DETERMINATION OF HIGH IMPACT EVALUATION METRICS FOR EVALUATING THE UNIVERSITY-INDUSTRY TECHNOLOGICAL LINKAGE

Abeda Muhammad Iqbal*

Adnan Shahid Khan**

Aslan Amat Senin**

Abstract:

The evaluation of collaborated research between university and industry has created the greatest interest amongst the collaborational researchers as it can determine the feasibility and value of the collaboration. Collaborated research of university and industry can enhance the ability of scientist to make significant advances in their fields. A successful Collaboration of university and industry is not dependent on any single parameter but instead on the confluence of multiple parameters from the growth of basic research to commercialisation. This paper intends to illustrate the key evaluation metrics for evaluating the university-industry technological linkage. The proposed evaluation metrics is appropriate for almost all types of collaborations, especially research collaborations between university and industry. By adopting this metrics any university or industry can easily cross the threshold in the grown-up research collaborational community.

***Keywords**:* University Industry Research Collaboration; Evaluation Metrics; Evaluation Model; Technology Transfer; Success Criteria.

* Faculty of Management and Human Resource Developmen,Universiti Teknologi Malaysia, 81310, Skudai, Johor, Malaysia

** UTM-MIMOS Center of Excellence, Faculty of Electrical Engineering, Universiti Teknologi Malaysia, 81310, Skudai, Johor, Malaysia.

1. Introduction:

University-Industry technological linkage is an essential and dynamic factor in social as well as in economical development in almost all fields of life [1], [3]. It is widely recognized that transfer of technology has played a vital role at industrial progress and overall economy of the nation [5], [4]. Despite the enormous importance of university-industry research collaboration there have been some certain problems in successful collaborations [9], [14]. These problems that include mainly the research agreements, conflict of intellectual property rights, freedom of publication, different objectives, financials barriers and culture difference have led to unsuccessful collaboration between universities and industries [16].Therefore, it is necessary for the developing countries to promote the relationship between university and industry and the important techniques should be adapted to evaluate the research collaboration that can identify those elements in which they are weak. Recently university-industry collaboration and their evaluation in terms of research have been developed and gain the level of interest widely. The process of evaluation of university-industry (U-I) research collaboration has generated the greatest attention among the scientist or the researchers of university and industry due to its feasibility, determination and technological value [17]. Many authors indeed focused on evaluation of research contribution between public and private sectors in the shape of give and take outcomes [18]. Luik believes that most of the research publications and commercialisations depend on the evaluation of importance of research being held between university and industry [19].This paper is organized as follows: section 2, describes related work, section 3, research method, section 4, illustrates proposed evaluation metrics, and in section 5, conclusion of the research has been presented.

2. Related work:

The idea and concepts associated with university-industry partnerships are not new and it is commonly agreed that universities are an important source of new knowledge for industry [7], [2]. In the USA some of the most prestigious universities (e.g., MIT) were established more than one century ago to support close research relationships between university and industry [6], [13]. The partnership between (U-I) has been considered as one of the main factors contributing to successful innovation and growth in the past two decades [12], [8], [10]. To increase the number

of fundamental innovations and for the technological development frequent collaboration and cooperation of university-industry is crucial [3], [11]. In this manner huge number of studies has been analysed the interactions between the firms and research organizations that generate knowledge and enable firms to transform it into tangible forms applicable by country but a few numbers of researches has been attempted for the assessing of research collaboration[1],[12][15]. Although number of successful indicators for the evaluation have been identified in previous researches but according to Philbin [20], The university-industry research collaboration must be evaluated by a powerful set of evaluation metrics that efficiently hold the tangible outcomes resulting from this research collaboration Further, an efficient evaluation phases must seek, how to develop successful collaboration and relationship between the two entities. If the research collaboration is not producing up to the expected outcomes, then its mean collaboration required evaluation because the evaluation phase shows considerable and comprehensive re-assessments of the research interaction matters, issues and expected outcomes. In another words it shows the strength and weakness of the research collaboration that is a high demand of the developing countries. In this paper, a robust set of evaluation metrics has been developed for successful evaluation of research collaboration between university and industry.

3. Research Method:

To achieve the best evaluation metrics data has been gathered from different research centers of three different universities, Universiti Teknologi Malaysia, University Sains Malaysia and University Putra Malaysia and their collaborated industries between December of 2009 and October of 2011. The main consideration in selecting these universities is that they are research universities and highly engaged in research and development with different industries. A large number of data were collected after the data gathering through the quantitative questionnaire. The data were coded and analyzed using SPSS software. Questionnaire was coded as the chosen scale (ranging 1 to 5) likert-scale. The questionnaire was comprised of three sections. First sections related to constraints that are comprised of eighteen questions, Second section was related to evaluation parameters and their success criteria that was comprised of thirty four questions. Third section is related to tangible outcomes which were comprised of ten questions. In this research we have four different variables, constraints, evaluation parameters, success

criteria and tangible outcomes. As this research is purely on the evaluation of research collaboration between university and industry and for the evaluation we have to achieve evaluation metrics so the evaluation parameter is dependent variable and constraints, success criteria and tangible outcome is independent variable. For generating of high impacts, descriptive statistics have been taken out. Descriptive statistics of all possible Constraints, Evaluation parameters, Success criteria and Tangible outcomes have been evaluated with the help of mean and standard deviation. In this analysis, high and low impacts of related parameters within their all possible lists. However, all the high impacts are taken based on the average value of their means to help in the development of evaluation metrics.

4. Proposed Conceptual Evaluation Metrics:

4.1 Generation of High Impact Constraints

From the Table 1 it is obvious to analyse the high and low impact constraints that exist between university-industry collaboration. This table provides strong evidence that majority of respondents agree that Education and training, Culture difference, Conflict of intellectual property right, Fund and financial matter, Time constraints, Technological competency are the best candidate to be measured at its priority to evaluate the strength of the collaboration of university and industry. According to this table it can be analysed that culture difference, consultancy and Fund and financial matter are the main constraints between university-industry collaboration. While education and training and technological competency are placed at second of selected constraints. However, conflict of IPR and time constraints are less chosen candidates by the respondents. In this Table, cultural difference, consultancy and fund and financial matter are going up to 4.593, 4.593 and 4.586 respectively, whereas education and training, public policies and technological competency are going up to 4.58, 4.58 and 4.57 correspondingly. At the end, less chosen candidates time constraints and conflict of IPR is going up to 4.566 and 4.56 accordingly that is a clear picture of major constraints. Since other constraints have been taken in to account but they do not have much more influence as constraints between university- industry collaboration. However, attributes less than the average value of means are removed from the high impact constraints lists. High impact constraints are calculated based on the average of means.

Table 1: Descriptive Statistics of High Impact Constraints

Constraints	Mean	Std. Deviation
Education and training	4.58	0.495212
Meeting with industry	4.32	0.468039
Culture difference	4.593333	0.492857
Number of Memos sign per year	4.406667	0.492857
Communication	4.36	0.481608
Research agreement	4.353333	0.479606
Conflict of Intellectual property right	4.566667	0.497196
Laboratories facilities	4.353333	0.479606
Fund and Financial Matter	4.586667	0.494081
Trust between university and industry	4.453333	0.499485
Mission and goals	4.366667	0.483509
Consultancy	4.593333	0.492857
Completion of in-time PhD	4.393333	0.490126
Public Policies	4.58	0.495212
Technical assistance	4.433333	0.497196
Time constraints	4.56	0.49805
Technological competencies	4.573333	0.49625

4.2 Generation of High Impact Evaluation Parameters

Table 2 illustrates all possible evaluation parameters that were collected from the response of the respondents. From this table it can be analysed that how firmly respondents agree to Knowledge sharing, Culture development, Cooperative R&D agreement, Communication and Joint venture respectively to be the best evaluation parameters.

Table 2: Descriptive Statistics of High Impact Evaluation Parameters

Evaluation Metrics	Mean	Std. Deviation
Knowledge Sharing	4.6	0.491539
Flow of human knowledge	4.36	0.481608
Ownerships of intellectual property right	4.46	0.500067
Cultural development	4.62	0.487013
Internship in the curricula of the study	4.42	0.495212
Cooperative R&D agreement	4.613333	0.488618
Financial support	4.56	0.49805
Provision of technical assistance	4.446667	0.498813
Research autonomy	4.433333	0.497196
Communication	4.553333	0.498813
Joint venture	4.573333	0.49625

Recognition and selection of high impact evaluation parameters is not complicated procedure. According to the table, Knowledge sharing, Culture development, Cooperative R&D agreements are the immediate priority of the respondents that are going up to 4.6, 4.2 and 4.61 respectively. While, Financial support, Communication and joint venture as evaluation parameters are the second precedence of the respondents that are going up to 4.56, 4.55 and 4.57 accordingly. As can be seen in the Table 2, many other parameters are proposed in the questionnaire but they are less chosen candidates via respondents that is why they cannot be included in the high impact evaluation parameters.

4.3 Generation of High Impact Success Criteria

Table 3 shows all possible success criteria that were collected from the respondents. From this table, it can be analysed that how firmly respondents agree with all the given attributes respectively to be the best success criteria to evaluate any research collaboration between university and industry. From the perception of the respondents all the criteria have their own importance and any criteria cannot be avoided during the evaluation. From Table 3 it can be analysed that every criteria have great importance regarding evaluation of research collaboration. Specially, Flexible and strong relationship, Strong commitment, Scholarship, Trust, Funds, Interchange of concept and ideas, Number of projects, Number of researchers per project and Number of research papers are one of highly ranked success criteria suggested by the respondents.

Table 3: Descriptive Statistics of High Impact Success Criteria

Success Criteria	Mean	Std. Deviation
Number of projects	4.573333	0.49625
Number of technical staff per project	4.573333	0.49625
Number of researchers per project	4.586667	0.494081
Number of research papers	4.58	0.495212
Cooperative education	4.493333	0.50163
Hiring of fresh graduates	4.58	0.495212
Work shops	4.58	0.495212
Seminars	4.553333	0.498813
Regular consultancy	4.566667	0.497196
Personal interaction	4.566667	0.497196
Promoting entrepreneurial culture	4.573333	0.49625

Similar objectives	4.566667	0.497196
Mutual perception	4.566667	0.497196
Identifying common goals	4.586667	0.494081
Group agreement	4.533333	0.500559
Institutional facilities	4.633333	0.483509
Informal interactions	4.346667	0.477503
Institutional agreement	4.426667	0.49625
Flexible and strong relationship	4.58	0.495212
Strong commitment	4.58	0.495212
Scholarship	4.58	0.495212
Trust	4.58	0.495212
Funds	4.62	0.487013
Endowments	4.46	0.500067
Exchanging of information	4.58	0.495212
Interchange of concept and ideas	4.62	0.487013

4.4 Generation of High Impact Tangible Outcome

Table 4 demonstrates the important parameters to be included in the tangible outcomes from the collaborative research between university and industry. According to the table, Published research paper, Master's and doctorate thesis, Licensing and patenting are the best tangible outcomes of successful collaboration. While commercialised product, National and international projects and Tangible research are the second best candidates as tangible outcomes. From the table it can be seen that Published research papers, Master's and doctorate thesis and Patents and licenses are going up to 4.62, 4.62 and 4.60 respectively. Whereas commercialised products, national and international projects and tangible research are going up to 4.58, 4.52 and 4.56 respectively.

Table 4: Descriptive Statistics of High Impact Tangible Outcome

Tangible Outcome	Mean	Std. Deviation
Published Research Papers	4.626667	0.48531
Master's and Doctorate Thesis	4.626667	0.48531
Patent and Licenses	4.606667	0.490126
Commercialised Product	4.58	0.495212
National or International Project	4.52	0.501274
Tangible Research	4.566667	0.497196

5. Evaluation Metrics for the Research Collaboration:

The generated evaluation metrics is responsible for not only evaluating the research collaboration but also good to investigate high impact constraints, evaluation parameters, success criteria and tangible outcomes. A robust set of evaluation metrics are developed with the help of above mentioned four major variables. These are (1) Constraints, (2) Evaluation parameters, (3) Success criteria and (4) Tangible outcomes.

Evaluation Metrics

1. Joint venture
2. Knowledge sharing
3. Cooperative R&D agreement
4. Cultural development
5. Financial support
6. Communication
7. Patents and Licenses
8. Master's and doctorate thesis

Figure 1: Evaluation Metrics for Research Collaboration

Conclusion:

The main finding of this research is proposed key evaluation metrics that has been developed for the evaluation of university-industry technological linkage. In this paper a set of evaluation metrics are developed with the help of four major variables. The first is constraints that exist between university- industry collaboration. The second variable is evaluation parameters to get the relationship with constraints, success criteria and tangible outcomes. The third variable is success criteria which help to give the indications for the successful collaboration and the fourth variable is tangible outcome that is core demand of this model. Based on four important variables the key evaluation metrics has been developed. This metrics is not only responsible for investigating high impact constraints, evaluation parameters, success criteria and tangible outcomes but also can help to strengthen the linkage in a very accurate, precise and time efficient manner.

Acknowledgements:

The authors would like to thanks Faculty of Management and Human Resource Development (FPPSM) and Research Management Centre (RMC), Universiti Teknologi Malaysia (UTM) for their partial funding contributions.

References:

- Abeda Muhammad Iqbal, Amat Senin Aslan, Adnan Shahid Khan, Saima Iqbal. Research Collaboration Agreements: *A Major Risk Factor Between University-Industry Collaboration.* An Analysis Approach. *3rd International Graduate Conference on Engineering, Science and Humanities (IGCESH2010), 2- 4 November, Johor Bahru, Malaysia* 2010.
- Agrawal, A., *"University-to-industry knowledge transfer: literature review and unanswered questions"*, International Journal of Management Reviews, Vol. 3 No. 4, pp. 285-302. (2001)
- Mansfield, E., and Lee, J.Y. *The modern-university: contributor to industrial innovation and recipient of industrial R & D support, Research Policy,* Vol.25 No.1, 1047- 58. (1996)

- Etzkowitz, H., and Leydesdorff, L. (2000*) The dynamics of innovation: from national systems and "Mode 2" to a triple helix of academic–industry–government relations.* Research Policy 26, pp. 109–123. (2000),
- Hall, B. H. *'University-Industry Research Partnerships in the United States'.EUI Working Paper ECO N°* 2004/14. (2004)
- Etzkowitz, H. *The norms of entrepreneurial science: cognitive effects of the new university-industry linkages*. Research Policy 27. (1997)
- Danell, R., & Persson,. *Regional R&D activities and interaction in the Swedish Triple Helix. Scientometrics*, 58(2), 205-218. (2003)
- Leydesdorff, L., & Fritsch, M. (2006). *Measuring the Knowledge Base of Regional Innovation Systems in Germany in terms of a Triple Helix Dynamics. Research Policy,* 35(10), 1538-1553.
- Mora Valentin, *A Theoretical review of co-operative relationships between firms and universities, Science and Public Policy* (1) pp. 37–46. (2002),
- Abeda Muhammad Iqbal, Adnan Shahid Khan, Saima Iqbal, Aslan Amat Senin. (2011) . Designing of Success Criteria-based Evaluation Model for Assessing the Research Collaboration between University and Industry, International Journal of Business Research and Management (IJBRM), volume 2 (2) pp 59-73
- Siegel, D. S., D., Waldman, D. A., Atwater, L. E., and Link, A. N. *Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration.* Journal of High Technology Management Research 14, pp. 111–133. (2003)
- Izaidin Abdul Majid & Kamariah Ismail (2009). "Entrepreneurial Management and Technology-based Firms", Lambert Academic Publisher, Koln. Germany. ISBN: 978-3-8383-1612-3
- Santoro, M. Success breeds success: *The linkage between relationship intensity and tangible outcomes in industry-university collaborative ventures. Journal of High Technology Management Research*, Vol. 11 (2), pp 255-273. (2000).

- Elmuti, D., Abebe, M., Nicolosi, M. "*An overview of strategic alliances between universities and corporations", The Journal of Workplace Learning*, Vol. 17 No.1/2, pp.115-28. (2005),
- Veugelers, R., and Cassimen B: *R&D Cooperation between firms and universities: some empiracle evidencefrom Belgiam manufacturing.* International journal of industrial organization 23pp.355-379 2005
- Bonaccorsi, (2007). **A** theoretical framework for the evaluation of university-industry relationships. *R&D Management*, pp 229 -247.
- Mitive, 2009, Evaluation of an Academic- Industry research collaboration. *Social science research network.*
- Spyros, (2005). University-Industry Knowledge and Technology Transfer in Switzerland: The University View, Swiss federal institute of Technology.
- Luik, A., (2005*).* Measurement and Evaluation of Transnational Technology Transfer between R&D Institutionsand SME-s. Tallinn: Department of Product Development.
- Philbin, (2008). Process model for university-industry research collaboration. *Imperial college London,* London UK, vol.11, No.4.