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A Novel Cost Efficient Evaluation Model for Assessing Research-Based Technology Transfer between University and Industry

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Abstract

Innovations and inventions are not outcomes of single activity of any organization. This is a result of collaboration of different partners. The evaluation of collaborated research between university and industry has created the greatest interest amongst the collaboration researchers as it can determine the feasibility and value of the collaboration. Despite the enormous importance of this collaboration, there have been certain problems in successful collaboration, for instance issues related to time, trainings, differences in their perceptions, orientations and goals, intellectual property right issues, some other technological competency and fund and financial matters are the key constraints that generates some how proportional to this collaboration. Thus to tackle the basis of these problems and to analyse the strength and weaknesses of these technological linkage, evaluation of such collaboration is highly demanded. This paper intends to illustrate an evaluation model to evaluate the university-industry collaboration and to enhance their technological linkage. For bridging the model, four important variables, constraints, evaluation parameter, success criteria and tangible outcome has been identified. The novelty of this model is, it is cost and time efficient and can be applied for any university-industry research collaboration.

Keywords: University-industry research collaboration; evaluation metrics; evaluation model; technology transfer

1.0 INTRODUCTION

The rapid technological changes and antagonism has made it crucial for industry to collaborate with university (Abeda *et al.*, 2011). This has enabled them to join their efforts to promote the diffusion of knowledge and innovation within national innovation system (Matkin, 1990), (Heqiang Teng, 2010). At the end of 50s, the developing countries had almost no industrial capacity. Industrialization deals with the strengthening up of national capacity to utilize raw materials and product development for domestic consumption (Todaro, 2006). The term "industrialization" is the organization of production in business enterprises. The social and physical infrastructures of many of them were not enough therefore the building of such capacity was seen to be tricky. Industrialization was seen as an essential feature for continuing or promoting national growth and improving the standard of living in a country. It was regarded as an instrument that could transform agriculture, construction, transport, and other service industries into highly productive sectors (David, 2006). Thus they do not have any doubt for this research collaboration to get maximum out of it from adoption to commercialisation stage. Despite the enormous importance of university-industry research collaboration there have been some certain problems in successful collaborations. Universities and industries are two different social entities as a result they differ considerably in the nature and objectives of their activities (Matkin, 1990). These dissimilarities create friction between the two entities and limit their interactions (Etzkowitz, 2000), (Hermans, 2007). However, if there is a very strong collaboration within these two entities it gives rapid rise to the tangible outcomes especially for the economy of the nation (Santoro, 2000), (Abeda *et al.*, 201). For the better achievements, there should be some compatibility; continuity and sustainability between this collaboration and these linkages should be evaluated periodically. The main purpose of evaluation is to suppress those parameters which inhibit the strength of the collaboration (Danell, 2003, Abeda *et al.*, 2011, Cilingir, 1984). This paper is organized as follows: section 2, describes related work, section 3, illustrates proposed model, section 4, presents research method and in section 5 conclusion of the research has been presented

2.0 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 (Heqiang Teng, 2010, Siegel, 2003). Both the industrialized and developing nations recognize the fact that

technology plays a significant role in economic growth and the improvement of living standards of their countries. It is widely recognized that transfer of technology has played a vital role at industrial progress and overall economy of the nation. And it is possible only from university-industry research collaboration. Successful cooperation between university and industry requires special kind of synergy (Santoro, 2000, Lydia, 2006). In this manner huge number of studies has been analysed about university-industry knowledge transfer and their technological collaboration (Etzkowitz, 2000) and up till now new research is going on to make this collaboration stronger, as this collaboration is crucial by social, economical, educational, industrial as well as political point of view (Veugelers, 2005, Hall, 2004, Winter, 2004). Unfortunately a few numbers of researches has been attempted for the assessing of research collaboration (Izaidin *et al.*, 2009) and up till now there is no robust set of evaluation metrics that can be applied directly to assess the research collaboration. In this paper, we have focused mainly on evaluation metrics to evaluate university-industry research collaboration and proposed time and cost efficient model that can be significant for all sorts of collaboration, especially research collaboration.

2.1 Evaluation

The evaluation of research collaboration between university and industry has generated the greatest interest amongst economists of national and international level. This is only because of evaluation's nature of determining strength and weakness of research collaboration between these two entities (Laamanen, 2010). Most of the authors published series of works on evaluations especially on the evaluation of research collaborations between public (universities) and private (industries) sectors in the technical and tangible outcome processes (Carlsson & Stankiewicz, 1991; Saviotti, Bellon & Crow 1994). For instance, according to Luik, many of the innovation come from the demand to evaluate the importance of research carried out in research centers (Luik, 2005). The research on evaluation of university and industry research collaborations deals with large and broad aspects of the measurement and estimation procedures. Generally, evaluation can be defined as rating the excellency of a precise methodology that can be scrutinized for its soundness or validity (Spyros, 2005).

2.2 Indicators for the Evaluation of University-Industry Research Collaboration

According to organization of economical corporation and development (OECD) an indicator is a quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect changes connected to an intervention, or to help assess the performance of a development actor (OECD, 2002). Most of the researchers used evaluation indictors as a method to evaluate the research collaboration between university and industry. Some of the indicators have been itemized in table 2.8 and 2.9 by Esham (2008) from the perception of university and industry.

Although number of successful indicators for the evaluation have been identified by Esham (2008) that is already mentioned in above section but according to Philbin (2008), 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 (Philbin, 2008). For this purpose, in the next section a theoretical framework has been developed to generate a set of evaluation metrics.

Table 1 Indicator for the evaluation of university-industry research collaboration (Perception of University)

Indicators
Industrial visits by students
Regular industrial visit by university
university activities relevant to industry
university-industry interaction cell in universities
Seminars, workshops for university researchers from industry
More autonomy for university to work with industry
Consultancy or collaboration linked
Lack of funds for collaboration

Source : Esham, (2008)

Table 2 Indicator for the evaluation of university-industry research collaboration (Perception of Industry)

Indicators
Joint venture to reduce time constraints problem
Inadequate lab facilities
Poor communication
Insufficient application of the research
Lack of periodical evaluation of university-industry collaboration
Different mission of university and industry
Industrial visit by researchers
Industry representation in university committee
University representation in industry committee
Cooperative R&D agreement

Source: Esham, (2008)

■3.0 PROPOSED EVALUATION MODEL

For developing an evaluation metrics, a mathematical declaration is stated. In this declaration, there are 5 technical and statistical steps used. For this purpose, different symbols are selected for all specific terminologies. For example the identical symbol of Evaluation metrics is (EM). Likewise in the place of Constraints, Evaluation Parameters, Success Criteria and Tangible outcomes (X, Y, Z and P) are used respectively. While HI are employed for showing the high impact of used terminologies and "r" is stand for the relationship between two different variables.

EM = Evaluation Metrics, X = Constraints, Y = Evaluation Metrics, Z = Success Criteria,
P = Tangible Outcomes, HI = High Impact

In the first step, all possible parameters of constraints, evaluation parameters, success criteria and tangible outcomes that obtained from the literature review is listed down. Where X_1, Y_1, Z_1 and P_1 are all possible constraints, evaluation parameters, success criteria and tangible outcomes respectively.

$$Step\ 1: \quad X_1, X_2, X_3 \ldots\ldots\ldots Xn = \sum_{n=1}^{N} Xn$$

$$Y_1, Y_2, Y_3 \ldots\ldots\ldots Yn = \sum_{n=1}^{N} Yn$$

$$Z_1, Z_2, Z_3 \ldots\ldots\ldots Zn = \sum_{n=1}^{N} Zn$$

$$P_1, P_2, P_3 \ldots\ldots\ldots Pn = \sum_{n=1}^{N} Pn$$

The second step elaborates the high impact constraints, evaluation parameters, success criteria and tangible outcomes. To develop the statistical method "mean and standard deviation" are utilized. To finalize the high impact values, average of all the means values is taken. If the mean of any attributes related to their respective variables is higher than the total average value, these attributes of variables constraints, evaluation parameters, success criteria and tangible outcomes are considered as high impact attributes.

$$Step\ 2: \quad H_I / \sum_{n=1}^{N} Xn = C$$

$$H_I / \sum_{n=1}^{N} Yn = Y$$

$$H_I / \sum_{n=1}^{N} Zn = Z$$

$$H_I / \sum_{n=1}^{N} Pn = T$$

Till second step, all the analysis is done based on quantitative analysis. To find the relationship of evaluation parameters with constraints, success criteria and tangible outcomes, qualitative analysis is used. The relationship is highly necessary to remove the redundancy in the parameters as well as its attributes. Third step shows the relationship between evaluation parameter with constraints, success criteria, and tangible outcomes. Once the relationship has been identified using qualitative approach, all the redundant parameters is removed and remaining parameters will be merge together to generate the final evaluation metrics. However complete sets of steps are considered as evaluation model. This evaluation metrics is generated using the steps of evaluation model. In Step 3, 'r' stands for relationship. From this step, related and non-related parameters are found out with the help of qualitative approach. In step 4, 'R' stands for related and 'N-R' stands for non-related parameters, 'U' stands for Union of both related and non-related parameters. In step 5, evaluation metrics is comprises of union of related and non-related parameters.

Step 3: (E r C), (E r S), (E r T)
Step 4: [R, N-R] $_{(E/C)}$ [R, N-R]$_{(E/S)}$ [R, N-R]$_{(E/T)}$
[(R $_{E/C}$) U (R $_{E/S}$) U (R $_{E/T}$)] U [(N-R $_{E/C}$)
U (N-R $_{E/S}$) U (N-R $_{E/T}$)]
[R] U [N-R]
Step 5: EM = [(R) U (N-R)]

■4.0 EVALUATION MODEL FOR ASSESSING TECHNOLOGY TRANSFER BETWEEN UNIVERSITY AND INDUSTRY

Evaluation Model has been developed for successful evaluation of research collaboration between university and industry. This model is a method that is responsible for not only developing evaluation metrics but also good to investigate high impact constraints, evaluation parameters, success criteria and tangible outcomes. In this proposed model 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 these four important variables, the key evaluation metrics has been developed.

Figure 1 shows the evaluation model where initially all the possible constraints, evaluation parameters, success criteria and tangible outcomes are found out from the literature review. Based on these data, quantitative and qualitative questionnaires were developed and analysed. From quantitative data analysis, all the high impact of above variables is generated. Relationships amongst the attributes of these variables are finalized by using qualitative approach. Once all the related attributes are sorted out, redundancies are removed and only one attributes is taken out to be the candidate for evaluation metrics. The selection of this attributes is also based on qualitative respondents as well as literature survey. At this stage, all the related and non-related parameters are enlisted. Finally, evaluation metrics that is responsible for evaluating the research collaboration is list down by the emergence of related and non-related parameters. The final version of evaluation model is shown in Figure1, where evaluation metrics is comprised of joint venture, knowledge sharing, cooperative R&D agreement, cultural development, financial support, communication, patents and licenses, master and doctorate thesis.

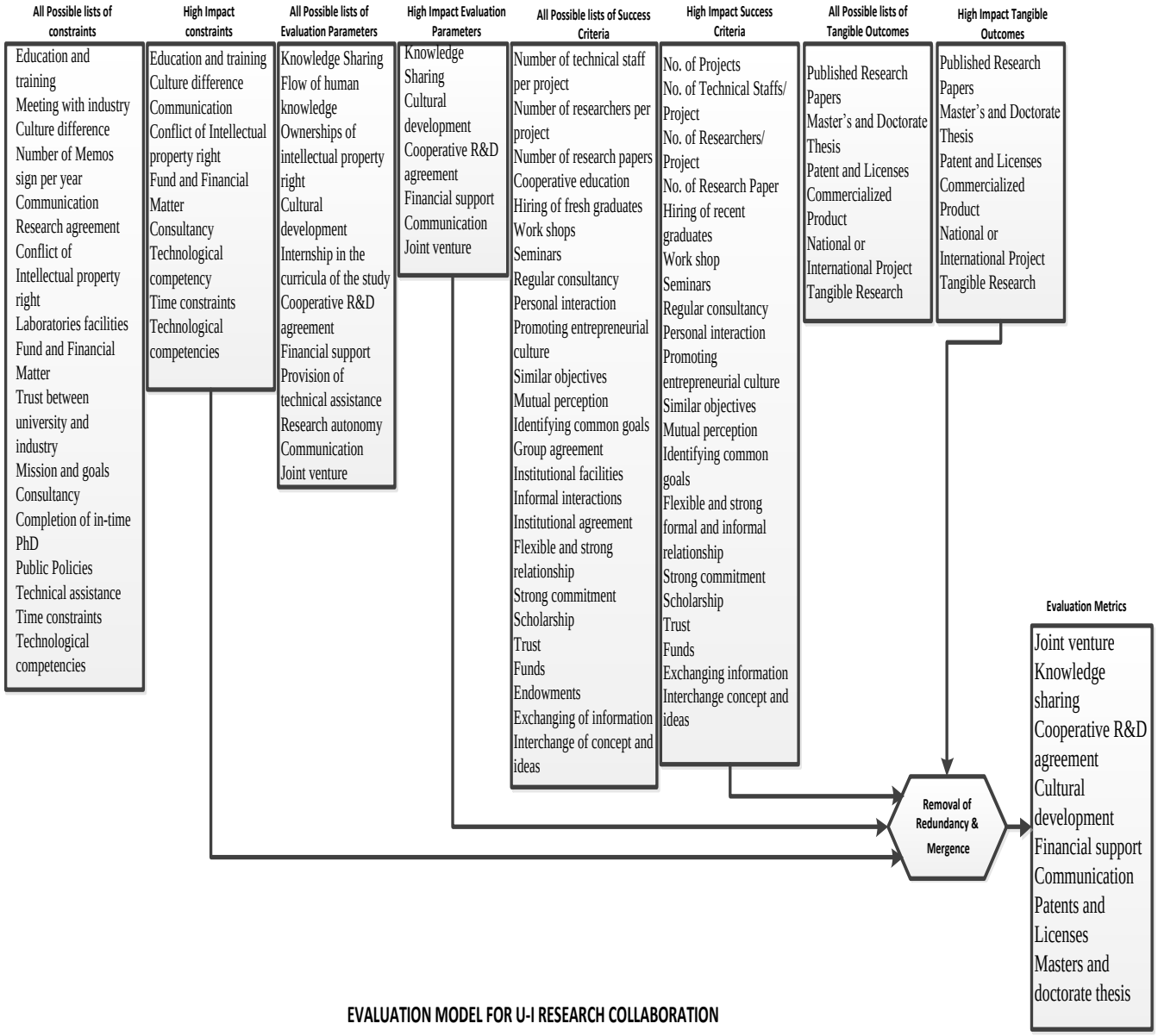

Figure 1 Model for the evaluation of U-I research collaboration

5.0 CONCLUSION

Successful collaboration between university and industry can be justified by the manifestation of industries related to subject development, the usage of scientific research to generate fruitful environment at firm's level and the economical globalisation and technology internationalisation. This research mainly focused on evaluation scheme to assess the strength or weaknesses of university-industry collaboration and to make the collaboration successful. For this purpose, an evaluation model has been developed that have a capability to generate evaluation metrics for any research collaboration between university and industry. Moreover, it also categories high influence constraints, success criteria and tangible outcomes to strengthen the collaboration with more focused manner. In addition, an evaluation metrics has been generated through this model will be highly cost and time efficient. This evaluation can be applicable to evaluate the linkage of any university industry research collaboration.

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