Annals of Library and Information Studies
Vol. 69, December 2022, pp. 294-303
DOI: 10.56042/alis.v69i4.66960

Perceptions of engineering faculty members regarding research collaborations

Bhaskar Mukherjee[a] and Priya Tiwari[b]

[a]Professor, Department of Library and Information Science, Banaras Hindu University, Varanasi, Uttar Pradesh, Email: mukherjee.bhaskar@gmail.com

[b] Research Assistant, Department of Library and Information Science, Banaras Hindu University, Varanasi, Uttar Pradesh, Email: priyaquarius24@gmail.com

Received: 28 September 2022; revised and accepted: 31 December 2022

The purpose of this study is to connect the perceptions and understanding of the collaboration of faculty members of NIRF ranked top-performing engineering institutes with the publication they have. The quantitative bibliometric analysis along with the enquiry with authors show that national collaboration, mainly with academic authors of same or other institution, still is a preferred. Despite international collaboration leading to more average citations, there is no significant gain seen. Scholars collaborate for many reasons, but mostly to gain popularity among peers or to receive citation benefits. Collaboration with private or government organizations, although uncommon, is primarily used to test newly developed ideas or to provide consultancy. Most of the respondents believe that funding is important for research collaborations and low commitment of team members to the shared goal is a major barrier in collaboration. We argue that as the share of University-Industry-Government research collaborations is low, a strong congruence between knowledge capital and entrepreneurial capital is needed to develop an entrepreneurial university.

Keywords: Collaboration; University-Industry-Government Collaboration, Qualitative and quantitative study

Introduction

Science has always been practiced through interaction among scientists. During interaction, scientists not only share information and study findings among themselves; they also co-produce and co-report research findings, or in other words, they collaborate as well as communicate. Scientific collaboration between authors and academic output of such collaborations has become an important indicator in scientific innovation in recent years. Government and various organizations are also designing policies to facilitate collaboration.

University, Industry, Government research collaboration is an efficient form of interaction between academicians, industrialists and government bodies which allows for effective communication as well as sharing of academic expertise for product development, sharing of technology and support regarding public funding across various industrial sectors. Collaborative research is increasingly common owing to internationalization of various sectors of industry as well as the need to reduce costs and increase funding. The thrust on international collaboration is also increasing due to access to newer markets and better-quality research worldwide, as perceived by academicians. Government is also promoting engineering institutes to conduct research for societal needs. The research expertise and resources of different institutes affect academics' perception of and ways to collaborate in various research projects.

Contemporary higher education reforms and ranking-based accountability initiatives focus on the quality of education, teaching and research. The National Institutional Ranking Framework (NIRF) of India is one of such initiative that lists the top performing engineering institutes every year. For the year 2022, under the criteria 'Engineering (Teaching & Research)' [https://www.nirfindia.org/2022/EngineeringRanking.html], Indian Institute of Technology (IIT), Madras tops the list, followed by IIT, Delhi. The 10th rank is occupied by National Institute of Technology Karnataka, Surathkal.

In NIRF, several criteria have been considered while ranking. One of the criteria is 'Research and Professional Practice' wherein quality and quantity of research in collaboration with industry and fellow professionals have been evaluated. Despite being encouraged to engage in such collaborative practices by university administration and public policies, academicians of engineering institutes in India are typically cautious to participate in such collaborative

practices. Academic culture has been changed drastically by promotion of academic capitalism. Academia has moved towards entrepreneurial culture. As engineering institutes' curriculum aligns with entrepreneurial objectives, we want to investigate the multidimensional perceptions of academicians regarding the fulfillment of their objectives fueled by the desire to create market worthy products for Indian consumers.

Academicians demonstrate a range of understandings and preferences affected by motivating factors and benefits of collaboration, which are significant indicators of this study. The intent of this study is to connect the perception and understanding of collaboration of faculty members actively engaged in research in top ranked engineering institutes of India with the publications they have. Establishing a connection between what is seen in the publication profile and their perception can help higher education organizations become more responsive to the need for greater collaboration.

Review of literature

Scientific collaboration among authors has increased significantly in recent decades[1,2]. Moreover, in order to enhance innovation and economic competitiveness at institutional levels, University-Industry-Government research collaborations have grabbed a significant place in present times[3, 4]. Ankrah and Tabbaa[5] have identified several motivating factors operating behind University-Industry-Government collaboration such as necessity stimulated by government policy, reciprocity of knowledge and expertise between university and industry, efficiency for funding and research, stability to achieve predictability and dependability and legitimacy of successful corporate image.

Paswan et. al. have attempted to analyze University-Industry-Government research collaboration to find out whether such collaborated research outputs attract higher bibliometric and altmetric impacts. They found out that research papers involving University-Industry-Government collaborations do not differ significantly in terms of citations as compared to non-collaborated papers. However, an advantage in terms of social media mentions was found for different types of University-Industry-Government collaborated papers[6].

Universities have been known to facilitate education and research from time immemorial. However, with the increase in multifaceted external factors, a third mission emphasizing on entrepreneurial activity has emerged in recent times[7]. This concept pushes universities to experiment with new business models to respond to the challenges of university-industry-government research collaboration[8,9]. Taken together, the role of entrepreneurial universities is not only limited to creation of knowledge via teaching and research but is focused on knowledge transformation and commercialization[10]. However, the development of such universities in Indian context is still lagging.

Research collaboration has been studied by a variety of other disciplines, including the economic sciences[11] sociology[12], or communication science[13]. In the engineering field, existing literature discusses that in early days research collaboration was mainly between engineers and non-engineers[14]; later with growth of the field, and expanding the numbers of academic centers of engineering education, increase of collaborative research in various countries has been noticed[15].

A considerable number of earlier researches identified diverse problems that occur in collaborative research. Disciplinary differences[16], different perspectives, styles of working, and priorities of participants[17], different educational contexts[13], gender and cultural differences[18] are few of them. A lack of experience and commitment of participants[19] and unprofessional or inefficient leadership and management[13] are further recurrent problems. Less frequently named examples are a lack of sustainability in funding, geographical distance[13], or the size of the research team[20].

Newell and Bain examine the perception of a group of academics engaged in course design and found that participants believe that the need of cognitive and social capacities for effective collaboration and the skill, structures, and process is necessary to enable team-based collaborative practice[21]. In another study, Kim and Ju explained major factors influencing knowledge-sharing among faculty members in a higher educational institution. In their research, they found that respondents do not consider other factors such as trust, openness in communication, collaboration, and communication channels based on IT Infrastructure to be main factors in collaboration[22].

Collaboration can also be perceived as problematic if the over-stress on social capital in research project approval mechanism for young academics of China creates a disadvantageous situation hindering the development of their sense of belonging in the research team[23]. Beyond these studies, little is known about attitude and perception regarding collaboration in academic environment and Indian context, such study is yet to be conducted.

Academic institutes are increasingly called on by the government to participate in applied research and

development activities for the betterment of the society, simultaneously with their academic programmes and basic research. Academic institutes especially in technology related fields, frequently need advanced infrastructure and multi-dimensional knowledge expertise to fulfill the needs of the society. Efficient resource management and high-level exploratory knowledge work enforced these academic institutes to collaborate with many industries, and governments in different research frontiers.

Similarly, industries like pharmaceuticals, construction, manufacturing, and government agencies dealing with defence, drug discovery etc., requires expert knowledge for developing and modifying their products. This require them to collaborate with academic institutions having expertise on those areas. The large companies like Tesla, Google, SpaceX are often work with universities to push the research frontiers. Moreover, in present economy almost all governments are asking their academic institutes to expand their entrepreneurial role, which also forces the academic institutions to collaborate with industries.

Scientometricians usually explore the research collaboration of an institution by exploring the secondary data. Another way to draw insights may be based on academicians' perceptions on collaboration. Uncovering the qualitative aspects like perception and attitude of faculty towards collaboration along with the quantitative figure will assist in developing a dynamic research environment. Motivated by these needs, this analysis was undertaken to understand how academicians from engineering institutes of India view collaborative researches and what opportunities exist for improving the academicians in balancing the workload in this different role.

Objectives of the study

The present study has been undertaken with the following objectives:

- To study the reasons for the preference of selecting co-authors based on the country of belonging of team members, their preferred team size and factors motivating them to collaborate;
- To discover the extent to which authors of engineering institutes prefer to collaborate with authors from government or private institutes and explore factors insisting them to perform such collaboration; and
- To investigate the perceptions authors bear about the benefits and barriers of collaboration and to analyze their expectations from their parent organization.

Research Methods

As, the intention of the study is to understand the perceptions of collaboration among academicians, survey method was found to be suitable for the purpose. A 17-point questionnaire (open-ended and option based, both) (Annexure-I) covering key aspects of university-industry-government research collaboration was prepared. This web-based questionnaire was sent to all the faculty members of top 10 NIRF ranked engineering institutes of India through email. Web-scraping techniques were employed to obtain the email addresses. We obtained emails of 4369 faculty members from the ten IITs and sent questionnaires to all. Two hundred and eight emails bounced due to errors in email addresses. A few (less than 1%) faculty members intimated their unavailability. The non-respondents were reminded after a week for three weeks.

In four weeks, 464 email were received. To examine whether this sample size can be considered as correct representation of population, following sampling techniques as given by Cochran[24] was used.

$$n_0 = \frac{z^2}{e^2}\, pq \qquad \textit{Follwed by} \qquad n = \frac{n_0}{1+n_0-1)/N}$$

Where, e is the margin of error in 95% confidence level (here critical value 1.96), p is estimated proportion of population (here 50%) which has attribute in question, q is (1-p), z value is found the Z table, N is the population size and n is the new adjusted sample size.

As, the number of received responses was higher than the calculated sample size at 95% confidence level with ±5% precision, we proceeded further for analysis. Demographically, our sample data have diversity in academic positions: director, senior professor, professor, associate professor, and assistant professor; by genders: male and female; & by subjects: chemical engineering, mechanical engineering, computer science, metallurgical engineering, and civil engineering, etc. All identifying details of the participants were anonymized.

To analyse the publication profile of the respondent academicians, we used the Web of Science (WoS) database. Although the data pertaining to publications were asked from the academicians, we relied on the actual figure as shown in WoS. To gain complete publication record of an individual academician, earlier adopted techniques[25] was employed.

To explore the extent of University-Industry-Government linkage, we excavate the C1 field (Address of authors) of WoS dataset of downloaded publications of respondents. When the C1 field contained the multiple addresses of authors and coauthors, we categorized it as University linkage. If any collaborative author's affiliation belonged to the institute that is directly funded and managed by the Government, like CSIR, DST, DBT, etc., or managed by a public sector undertaking (PSU, eg. Maharatnas and Navratnas companies), we categorized it in the Government linkage, and when such an institute was funded and managed by private bodies, like Sun Pharma, TVS motors, IBM Corporation, etc, we kept it under Industry linkage.

Results

Demographic information of respondents

As the distribution of respondents by rank (Professor: Associate Professor: Assistant Professor - 41:31:28 ratio) and by gender (Male:Female—58:42 ratio) did not differ significantly, in Table 1, therefore, collaborative publication, citation profile and extent of the respondents have been displayed by institutes. In terms of research experience, of the total respondents, 46% have more than 20 years of research experience followed by 38% having 10 to 20 years of experience and 16% have up to 10 years of experience.

Before analyzing the perceptions of the respondents, it was felt necessary to understand how the respondents are scientifically involved in collaboration. To what extent do they collaborate nationally or internationally and to what extent do they collaborate with other academic- industrial and governmental institutes (UIGs).

As we can infer from Table 1, the number of nationally co-authored papers is higher than internationally co-authored papers for each institution. However, the citations received per article follow a different trend, with higher citation per article for international publications was received by the authors from IIT-Delhi (39.17 cit/art) followed by IIT-Roorkee (30.65 cit/art). The weighted impact factor of the published journal of the articles in foreign collaboration is 3.81 against national collaboration with 2.83. The results of this study show that academic authors still prefer to publish more in national collaboration than international and collaborating internationally than nationally does increase the citation benefit.

Authors' perception

Collaboration countries

A question was asked about which country they would prefer to collaborate with and why, to know the reasons for their preference or non-preference. Respondents prefer to collaborate with Great Britain, Germany, Japan, USA, Canada, Netherlands, Australia as these countries are considered to have cutting-age research programmes, excellent research culture and infrastructure. Respodents have preferred UK, USA and France for their knowledge exchange, better understanding in research; Netherlands, Germany, Australia, and China for better academic connections and specialization in that domain, common research agenda. Respondents have chosen USA, Australia, Norway for joint-venture ongoing projects including students' mobility (UK); US, Canada, Switzerland, France, Columbia, Japan, Germany, Hong Kong for

Table 1 — Collaborative publication pattern of respondents as seen in Web of Science

Institute Name	NR	NP	Team size /article	NCP:TC	ICP:TC	No. of Collaborative articles with		
						Univ	Indus	Govt
IIT-M	48	1656	4.2	1296:15084	508:9892	1440	48	168
IIT-D	45	989	4.1	656:18104	164:6424	869	24	96
IIT-B	32	1264	3.5	936:11580	332:7944	1076	92	96
IIT-K	49	996	3.9	700:9176	244:5260	815	29	152
IIT-Kgp	46	2124	3.5	1860:31544	268:4232	1896	60	168
IIT-R	50	2044	3.7	1436:27456	596:18268	1832	68	144
IIT-G	49	1289	3.6	696:6704	572:10668	1194	19	76
NIT-Tiru	48	1180	3.8	876:9236	348:4828	973	19	188
IIT-H	48	1468	3.8	1116:15776	356:4124	619	120	729
NIT-Sur	49	1482	3.8	1240:13164	292:3784	1226	64	192

IIT-' '= Indian Institute of Technology (M-Madras, D-Delhi, B-Bombay, K-Kanpur, Kgp-Kharagpur, R-Roorkee, G-Gandhinagar, H-Hyderabad, NIT-Tiru-National Institute of Technology, Tiruchirappalli, NIT-Sur- National Institute of Technology Karnataka, Surathkal. *NR=Number of Respondents, NP=Number of Publications; NCP=National Collaborative Publications; TC= Total Citation, ICP=International Collaborative Publications; Univ-University, Indus-Industry, Govt-Government*

effortless communication in English and easy to travel; Canada, UK for mentor, research students working in those countries; USA, Canada, UK for expanded opportunities for future research; Great Britain, Germany, Japan for sanctity and academic honesty of the collaborator and ethics of research; Japan, Australia because of their seriousness in research; South Korea for cordial nature and helpfulness; USA, UK, Slovenia, Italy, Sweden, Turkey for helpful in thesis review.

It was also asked to the respondents whether they have any reservation in terms of countries with which they would not prefer to collaborate. Although most of the respondents answered that there are no such countries because "collaborations are not by force, they happen as peer need", but few of them mentioned their apathy with: a) countries with which our nation does not have good diplomatic relation; b) countries where works are done by force; c) countries where their work ethics is questionable, potential of fraud, plagiarism concern; d) countries having language barrier.

Motivating factors and team size in collaboration

Responses to the questions enquiring into the motivating factors for collaboration show that (Table 2) 80% of the respondents believed in obtaining cross-fertilization among disciplines as the significant factor, followed by helping increase scientific popularity of authors (39%), followed by escalating cost of collaborative research (15%). Although the figure is quite low, but it is believed that collaboration leads to monetary benefits (8%). This signifies that academicians prefer to take up multidisciplinary research for more impactful outcomes.

In Table 1, it was seen that published articles of these authors mostly appeared with a team-size of 3 to 4 authors per article. These results also reflected in the answers to a question about preferred team size.

Table 2 — Team Size & motivating factors in collaboration

Factors	Frequency	Percentage
Team size		
2 to 3 members	44	9%
3 to 5 members	207	43%
5 to 10 members	114	24%
Depending upon requirement	99	21%
Motivating factors		
a) Escalating cost of collaborative research	60	15%
b) Obtaining cross-fertilization among disciplines	320	80%
c) Helps increase scientific popularity of authors	156	39%
d) Higher levels of monetary benefits	32	8%

University-Industry-Government Collaboration

As indicated in Table 1, academicians of engineering institutes still prefer to collaborate more with other academic counterparts. A similar observation was also noticed (Table 3) when the question was asked to them on sectors with which they prefer collaborating. They are of the opinion that inter-university collaboration is the best choice (82%) to them followed by intra-university (~46%). Our observations are in accordance with the findings of Chinchilla-Rodríguez[26] where they found inter-institution and international collaboration have been increasing and intra-institutional collaboration has been decreasing. Their eagerness to collaborate with government bodies or private institution has not emerged as preferred choice.

We also tried to know their perception regarding the major causes of collaboration with government and private industries. Majority of respondents chose product development (44%) and consultancy for day-to-day problems (44%) as the major motive for collaboration with industries or government. Funding arrangements (34%), sharing of laboratory equipment (23%), indirect benefits like growth opportunity or monetary benefits (17%) were also chosen among other motives.

In another question, the respondents were asked to list out the five major government and private organizations with which they've collaborated so far. As mentioned in Table 3, the percentage of respondents collaborating with government organizations is much higher than private organizations. Defence Research and Development Organization (DRDO) (21%) has been mentioned as the most favorable organization for collaboration in government sector, while Tata Steel (8%) tops the list in the category of private organizations.

Expectations from own institution

The question of expectations from their own institution regarding an increase in collaborative research is an important one, especially at present when the government is putting a thrust on innovation through such collaborative practices. Table 4 shows that 73% respondents believe that institution funding is important towards research collaboration and commented that "*without establishing the research facility with institute funding, it is impossible to have*

Table 3 — Sectors on collaboration

Criteria	Frequency	Percentage
Preferred sectors for collaboration		
a) With other academicians of your department	208	45%
b) With other academicians of your university	213	46%
c) With other academicians of other universities	380	82%
d) With government laboratories	162	35%
e) With private organizations	144	31%
Frequency of collaboration with govt. organizations/ private organizations?		
a) Frequently	84	18%
b) Moderately	19	4%
c) Seldom/Rarely	79	17%
d) Not answered	283	61%
Causes of collaboration with private organizations/govt. organizations -		
a) Product development	204	44%
b) Synergic help for increasing production	102	22%
c) Consultancy for day-to-day problems	204	44%
d) Indirect benefits like growth opportunity or monetary benefits	79	17%
e) Sharing of laboratory equipment	107	23%
f) Funding arrangements to your institution's laboratory	158	34%
Five Major Government organization with which Collaboration so far have been made		
DRDO	97	21%
DST	84	18%
CSIR	74	16%
ISRO	70	15%
BHEL	28	6%
Five Major Private organization with which Collaboration so far have been made		
Tata Steel	37	8%
General Electric Company	19	4%
Tata Consultancy Limited/JSW Steel	14	3%
Others	9	2%

collaboration". However, a few (~15%) do not feel the need of such funding. Few comments are quite impressive like: "*I don't expect anything from my affiliating institute, since it is majorly determined through nepotism*". Some other academicians are in opinion that "*a strong academic culture for worthy collaborations that will always be helpful*" & "*An environment for collaborative approach at the national level among institutes /industries and individuals is required to be developed*".

Few other expectations on which the respondents offered their opinions were on 'more transparent purchase mechanism' and 'flexible overhead charges'. Also, some academicians expected less intervention with other academic activities to increase collaborative research. As reflected in the words of one academician, *"Proportional academic load should be lowered with respect to the magnitude of collaborative projects*". Since international travel funding is an important affair, many academicians wanted increased funding for international travel, computing resources and postdoctoral manpower. As revealed "*Travel Funds for Students and Postdocs can be more freely and generously given*".

Table 4 — Expectations from own institutions

Expectation from own institution for increase in -		
Funding:		
Yes: No: No comments	339 : 69: 56	73% : 15% : 12%
Sophisticated research laboratories?		
Yes: No: No comments	288 : 135: 41	62% : 29% : 9%

Benefits and barriers in collaboration

Scholars often refer to science policy including funding or bureaucratic mechanism towards barriers in quality research[17]. Our intention was to understand what challenges authors perceived as barriers in collaboration and what they believe as benefits in collaboration? As indicated in Table 5, majority are in favor that getting scientific popularity among world peers (44%) is the major gain in collaboration followed by citation gain (34%). Great visibility of their research output (22%) and enhancing academic status in their own institution (17%) are also understood by few academicians as benefits. This shows that collaborations are vital to the progress of academicians and important in terms of their local and international standing.

Throwing light on the barriers encountered during collaboration, bulk of respondents consider low

Table 5 – Benefits of collaboration and barriers to collaboration

Benefit	Frequency	Percentage
a) Citation gain	157	34%%
b) Visibility of your research	102	22%
c) Getting scientific popularity among world peers	204	44%
d) Academic status in your own institution	79	17%
Barriers		
a) Low commitment of team members to the shared goal	173	37%
b) Denial of funding extension	127	27%
c) Restricted autonomy of team members by administration	132	28%
d) Lower royalty rates	34	7%

commitment of team members to the shared goal (37%) is a major barrier in collaboration, followed by restricted autonomy of team members by administration (28%), followed by denial of funding extension (27%) and lastly, lower royalty rates (7%). Despite the gains, lack of willingness among collaborators to achieve the desired goal is a major inhibitor to the uptake of collaboration. The percentage exceeds 100% because of the respondents were allowed to choose more than one option, if needed, as benefits and barriers in collaboration.

Discussion

Our study is based on assumption that collaborative research is mainly driven by the involved researchers themselves – their interactions and relationships with the members of research team. The collaboration they made nationally or internationally were established mainly through individual bottom-up activities. Thus, understanding perception of these researchers is crucial at a time when many institutions and governments design and implement policies to enhance these activities majorly determine the key contributions of this paper. Furthermore, these collaborations were focused on research only, leaving aside other forms of collaborations like teaching collaboration, expert for joint supervision undertaking that are also a common scenario in academic institutions.

We found that academicians highly valued and engaged more often in national collaborations than international ones and they prefer to collaborate with a team size of 3 to 5 members. Studies have shown that when the outputs are lower, the team size is larger. Therefore, grouping more academics unnecessarily into science team hasn't yet resulted in higher scientific output[27]. As the intention to collaborate, nationally or internationally, is mainly for cross-fertilization among disciplines, it is important to understand what benefits the researcher will gain and what degree (problem-solving, research, innovation, skill development through education, resource sharing, large scale production of research discoveries, etc.) of collaboration is needed and up to what duration. In this study we also found the perception of the motivation underlying research collaboration to a range of issues. Few comments like '*Identifying an important problem which can be solved by different expertise'; 'Helps to tap into the expertise of other researchers to address long-standing questions'; 'Ensuring that the developed technologies get commercialized' or 'Certain inter-disciplinary research problems require expertise from vastly different areas'.* These statements highlight the meaningful, long-lasting relationship on collaboration.

Majority of the academicians preferred to collaborate with developed countries due to better access to state-of-art technologies and research culture. However, they were skeptical regarding collaboration with countries where work ethics is questionable and those that do not have good diplomatic relations with India. Thus, it is understandable that respondents chose to become part of strong research culture in both ways.

Significantly, majority of respondents did not answer when asked about their tie-up research activities with government or industries. The share of university-industry-government research collaborations is disturbingly low. In this regards the opinions like: "*Industry needs to make profit. Academicians do the basic lab work. The gap to scale up and freeze proof of concept is not filled and nobody really wants to do it. It cannot be published so the academicians do not want to do it. Industry looks at it as a cost and does not commit*" are quite meaningful. The biggest challenge of successful collaboration is to identify stakeholders for collaboration in basic research, applied research, start-up companies, innovative research companies, infrastructural support institutions, development-based companies, education-training related companies, and business interest companies, etc. And we are still far behind in a targeted identification of such organizations. For sustainable collaboration, academicians must identify the right stakeholder who are willing to collaborate and share responsibility, capital, resources, and expertise. This compels us to rethink and reconsider the advanced objective of institutions, which is entrepreneurship. A new

university model is the need of the hour, facilitated by a strong congruence between knowledge capital and entrepreneurial capital. This will enable us to realize our dream of transforming our academic institutions into entrepreneurial universities.

Conclusion

Our study has observed that authors of engineering institutes prefer to collaborate with a small team size and are particularly willing to collaborate more nationally than internationally. Although one of the objectives of their collaboration is mainly for cross-fertilization among disciplines, seeing them as beneficial for complex research problems, however cross-fertilization is not widely visible in their publication profiles. To gain access to complementary resources, equipment and knowledge, therefore, academicians must step outside of their comfort zone and consider international collaboration for a deeper and more thorough interpretation of data because of different cultural views. While research is often considered international by definition, less attention has been devoted to the internationalization of research activities, despite various policies and measures being implemented by every government to promote the internationalization of research itself. Our analysis on perception leads us to conclude that the primary purpose of collaboration among academicians with government or industry is to gain access to more funds or to accelerate the translation of their innovation into new products. The low percentage of university-industry-government collaboration may be the reason behind differences in the primary objectives of these institutions. While the academic culture encourages openness which stimulates the researchers to publish new findings, industry culture is more guarded; they are driven by the need to monetize their innovation. For a successful partnership, both stakeholders should develop a mutual set of principles relating to intellectual property rights, conflict of interests, human resource training and engagement, and the extent of financial support that will ensure long-term commitment. Innovative ecosystems may flourish when proximity between university and industry is low, leading to a vast expansion in the collaboration rate.

It is worthy to note that not all respondents felt that institutional funding is not the only essentiality for collaborative research; they were also of the opinion that developing a strong academic culture and environment for collaborative research will go a long way. The major benefit of collaboration was outlined as getting scientific popularity among world peers, which signifies that academicians are very concerned about their national and international standing. The major barrier encountered by them was a lack of commitment among team members to the shared goal. This is an important evidence of the aspiration-practice gap. While they are aspiring for gaining scientific popularity, they are left behind due to absence of persistency and determination towards the common target.

References

1 Huang F, Finkelstein M and Rostan M, The Internationalization of the Academy: Changes, Realities and Prospects, (Springer;Netherlands), 2014, p. 119–143. doi:10.1007/978-94-007-7278-6_7

2 Vick T E and Robertson M A, Systematic literature review of UK university–industry collaboration for knowledge transfer: a future research agenda, *Science Public Policy,* 45 (2018) 579–590. doi: 10.1093/scipol/scx086

3 Dvir Y and Yemini M, Mobility as a continuum: European commission mobility policies for schools and higher education, *Journal of Education Policy*, 32(2) (2015) 198–210. doi:10.1080/02680939.2016.1243259

4 Douglass J A, The New Flagship University: Changing the Paradigm from Global Ranking to National Relevancy, (Palgrave Macmillan; New York), 2016, p. 9-29. doi:10.1057/9781137500496

5 Ankrah S and Al-Tabbaa O, Universities–industry collaboration: a systematic review, *Scandinavian Journal of Management*, 31(3) (2015) 387–408. doi:10.1016/j.scaman. 2015.02.003

6 Paswan J, Singh V K, Karmakar M and Singh P, Does university–industry–government collaboration in research gets higher citation and altmetric impact? A case study from India, *Scientometrics*, 127(11) (2022) 6063–6082. doi:10.1007/s11192-022-04508-1

7 Audretsch D B and Belitski M, Three-ring entrepreneurial university: in search of a new business model, *Studies in Higher Education*, 46(5) (2021) 977–987. doi:10.1080/ 03075079.2021.1896804

8 Moed H F, Bar-Ilan J and Halevi G, A new methodology for comparing Google Scholar and Scopus, *Journal of Informetrics*, 10(2) (2016) 533–551.

9 Arroyabe M F, Schumann M and Arranz C F A, Mapping the entrepreneurial university literature: a text mining approach, *Studies in Higher Education*, 47(5) (2022) 955–963. doi:10.1080/03075079.2022.2055318

10 Radko N, Belitski M and Kalyuzhnova Y, Conceptualising the entrepreneurial university: the stakeholder approach, *The Journal of Technology Transfer*, (2022). doi:10.1007/ s10961-022-09926-0

11 Baker J A and White M D, Economics and the Virtues: Building a New Moral Foundation, (Oxford University Press;

Oxford), 2016, p. 119–140. doi: 10.1093/acprof:oso/9780198701392 .003.0007

12 Costa M R, The dynamics of social capital in scientific collaboration networks. *Proceedings of American Society for Information Science and Technology*, 51 (2014) 1–4. doi: 10.1002/meet.2014.14505101137

13 Volk S C, Comparative Communication Research: A Study of the Conceptual, Methodological, and Social Challenges of International Collaborative Studies in Communication Science, (Springer;New York), 2021, p. 175-261.

14 Borrego M, Beddoes K and Jesiek B K, International perspectives on the need for interdisciplinary expertise in engineering education scholarship, *In Proceedings of the paper presented at 20th AAEE Annual Conference*, University of Adelaide, Australia, 2009, p. 695-696.

15 Jesiek B K, Borrego M and Beddoes K, Advancing global capacity for engineering education research: relating research to practice, policy and industry, *European Journal of Engineering Education*, 35(2) (2010) 117-134.

16 Cummings J N and Kiesler S, Who collaborates successfully? Prior experience reduces collaboration barriers in distributed interdisciplinary research, *In Proceedings of the paper presented at ACM Conference on Computer Supported Cooperative Work*, San Diego, CA, USA, 8-12 November 2008, p. 437–446. doi: 10.1145/1460563.1460633

17 Simon D, Kuhlmann S, Stamm J and Canzler W, Handbook on Science and Public Policy, (Edward Elgar Publishing; Cheltenham, UK), 2019, p. 419–447. doi: 10.4337/9781784715946.00033

18 Dusdal J and Powell J J W, Benefits, motivations, and challenges of international collaborative research: a sociology of science case study, *Science Public Policy*, 48 (2021) 235–245. doi: 10.1093/scipol/scab010

19 Bozeman B, Gaughan M, Youtie J, Slade C P and Rimes H, Research collaboration experiences, good and bad: dispatches from the front lines, *Science Public Policy,* 43 (2016) 226–244. doi: 10.1093/scipol/scv035

20 Cummings J N, Kiesler S, Bosagh Zadeh R and Balakrishnan A D, Group heterogeneity increases the risks of large group size: a longitudinal study of productivity in research groups, *Psychological Science,* 24 (2013) 880–890. doi: 10.1177/0956797612463082

21 Newell C and Bain A, Academics' perceptions of collaboration in higher education course design, *Higher Education Research and Development*, 39(4) (2020) 748–763. doi:10.1080/07294360.2019.1690431

22 Kim S and Ju B, An analysis of faculty perceptions: attitudes toward knowledge sharing and collaboration in an academic institution, *Library & Information Science Research,* 30 (2008) 282–290.

23 Manhong L and Linlin L, Early career researchers' perceptions of collaborative research in the context of academic capitalism on the Chinese Mainland, *Higher Education Research & Development*, (2020). doi: 10.1080/07294360.2020.1724898

24 Cochran W G, Sampling Techniques, 3rd edn (John Wiley & Sons;New York), 1977, p. 74-75.

25 Mukherjee B and Gangopadhyay S, Inconsistencies in the retrieval of indic names in web of science: a case study of women authors, *Annals of Library and Information Studies*, 68(2) (2021) 170–77.

26 Chinchilla-Rodríguez Z, Liu J and Bu Y, Patterns of knowledge diffusion via research collaboration on a global level, *In Proceedings of the paper presented at 18th international conference on Scientometrics and Informetrics*, Leuven, Belgium, 12-15 July 2021, p. 269–280.

27 Bouabid H and Achachi H, Size of science team at university and internal co-publications: science policy implications, *Scientometrics,* 127 (2022) 6993–7013. doi:10.1007/s11192-022-04285-x

Annexure- I Questionnaire

Name of the faculty member- Current position- …… since ……..

Q1. How long would you estimate having involved in research activity? .. yrs & … in Academic domain

Q2.How many of your articles/research papers have been published in collaboration? National: International

Q3. How many articles/research papers have you published in collaboration with foreign authors?

Q4. With which countries are you willing to collaborate and why?

Q5. With which countries are you not willing to collaborate and why?

Q6. What extent of team size do you prefer most while collaborating?

Q7. How often would you estimate having engaged in collaborative contributions with govt. organizations/private organizations?

Q8. What forms of collaboration you prefer the most?
a) With other academicians of your department
b) With other academicians of your university
c) With other academicians of other universities
d) With government laboratories like CSR, DST, ICMR, CDSCO etc.
e) With private entities like Tata Steel, Cipla, Reliance Industries, ITC etc

Q9. In your opinion, what are the factors motivating such collaboration? (Can Choose more, please select order)
a) Escalating cost of collaborative research
b)Obtaining cross-fertilization among disciplines
c) Helps increase scientific popularity of authors
d) Higher levels of monetary benefits

Q10. Name any 5 such govt. organizations with which you've collaborated.

Q11. Name any 5 such private organizations with which you've collaborated.

Q12.What are the major causes of collaboration with private organizations/govt. organizations according to you?

Q13. How many of such collaborations appeared as form of scholarly research output published in journals?

Q14.Do you think there is an increased need for collaborative research funding/sophisticated laboratories from your own university?

Q15. How do you benefit from national/international collaboration? a) Citation gain
b) Visibility of your research
c) Getting scientific popularity among world peers
d) Academic status in your own institution

Q16. What are the barriers faced by you while being a part of such collaborative projects?
a) Low commitment of team members to the shared goal
b) Denial of funding extension
c) Restricted autonomy of team members by administration
d) Lower royalty rates

Q17. What are your expectations from your own institution regarding increase in collaborative research?