic management for visible profit. The results need to flow out of industries based on the research done by academia. To make researchers productive it is also important for academies to make arrangements for staff and to bring incentives. Industries are always keen in recruiting people in expert fields. For example, in 2015 uber hired 40 researchers away from Carnegie Mellon University. There are times that academia become endangered of professional's researchers as pay in the sector is comparatively low. Therefore, University of Waterloo founded a model Applied Brain Research (ABR) where researchers can work from inside their research laboratories for industries. ABR helps researcher to publish their work and support involvement in academic labs (Gann, Montresor and Eisenberg, 2018).

Further while constructing a model for India it is important for stakeholders to understand the vital role played by social sciences. It is considered that social sciences researcher work becomes the basis for innovation products and services. Their research on societal impact of fast-growing technological innovation gives a knowledge in hand on legal, social and cultural framework (Rybnicek and Königsgruber, 2019).
In addition, there should be flexibility for tech transfer from university to industry. Commercialisation of research gives a security to both industry and the researcher. Government plays an important role where private funding is not sufficient for a company to grow. With the help of government funding, private grants and academia, a quintessential lab is developed for the growth of technology innovation.

Investing at early stage of research is another way of getting benefits out of industry and research collaboration. Companies fund doctoral or post-doctoral researchers studying new technological formation that is of interest for the company, and if something promising or new research emerges then more investment is forthcoming. Not only individuals but cultivating institutions help industries to foster long term projects which is layered by multiyear funding (R. Lutchen, 2018). Also developing common ground for non-disclosure agreement and flexible in patent licensing, universities will contribute fairly and will stand on a common ground with industries.

Rybnicek and Königsgruber (2019) in their research talked about commitment. Commitment talks about the person and how much he identifies himself with collaboration and its goals and time and efforts he is willing to put in research. so, the existence of mutual commitment binds the industry- research relationship. Contractual safeguard eliminates the uncertainty of backing out from research before it gets commercial success as not all research goes for trial and commercialisation of products.

CONCLUSION

Industry and research collaboration of highest importance and is in the interest of the government, policy makers, researchers, practitioners and industry for delivering successful innovation. Despite the obstacles and hindrances there are advantages and potential of collaboration which are well recognised at a world level. Numerous examples from different nations are sufficient in itself to state the importance of collaboration especially for pharmaceutical companies. Pharmaceutical companies are sensitive to change and failure, the product in their portfolios will become irrelevant once the patent is expired. Therefore, they need constant recharge from technological innovation to stay in the market as well as fruitful in developing a drug which help in curing a deadly disease. These evolutions require years of research which is not possible without the academia as they have systematic and advanced research laboratories conducted professionals. Further create innovation which once was a challenge.

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