LEARNING MANAGEMENT SYSTEM ON UNIVERSITY-INDUSTRY COLLABORATION

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Abstract

University-Industry Collaboration is one of the most important factors to sustain strategic advantage for High Technology Intensive Industries. The purpose of this study is to provide a model for "University-Industry Collaborations" and to generate a heuristic method for "Collaboration Capability Levels". Because of the changing competitive conditions in knowledge centered industries, firms have to generate roadmap with the help of technological collaborations. Upon the examination of the previous models, this research defines the structure of relationship by modeling collaboration parameters. The model parameters are defined according to High-technology industries' R&D need and constructed with AHP method to assess internal& external relations.

Keywords: University - Industry Collaboration, High Technology Intensive Industry,

Collaboration Capability Level

1. Introduction

1.1. Objectives of the work

Technology intensive industry is one of the most competitive lanes which can only be managed by differentiating products/services with the help of academic knowledge. Not only to survive but also to sustain the strategic market position, the companies stand on technology development. For these reasons, a process (universally well known for advanced research & development) can be built up in cooperation and collaboration with universities in regional and national economies.

As far as the concept is the focal point of strategic management in companies, university-industry collaboration decision is taken at management level. As Chiesa and Manzini stated, the collaboration is constructed according to the following criteria in vertical level with universities; [8]

- The demand side (namely, the company) characterizes the technology gaps and requirements to carry out cooperation with the university efficiently,
- The firm matches the capabilities of the potential partners with its' technology requirements.
- The firm selects the most suitable form of collaboration with the university.

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This research paper is established for managers to take "**Go/No Go"** decision for collaboration with universities in vertical level by optimum model from the firms' perspective. Grown out of this focal point, the model in the present study is centered on measuring success of five metrics in the selected universities. These parameters are Structure of Students, Project Status of Related Department of University, Publication Status of that Department, Commercial Activity Status of that Department, Structure of Teaching Staff.

To begin with, this research paper analyzes the core competency criteria of collaboration actors according to the literature with the given methodological analysis. To achieve this goal, level of collaborative interactions is used to define parameters of the study in five zones, defined as **Collaboration Capability Level (CCL).** Next, characteristics of the given samples are selected according to technological response agility to embed in **CCL.** Then, a set of indicators is defined and data collection is completed. Next, descriptive results are displayed and cumulative grade is embedded into the **CCL.** In conclusion, the scale level of cumulative generates the current profile of University-Industry Collaboration and constitutes specific feedback as a further action. The current study defines the inadequacies in collaboration system with respect to five ranked zone while constructing a new methodology to improve these weaknesses in further evaluation.

Finally, the limited use of the study is one of its restrictions. The homogeneity of Delphi resources are used in comparison with five parameters. Also sub categories of each domain parameter are analyzed with Delphi method for classification too. The given order of parameters in Analytical Hieararcy Process (AHP) is based on personal experience of technology-intensive professionals. The selected sub categories are applicable in nation-wide as the "publication of the universities" domain is divided in four sub categories.

1.2. Literature Survey

The earliest consciousness in the history for knowledge production started with the idea of Francis Bacon in 17th century. He intended to develop a detailed product catalogue to define the ways products manufactured in "History of Trades" publication. By this catalogue, producers could build the links while scientists could use the existing knowledge to lead basic research. [2]

In 1862, the first legal movement initiated with USA Congress application. According to this law, university-industry relations were legitimated to improve conditions in agriculture and mechanics which is today known as "Morill Laws". The given legal incentives led the public universities in USA to generalize the applied science methods and publish papers based on their research**.** [3]

After Second-World-War, university resources increased by advanced governmental funding especially for military-purposes. With this development, management and practical use of research output could be supported by firms. [1]

In mid 1970s the governmental incentives decreased because of economic downturn that R&D projects became more competitive. [1] In 1980, by development of "National System of Innovation" concept, role of universities and companies were shaped sharply. Industries started to participate in collaborative actions with intellectual capital of universities. Research funds were restricted with new governmental policies in United States. [4] While adapting to the collaboration with universities, firms also experienced a new way of working and a strengthened network with their partners, suppliers and consumers successfully. [5]

In 1990s, Etzkowitz and Leydesdorff, developed **"Triple Helix Model"** which defined university-industry-government relations in developing nature of technology. Triple Helix Model was used as an alternative of "Market Pull & Technology Push" while defining roles to government with linkage between industry and university. To sustain cooperation between these two actors government formed different mechanisms for research funding and research infrastructure. According to Etzkowitz, the universities' changing role in Triple Helix model was set as an "Enterpreneur" [6]

Universities are weak for patent production. However; three dimensional approaches can be used to develop its capacity for patenting. Companies play the key role for interface to spin-off academic activities into use of new product/process. [7] Since there is no best practice for Triple Helix Model, the level of relations can be advanced in further models.

2. Materials and Method

This research methodology is based on primary source data. The data is accumulated by faculty staff surveys and Business Activity Reports in 2013 on two different kinds of universities that construct new technology involved projects by their academic institutions in Turkey. In addition, the study is generated on these universities' faculty of engineering that establishes one-to-one correlation with the R&D project.

In order to estimate the model, two different models for this study are set as **upper benchmark** and **lower benchmark** within same economic constraints in national innovation system. The first sample, defined as **"University A" that is a private university**, propounds a "Strong Collaboration Model" when the methodology is applied with defined parameters. On the contrary, the second sample, defined as **"University B" that is a public university** presents a "Very Strong Collaboration Model". As the survey is constructed on the faculty of engineering, the sample defines only partial explanation that includes 25% of the total population at these universities. The completed survey gives the model in the following part of this research study on the support of objectives of collaboration methodology.

First of all, the model is built up on Collaboration Capability Level (CCL) by defining the metrics to calculate final grade (Figure 1).

100-80 %	80-60 %	60-40 %	40-20 %	20-10 %	Final Cumulative Grade	Grade Color
Very Strong	Strong	Medium	Weak	Not Feasible		

Figure 1. The Cumulative Grade Scale in CCL Model

According to the CCL pyramid in the model; **0-20%** represents **"Not Feasible"** area which means that it is the base level and there is no official university-industry collaboration. In long term, the related index parameters have to be improved to achieve efficient contact. **20-40%** range represents **"Weak"** area which means that it is the secondary level of the CCL pyramid. At this range, the student clubs of related university are supported. Moreover, various kind of weak connections are sustained according to personal contacts between university and industry. According to these weak contacts, even some of the teaching staff can give consultancy services within limited work definition. **40-60%** range represents "**Medium**" area which means that it is the third level of CCL pyramid. At this level, university-industrial collaborations are constructed with some specific universities and some reputable university professionals. There is more option for consultancy of the teaching staff that can play a limited role in various projects. **60-80%** range represents **"Strong"** area which means that it is the fourth level. At this level, university-industry collaborations are conducted with different types of universities according to corporate contacts. Partnership in international projects such as European Union 5^{th}, 6^{th} and 7^{th} Framework Programs is carried out. **80-100%** range represents **"Very Strong"** area which means that it is the top level of CCL pyramid. At this level, various technology related student clubs are guided, thesis works of the undergraduate, graduate and doctorate students are formed jointly within the industrial necessity. Board of Trustee at related university and upper managerial levels of the firm come together regularly and discuss further steps to draw a long-term collaborative strategy. The university-industry collaboration is directed to trigger new R&D projects according to firm's technology road map.

Throughout the study, AHP method is used to generate University-Industry Collaboration Model. In this model, survey study is clustered in five main categories that are;

- structure of students,
- project status of related department,
- publication status of that department,
- commercial activity status of that department,
- structure of teaching staff.

All of the metrics are defined according to the accessibility at faculty of engineering level in **University A** and **B**. After defining main categories, each major parameter is defined with comparative ranks in 0-5 range.

2.1. Theory/Calculation

In the first step, the five domain parameters are compared with each other according to Delphi Method Analysis in Table 1. According to the DMA results obtained from high technology intensive industry professionals, project status of the related department in university is the most important metric in overall. Publication status is the second important metric. Commercial activity status is the third important metric. Structure of the teaching staff is the fourth important. Structure of students is the least important parameter in the comparison. According to the application of AHP methodology, the result comes out as consistent. The weight coefficients are normalized according to the results.

Table 1. AHP Analysis on University-Industry Collaboration Parameters

RESULTS	
	Weight coefficients
Indicator1: Structure of Students (University)	0,050
Indicator2: Project Status of Related Department (University)	0,464
Indicator3: Publication Status of that Department (University)	0,270
Indicator4: Commercial Activity Status of that Department (University)	0,123
Indicator5: Structure of Teaching Staff (University)	0,094

The second step of the analysis is done by using **University A** and **University B** activity grades' calculation excluding the relations between University A and University B. The selected parameters are defined according to technology intensive industry need. The collected raw data is analyzed according to defined sub category ratios. Next, the calculations for each university cluster (department or faculty), the parameters are scored in 0-5 range. For example, in structure of the students index, if the number of bachelors of science students/number of teaching staff of that department calculation is between 0-10, it is ranked by the highest factor (5); for 11-15 range, ranked (4); for 16-20 range, ranked (3); for 21-25 range, ranked (2); for 26-30 range , ranked (1); for x>31, ranked (0). Similarly, in project status of the department index, if the number of international projects/total number of the projects calculation is x>0.7, it is ranked by the highest factor (5); for 0.7-0.5 range, ranked (4); for 0.5-0 range, ranked (3); for x=0, ranked (0). Moreover, in publication status of the department of university index, if the number of the international academic paper/the number of the teaching staff calculation is x>2, it is ranked by the highest factor (5); for 2-1 range, ranked (4); for 1-0 range, ranked (3); for x=0, ranked (0). Likely, in structure of teaching staff index, if the number of laboratory/the number of teaching staff calculation is between 60-100%, it is ranked by the highest factor (5); for 40-60% range, ranked (4); for 20-40% range, ranked (3); for x<20%, ranked (0).

Next, the given ranks (0-5) are multiplied with the actual eigenvector of each sub categories. As, the cumulative of each sub categories equals to the main indicators, the indicator 1 is cumulative of 5 sub categories, indicator 2 is cumulative of 8 sub categories, indicator 3 is cumulative of 4 sub categories, indicator 4 is cumulative of 2 sub categories, indicator 5 is cumulative of 5 sub categories which are shown in Table 2. Then, the subcategories are divided equally to achieve final rank. After that, summation of each subcategory is completed and the parameters are changed into 0-100 index by multiplying the final cumulative rank with 20.

According to Saaty's definition, consistency index for random matrix is counted as 1.12 while running model with five parameters. To define optimum weights in each of five sub categories, the consistency index is counted as 1.12 for first, 1.41 for second, 0.9 for third, 0.58 for fourth, 0.9 for fifth AHP application. [8]

In final part of the methodology, the cumulative rank of University A and B are compared in Cumulative Grade Scale. University A is ranked 66.89 which is defined as **"Strong"** range with yellow grade scale color in the Cumulative Capability Level (CCL). On the contrary, the University B is ranked 80.31 which is defined as **"Very Strong"** range with in CCL.

In following parts of this research, the prioritization is made by virtue of foresight of technology intensive industry need. For example, according to the AHP results, the order of subcategory in structure of students is defined as; doctorate students is the most important factor.

Also, according to the AHP results, the order of subcategory in project status is defined as; number of international projects of the university is the most important factor.

On the other hand, according to the AHP results, the order of subcategory in publication status is defined as; number of international article in referee publication of the university is the most important factor. Similarly, in AHP results of subcategory in commercial activity parameter, the order is defined as; the number of technology transfer is the most important factor. Furthermore, in AHP results of subcategory in structure of teaching staff parameter, the order is defined as; the number of teaching staff is the most important factor.

Finally, to generate effective results at this study all of the firm related data involving the number of graduates working in industry and the number of employee studying MS/PhD degree at related university is collected from a technology intensive manufacturing company.

Table 2. Types of Parameters in University-Industry Collaboration Index

Domain	University-Industry Collaboration Subcategories
(a) Structure of Students	1. Number of BS Degree Students/ Number of Teaching Staff of That Department
	2. Number of Master Degree Students/ Number of Teaching Staff of That Department
	3. Number of Doctorate Students/ Number of Teaching Staff of That Department
	4. Number of Labor Works at the Corporation (Graduated from the University's Related Department) / Total Number of R&D Engineer
	5. Number of Labor Works at the Corporation (Studying MS/PhD at the University's Related Department) / Total Number of R&D Engineer
(b) Project Status of Related Department (University)	1. Number of Projects of that department / Number of Teaching Staff of That Department
	2. Number of TÜBİTAK(Turkish Science and Technology Research Foundation) Funded Projects of that department / Number of Teaching Staff of That Department
	3. Number of Public Funded Projects of That department / Number of Teaching Staff of That Department
	4. Number of Industry Funded Projects of That department / Number of Teaching Staff of That Department
	5. Number of Comleted Projects (Completed with equity capital of University) / Total Number of Projects of That Department
	6. Is there an agreement between University's Related Department with the Industry for Internship/Integrated Training/KOOP? (1/0)
	7. Does the Corporation fund the University's Scientific Student Club? (1/0)
	8. Number of International Projects of the University (Cappadocia, Sesar, Disco) / Total Number of Projects of That Department
(c) Publication Status of that Department (University)	1. Number of National Publication (Report, Conference, Scientific Newspaper) / Number of Teaching Staff of That Department
	2. Number of International Publication (Report, Conference, Scientific Newspaper) / Number of Teaching Staff of That Department
	3. Number of National Article (In Referee Publication) / Number of Teaching Staff of That Department
	4. Number of International Article (In Referee Publication) / Number of Teaching Staff of That Department
(d) Commercial Activity Status of that Department (University)	1. Number of Assets (Patent etc.) / Total Number of Projects of That Department
	2. Number of Technology Transfer / Total Number of Projects of That Department
	3.Number of training delivered as a result of a paymet (prepared by university for industrial purpose) /Total number of trainings
(e) Structure of Teaching Staff (University)	1. Number of Teaching Staff involved in Internation Activities (MS,PhD,International Work Experience,Visiting Scholar etc.) / Number of Teaching Staff of That Department
	2. Number of Research Assistant / Number of Teaching Staff of That Department
	3. Number of Corporate Counseling Services provided by Related Dept. Of University / Number of Teaching Staff of That Department
	4. Number of Laboratories used in projects of Teaching Staff

3. Results

In the result, the CCL methodology generated two different rankings for University A and B given in Table 3. Of the University A and B, the structure of the students is stronger in B than A. The project status (Faculty of Engineering) is stronger in University B than A. The publication status including national/international sub categories is equal in both universities. On the other hand, commercial activity status of that department is better than University B than A. Moreover, the structure of teaching staff is better in University B than A.

Table 3. CCL Results of Selected Universities

MAIN PARAMETERS	CCL-University A	CCL-University B	ω
Structure of Students	0,187779721	0,228290775	0,050
Project Status of Related Department (University)	1,408972943	1,68955579	0,464
Publication Status of that Department (University)	1,275760273	1,099391704	0,270
Commercial Activity Status of that Department (University)	0,0603035	0,574797667	0,123
Structure of Teaching Staff (University)	0,411827092	0,423809412	0,094
Sum grade	3,344643529	4,015845348	
Sum %	66,89287058	80,31690696	
CCL Grade Color	3,344643529	4,015845348	

4. Conclusions

This study shows an overall perspective to make long-term engagement plan based on university performance from managerial perspective. So, the study is useful when given data is compared with similar tools as it is employed for only faculty of engineering in both universities. Since the necessity of the knowledge varies in industries different from technology-intense studies, comparative importance of arrangement in DMA changes. Output of this study is beneficial for R&D managers in two dimensions. First, the study is an important tool for firms to trigger and successfully complete long term R&D projects by strengthening with advisory of teaching staff, qualified publications generated by teaching staff/researcher/MS-PhD degree students. Secondly, the study is useful for any company to perform research based of its critical technologies on “Technology Road Map” with suitable university research potential.

Finally, the comparison is built up on two specified universities only to test the validity of CCL model with the help of AHP analysis. These research parameters can be diversified to modify in international literature for further studies.

5. List of Abbreviations

CCL Collaboration Capability Level

AHP Analytic Hierarchy Process

DMA Delphi Method Analysis

6. List of Tables

7. List of Figures

8. References

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