



A Perceptive of Bibliometric Analysis on University-Industry Collaboration Using PRISMA Framework

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Article History	Abstract
<p>Received: 05 December, 2023 Revised: 09 January, 2024 Accepted: 27 January, 2024</p> <p>CC License CC-BY-NC-SA 4.0</p>	<p>Collaboration between the university and industry can lead to successful knowledge transfer, technology transfer, and skill development. To improve the economy in the world, this collaboration advocates IPR, real-time research, and skilled students who are ready for the workforce. The bibliometric analysis methodology is employed in this study to examine, assess, and pinpoint the advantages and disadvantages of UIC. We searched for pertinent research papers for this study using the Google Scholar database and the search term "University-Industry Collaboration". Although there were many articles available, we only included one that had at least 21 citations and was published by Springer and Elsevier between 1998 and 2023. The introduction, methodology, result, and conclusion are the four sections that make up this paper. The present state of research, findings, gaps, and methodology are highlighted in this research article to help steer future investigations.</p> <p>Keywords: University-industry Collaboration, Knowledge Transfer, Technology Transfer, Innovation and Research, Skill Development, Meta-Analysis etc.</p>

Introduction

Collaboration between University and Industry is very important in many aspects. UIC plays an effective role in technology transfer, knowledge exchange, research, funding, skill development, etc. UIC also places a strong emphasis on exposing students to real-world scenarios and fostering the development of their global competencies.

To improve chances for faculty development, skill-based student recruitment, technology transfer, knowledge transfer, and the role of UIC in R&D, universities and industry should collaborate (Valentin & Jensen, 2007). Knowledge sharing and engagement with the goal of identifying possible opportunities allowed the intrinsic knowledge in the relationship between the industry and universities to be effectively implemented (Al-Tabbaa & Ankrah, 2016). Knowledge transfer between universities and industry is a broad term that refers to a variety of contacts between businesses and academic institutions with the goal of exchanging knowledge about

research and technology transfer (Scandura, 2016). Thus, university-industry collaboration is a formalized partnership in which parties speak for their respective institutions' interests (Rajalo & Vadi, 2017). Over the past few decades, there has been a rise in university-industry collaboration, and this growth is attributed to several causes, including enhanced technological opportunities and increasing competitiveness (Valentin & Jensen, 2007). Universities and the industrial sector are closely linked, as seen by the quick growth of technology and knowledge-based economies (Steinmo & Rasmussen, 2018). Creating a collaborative environment between academia and industry is essential to delivering positive results for university stakeholders. (Frasquet et al., 2012).

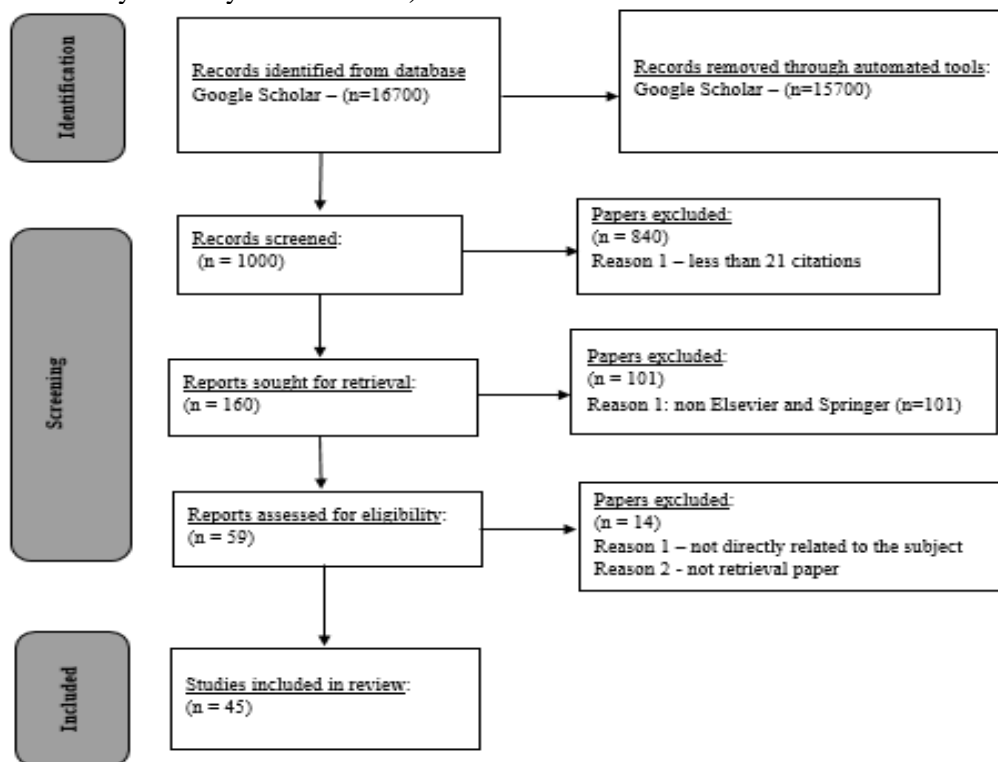
Healthy University and Industry Collaboration It is necessary for both parties to work together. But they have a lot of barriers, Finding the right partners and building trust are the two biggest obstacles to university-industry collaboration (Q. Wang et al., 2017). Academic organization, competence-related, concept-related, performance-related, resource-related, and system-related are six categories in which barriers to collaboration at various levels within and between organizations have been identified (Bjursell & Engström, 2019). Inability to recognize the needs of this collaboration due to a lack of knowledge of the university and industry (Siegel et al., 2003). Conflicts in U-I collaboration are likely to originate because of partners' incompatibility in views (Bruneel et al., 2010). Conflicts between cultures, rigid bureaucracy, shoddy incentive schemes, inadequate (Siegel et al., 2003) tension between universities' conventional academic missions and the real-world requirements of industry (Yong S. Lee, 2000). Lack of communication, the traditional approach of the university and industry needs a practical approach (Yong S. Lee, 2000) which could be also a barrier to healthy collaboration. Different interests, objectives, constraints, (Okamuro & Nishimura, 2013) policies, (Chandran et al., 2014) structural issues of the industry and the universities as pressing issues (Chandran et al., 2014) that require more attention for effective UIC. Oriented-related barriers and transaction-related barriers (Bjursell & Engström, 2019; Bruneel et al., 2010; Ramli & Senin, 2015) both also make huge hurdles for successful UIC. Apart from this barrier, the University focuses on basic research and generates knowledge (Motoyama, 2014), create knowledge (Tseng et al., 2020) and exchange resources and knowledge (Draghici et al., 2015; Steinmo & Rasmussen, 2018). Academic research performance can be enhanced through industry collaboration when such research and technology (Zhang & Wang, 2017) are applied for commercialization (Motoyama, 2014). Constant communication is usually cited as the ideal approach (Nsanzumuhire & Groot, 2020) for idea exchange and knowledge creation in R&D (Fiaz, 2013). Relationships are largely built on positive and effective communication, which raises commitment to and trust in university-industry collaboration (Frasquet et al., 2012). Achieving a suitable balance between the significance of academic goals and industry is necessary for a successful university-industry collaboration (Şendoğdu & Diken, 2013). University-industry collaborations have been carried out using both tactical and long-term strategic approaches (Liew et al., 2012, 2013). For that, UI Collaboration can be being together, using together, and doing together approach should be applied for their linkage (Huhtelin & Nenonen, 2015). Effective collaboration between university-industry always helps open innovation (Ivascu et al., 2016). Once they perceive a high degree of support from industry, researchers, faculties, students perform at a high level in academic innovation (Huang & Chen, 2017) and students also get better opportunities for job search and additional career development (Y. Wang et al., 2016). The Paper is structured in three parts: the first part is the Research Methodology, the second is the Result and Discussion and the third part is the Conclusion.

Research Methodology

Collaboration between universities and the industry is a type of network or relationship between organizations in which two or more join forces to exchange resources and knowledge for a common goal (Steinmo & Rasmussen, 2018). The Successful Collaboration between the University and Industry gives several benefits to both parties.

Our study used a bibliometric methodology to understand the strengths and weaknesses of the collaboration of the university and the industry. This helps to remove a maximum barrier to make more transparency and build trustable relations between the university and the industry. Strong UIC help to achieve significant benefit in the field of generating employability, good research culture, patent, etc. Universities are a major source of knowledge creation (Tseng et al., 2020) and Industries are a major source of resources, funding and technology development (Chandran et al., 2014).

Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Framework (For University-Industry Collaboration)



For this study, data were collected from year 1998 to 2023 in the Google Scholar databases. To find the article, we used the keyword search topic “University-Industry Collaboration”. The search was only done using a single keyword without using any kind of condition. Using the above search keyword, we found around 16,700 articles. From the given result, we extracted the top 1000 records and the rest were removed. An article that has less than 21 citations and which was published in Elsevier and Springer journals was also excluded. Based on some exclusion conditions, the final result was reduced to 45 articles. For the majority of the final set of papers that were reviewed, a consensus was reached among the authors. A final sample of 45 papers was reached after discussion and consideration of the remaining papers.

Figure 2: Keyword - Word Cloud



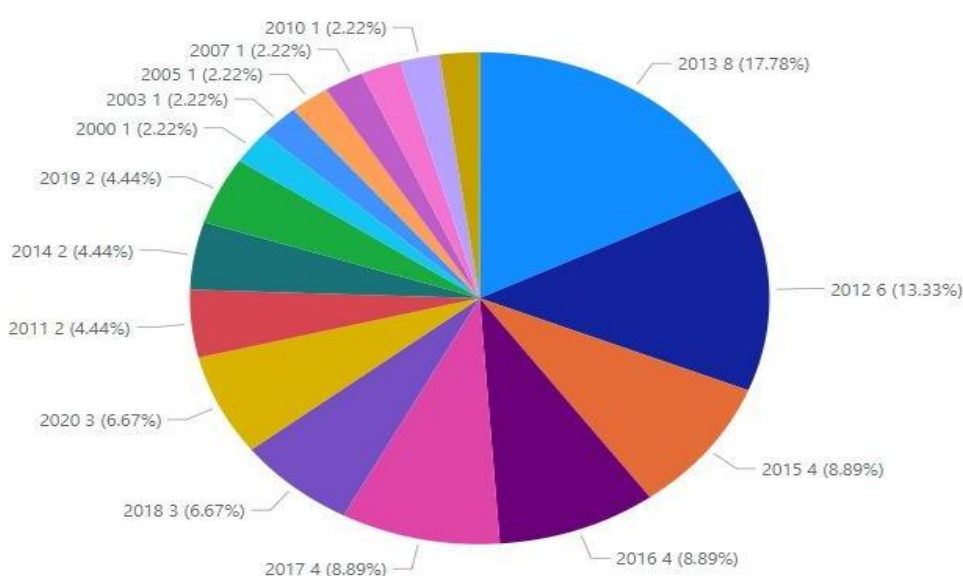
A Word Cloud has been created by examining the keywords from all the articles and identifying the most pertinent and commonly employed terms in the articles, as depicted in Figure 2. The frequently recurring keywords are “University-Industry” and “Collaboration”. Apart from these two keywords, others mainly used in the article are: Innovation, Research, Technology, Knowledge and so on.

Figure 3 defines the number of papers published in a particular year which shows trends in 2013 and 2014 most articles published.

Results and Discussion

In recent years, the research landscape concerning University and Industry Collaboration has witnessed a remarkable surge. This surge has been driven by an overarching aim to foster and promote the pursuit of Quality Research, Faculty Development, Skill-oriented Education, Empowering Students in Practical Skills, Implementation of Industrial Projects, and the proficient Management of such endeavours, among various other facets.

Figure 3: Number of Paper Published Per Year (in %)

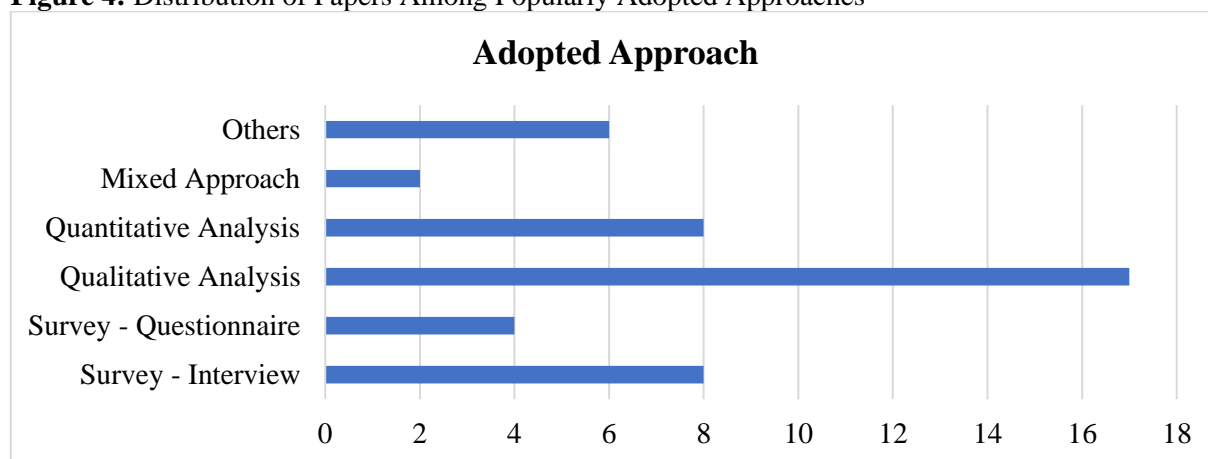


A multitude of research studies have been conducted, employing a diverse array of methodologies to investigate this subject comprehensively. These methods include surveys, interviews, data analysis, case studies, literature reviews, and statistical analyses, among others. Researchers collected data from various sources, such as surveys with faculty members and industry professionals, patent data, interviews with stakeholders, and reviews of academic literature.

This paper seeks to contribute to this expanding body of knowledge by classifying the methodologies employed in these research investigations into six distinct categories: 1. Survey-Interview, 2. Survey-Questionnaire, 3. Qualitative Analysis, 4. Quantitative Analysis, 5. Mixed Approach and 6. Others. These diverse methods and data sources contribute to a comprehensive understanding of UIC. Following is a comprehensive analysis of the results obtained using these methods:

Table 1: Distribution of Papers Among Popularly Adopted Approaches

Sr. No.	Adopted Approach	No. of Papers
1	Survey - Interview	8
2	Survey - Questionnaire	4
3	Qualitative Analysis	17
4	Quantitative Analysis	8
5	Mixed Approach	2
6	Others	6
Total		45

Figure 4: Distribution of Papers Among Popularly Adopted Approaches

Discussing as a summary of results, in the realm of university-industry collaboration (UIC), several key findings and insights emerged from various studies [Ref. Annexure -1]. The research quality of universities has a higher impact than geographic distance on industry collaboration capability. However, a successful collaboration model relies on a shared vision, communication, trust, satisfaction, commitment, and supportive policy. Universities should adopt more flexible approaches to research that can accommodate the needs of industry partners. An interdisciplinary approach for UIC highlights universities' role in local economic development and knowledge transfer. Various models and strategies exist to optimize UIC, with communication, trust, satisfaction, and commitment being vital for fostering successful collaborations. These findings shed light on the multifaceted nature of university-industry collaboration and offer valuable insights for researchers, policymakers, and practitioners aiming to improve collaborative efforts between academia and industry. U-I collaboration benefits all stakeholders like students, faculties, researchers, technology managers, etc.

Conclusion

This study on university-industry collaboration reveals several common themes and important insights. Collaborative research, Patent, technology transfer, knowledge transfer, innovation, and project development all are common discussions. They emphasize the significance of trust and mutual understanding between academics and industrial practitioners. They also, emphasize the need for long-term investments in interactions to bridge the gap in incentive systems and goals. However, several barriers make hurdles to achieving the maximum benefit of UIC. Such as cultural differences, bureaucratic inflexibility, oriented-related problems, transaction-related problems, poorly designed reward systems, inefficient management systems, lack of communication, differentiation between objectives, and many more.

Moreover, behavioral results and the exchange of practices based on the market are critical to maintaining the long-term viability of university-industry collaboration. The benefits of these partnerships in terms of increased grants, increased IPR, multidisciplinary innovation, and research productivity. To fully realize the potential of these collaborations and their contribution to innovation and technological upgrading, these papers highlight the need for an enabling environment, the need to address barriers, and the recognition of the diverse characteristics and growth structure in university-industry relationships.

As future research, this study can be reproduced by selecting more Scopus databases, SCI, or ABDC databases. This study can help by enlightening research trends on University and Industry Collaboration and also help in identifying the future scope of study at UIC.

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Annexure

Annexure - 1

Sr. No.	Paper Title	Methodology Type	Reported Outcomes
1	Investigating the factors that diminish the barriers to university-industry collaboration	1	R&D-intensive industrial and service sector companies are more affected by orientation-related obstacles which are mitigated by interaction and experience.
2	Commercial knowledge Transfers from universities to firms: improving the Effectiveness of university-industry Collaboration	3	UITT stakeholders have diverse perspectives, with common collaboration barriers related to understanding norms; recommendations include improved communication and flexible policies.
3	The sustainability of university-industry research collaboration: An empirical assessment	1	Although there are obstacles such as cultural differences, disputes over intellectual property, and goal alignment, university-industry research collaboration benefits academics and technology managers; regular contacts provide better outcomes.
4	University-industry collaboration and innovation in emergent and mature industries in new industrialized countries	1	Collaboration focuses on process development in mature industries and product development in emerging industries.
5	University-industry innovation collaboration: Reconceptualization	1	Different outcomes were found for each type; patterns based on individual requirements with literal replication; case study findings validate the suggested conceptual framework and contribute to the body of knowledge on U-I collaboration.
6	University-industry collaboration in Italy: A bibliometric examination	3	It is common for Italian universities to collaborate in the fields of engineering and medicine. These partnerships improve university researchers' research output, and private-public co-authorship is multidisciplinary.
7	University-industry collaboration and firms' R&D effort	1	Collaboration among academia and industry increases firms' share of R&D employment and has a positive impact on R&D expenditure per employee at $t + 3$, with a qualitative effect that is not statistically significant at $t + 5$.
8	Social capital to facilitate 'engineered' university-industry collaboration for technology transfer: A dynamic perspective	3	In the context of university-industry collaboration, social capital is essential for facilitating technology transfer. The structural, relational, and cognitive dimensions of social capital help to mitigate barriers, and the Faraday Partnership Initiative in the UK used social capital to drive innovation. The case study method makes theoretical generalizability and replication logic possible.
9	Effects on academia-industry Collaboration of extending university property rights	3	The LUP reform had a negative effect on academic inventor contributions to industry-owned patents; Denmark and Sweden exhibit differences in their DBF sectors as a result of the LUP reform; joint research is a robust factor in academia-industry collaboration, serving distinct purposes.
10	Quality comes first: university-industry collaboration as a source of academic entrepreneurship in a developing country	4	In research-intensive universities, UIC openness has a stronger positive correlation with academic patenting and spin-off activity. In developing nations, UIC is more effective in promoting knowledge-intensive entrepreneurship when it has stronger intellectual property protection.
11	How can academic innovation performance in university-industry collaboration be improved?	2	The UIC management mechanism has a positive effect on academic innovation performance; this relationship is mediated by entrepreneurial activities.
12	The interplay of cognitive and relational social capital dimensions in university-industry collaboration: Overcoming the experience barrier	3	Successful university-industry collaboration requires both relational and cognitive social capital, with relational social capital fostering strong relationships and cognitive social capital aiding in overcoming experience barriers.
13	Factors of university-industry collaboration affecting university innovation performance	3	University-industry collaboration funding positively influences innovation performance, with a stronger effect for research-capable universities and high-tech industry collaborations.
14	University-industry collaboration: patterns of growth for low- and middle-level performers	5	Low- and middle-level performers work with industry to enhance research funding and foster regional economic development; successful, commercialization-focused collaborations need high-tech infrastructure development, national reach, quality technologies, and committed technology transfer personnel.

15	University-industry research collaboration: a model to assess university capability	3	Universities' ability to collaborate with industry is more impacted by the quality of their research than by their location, which supports their "third role" in socio-economic development.
16	Business Model for the university-industry Collaboration in open innovation	6	The suggested business model provides strong assessment metrics for industry-university cooperation; for industry, measurable results are essential, while for universities, reputation is significant.
17	University-industry collaboration from a relationship marketing perspective: An empirical analysis in a Spanish University	4	In academia-industry collaboration, communication, trust, satisfaction, and commitment are interdependent; functional conflict has a negative impact on these variables.
18	Evolution of university-industry collaboration in Brazil from a technology upgrading perspective	4	Leading Brazilian universities are increasingly involved in technology upgrading and market connections; deeper connections with foreign agents and multinationals are necessary for faster technology upgrading.
19	Examining the university-industry collaboration policy in Japan: Patent analysis	4	University-industry collaboration (UIC) patents increased after national universities were incorporated in 2004; university IP policies had an impact on the improvement in UIC patent quality.
20	University-industry collaboration models in Malaysia	3	A successful model of university-industry-government collaboration improves graduates' employability and skills; it is based on mutual trust, effective communication, and supportive policies. Successful partnerships in the petroleum and agriculture sectors follow this model, as does Malaysia.
21	Context perspective on University-Industry Collaboration processes: A systematic review of literature	3	A review identifies major themes in UIC, effective interaction channels, common barriers, key enablers, and diverse outcomes of UIC.
22	Impact of university intellectual property policy on the performance of university-industry research collaboration	4	The performance of partnerships is positively impacted by companies' assessment of partner universities' intellectual property policies; IP policy also has a positive impact on technological outcomes such as product development and patent applications.
23	An empirical study of university-industry R&D collaboration in China: Implications for technology in society	4	UIC is supported in China by several factors, such as political stability, trust, and state support. R&D determinants are similar for universities and industries; the average U-I collaboration data is 2.22.
24	The role of information asymmetry in the market for university-industry research collaboration	3	For company-university research collaboration, geographic proximity is essential; however, bibliometric analysis has limitations in measuring collaboration and information asymmetry exists, leading to inefficiencies.
25	A knowledge management approach for the university-industry collaboration in open innovation	6	An interdisciplinary approach for UIC based on the Innovation U model highlights universities' role in local economic development and knowledge transfer; ontology, marketing research, and web platform support U-I collaboration.
26	A context-aware researcher recommendation system for university-industry collaboration on R&D projects	6	A recommendation system for UIC outperforms content-based, sum-based, and social network-based methods; suggested researchers are more relevant and higher quality.
27	The effects of universities' proximity to industrial districts on university-industry collaboration	3	Although there is still much unrealized potential benefit, university-industry collaboration is stronger when academic institutions are located near industrial districts.
28	The determinants of university-industry collaboration in food science in Italy	4	Collaboration between academic institutions and the food science industry is positively impacted by the existence of a European Patent Management Office; research performance and private funding also have an effect.
29	University-industry collaboration: using meta-rules to overcome barriers to knowledge transfer	6	In university-industry collaborations, meta-rules support learning and strategic alignment while managing resource constraints and a range of stakeholder priorities.
30	Development of internship & capstone design integrated program for university-industry collaboration	6	To highlight the efficacy of the ICIP program in giving students practical experience, developing their skills, and promoting university-industry collaboration, the paper focuses on successful university-industry collaborations in software development, mobile app development, and embedded systems design.
31	University and industry collaboration: towards a successful and sustainable partnership	2	The bulk of survey participants were engineers and technicians, with technicians being sent by local businesses. Administrators were also represented by both local and multinational businesses, demonstrating a favorable attitude toward university-industry collaboration.
32	Strategic and tactical approaches on university-industry collaboration	6	Setting milestones, continuity, and measuring success by research applicability highlighted in optimizing collaborations.
33	Long-term collaboration between university and industry: A case study of nanotechnology development in Japan	3	Long-term collaboration, interdisciplinary collaboration, and knowledge exchange are critical. A case study demonstrates deep interdisciplinary collaboration and the role of universities as hubs for networks and researcher training.
34	Innovation systems in Malaysia: a perspective of university-industry R&D collaboration	5	Malaysian university-industry R&D collaboration gaps are related to structural weaknesses and an institutional role that serves as an intermediary and could provide insights for other developing nations.
35	Success factors to reduce orientation and resources-related barriers in university-industry R&D Collaboration particularly during development research stages	1	Obstacles in university-industry collaboration during development research stages, with orientation and resource-related barriers being significant.
36	A research on the problems encountered in the collaboration between university and industry	2	The majority of Konya's administrators stress the value of teamwork, mentioning access to new information and technology as advantages; communication and cultural differences are frequent obstacles.

37	Does teaching benefit from university-industry collaboration? Investigating the role of academic commercialization and engagement	4	Academic engagement has a positive impact on teaching performance, and there is an inverted U-shaped relationship between academic commercialization and teaching performance. This relationship is stronger in research-intensive universities.
38	A Co-creation Centre for university-industry collaboration—a framework for concept development	3	Various knowledge types, creation processes, and party requirements are highlighted in this conceptual framework for multiuser Co-creation Centers in campus management, which supports multidisciplinary innovation environments and campus management.
39	What drives university-industry collaboration? Research excellence or firm collaboration strategy?	3	In university-industry collaboration (UIC), research excellence has a positive relationship with firm collaboration; firms are more likely to work together in areas with higher levels of publication, citation, and research excellence.
40	Enablers in enhancing the relevancy of university-industry collaboration	3	Merely 20% of partnerships yield prosperous outcomes that apply to the industry; success factors include mutual comprehension, confidence, dialogue, and common objectives.
41	A Lewinian approach to managing barriers to university-industry collaboration	1	Time, incentives, trust, communication, shared goals, leadership, resources, support, and alignment with the organization's mission are some of the obstacles that stand in the way of university-industry collaboration at the individual, group, and organizational levels.
42	Empirical study on influence of university-industry collaboration on research performance and moderating effect of social capital: evidence from engineering academics in China	3	Academics' research performance is negatively impacted by UIC; tie strength modifies the relationship positively; there is no indication that network ties mild the relationship.
43	Levers of management in university-industry collaborations: How project management affects value creation at different life-cycle stages of a collaboration	1	Project management is the most important management lever for generating value in university-industry collaborations. The other six management levers are governance, organization, culture, capabilities, and resources.
44	Diversified resources and academic influence: Patterns of university-industry collaboration in Chinese research-oriented universities	3	A small percentage of publications from Chinese universities are co-authored by researchers from the industry; these publications vary in terms of academic influence and resource matching; most UICs should preserve their advantages in having a diverse pool of resources while boosting their academic impact.
45	How background, motivation, and the cooperation tie of faculty members affect their university-industry collaboration outputs: an empirical study based on Taiwan higher education environment	2	Age, academic standing, number of years spent teaching, productivity in publications, and managerial position of faculty members all positively correlated with UIC outputs; gender, record of awards, and industrial experience did not significantly correlate, but funding and in-kind resources had a positive impact.

Annexure – 2

Sr. No.	Adopted Methodology	Paper No. [As per Bibliography]
1	Survey - Interview	[7], [8], [9], [27], [31], [32], [34], [44]
2	Survey - Questionnaire	[17], [18], [30], [35]
3	Qualitative Analysis	[1], [2], [3], [5], [6], [12], [19],[22], [24], [26], [28], [33], [37], [38], [39], [41], [45]
4	Quantitative Analysis	[13], [14], [15], [16], [23], [25], [29], [43]
5	Mixed Approach	[10], [40]
6	Others	[4], [11], [20], [21], [36], [42]