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A Study to Design a Survey to Encourage the University-Industry Relation

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***Abstract*—**The purpose of this research is to present a survey to be applied to professors of public universities, to identify the factors that benefit or hinder the university-industry relation. Hence, this research studies some elements that integrate the variables: Knowledge management, technology management, and technology transfer; to define the existence of a relation between these variables and the industry necessities of innovation. This study is exploratory, descriptive and non-experimental. The research question is: What is the impact of the knowledge management, the technology management, and the technology transfer, made by administrative support areas of the public universities, in the industries innovation? Thus, literature review was made to identify some elements that should be considered to design a survey that allows to obtain valid information to the study variables. After this, the survey was developed, and the Content Validity Analysis was made through the Lawshe Model. The analysis indicated that the Content Validity Index (CVI) was 0.80. Hence, it was determined that this survey presents acceptable psychometric properties to be used as an evaluation tool.

***Keywords*—**Innovation, knowledge management, technology management, technology transfer.

I. Introduction

THE importance of leveraging knowledge to increase efficiency and effectiveness within the organization is now widely acknowledged not only among large corporations and small business enterprises, but also among educational institutions. Nowadays, many organizations are launching knowledge management initiatives, believing that their well-intended effort will naturally result in the better exploitation of knowledge assets for business benefit [1].

Commercialization of university-discovered technologies is a driver of economic growth and universities have played a major role in bringing innovative ideas and inventions to market. Technology transfer can potentially generate revenues for universities, create research connections between academia and industry, and enhance regional economic growth and development [2].

Academia has become entrepreneurial in its inner dynamic as well as through external connections made to business firms for research contracts and transfer of knowledge and technology. The first academic revolution, taking off in the late 19th century, promoted research as a university function in addition to the traditional task of teaching. A second academic revolution then transformed the university into a teaching, research and economic development enterprise. The entrepreneurial academic model was then transferred to Stanford where it was introduced into the liberal arts university culture in the early and mid-20th century [3].

The university is an especially propitious site for innovation due to such basic features as its high rate of flow through of human capital in the form of students who are a source of potential inventors. The university is a natural incubator; providing a support structure for teachers and students to initiate new ventures: intellectual, commercial and conjoint [3]. For these reasons, this research analyzes four variables and the relations among them, to present a survey to identify the elements that benefit or hinder the university-industry relation. The next section presents the basis on which the survey was developed.

II. Literature Review

A. Technology Transfer

The base of the technological knowledge essentially exists in the professionals, as technologists, engineers, scientists and researchers in the different disciplines. For this reason, it is overriding the approach between the professionals and the production and commercialization entities to make the technology transfer possible. In accordance with the competitiveness objectives of the enterprises, such as, in operation, products and services supply, and the business strategy, they need to collaborate with experts and researchers to increase their competitiveness [4]. When the linkage is successful, it can be seen in the frequency of their relations with the experts, becoming of sporadic to higher depth relations. The technology transfer is one of the visible results of the linkage, and it can occur as a part of the strategic plan of the petitioner entity, as a knowledge diffusion plan of the offeror entity, or even, as a casuistic result of an opportunity of commercialization of any of the organizations. The process of transfer requires the definition of metrics and the establishment of indicators that allows to evaluate the effectiveness of the offeror and the impact in the acquirer enterprise. The pragmatic result should be the beginning of a technological assimilation stage, whose results help to the mentioned indicators [4].

According to the Innovative Enterprises Forum [5] “the process of technology transfer is not limited to the change or authorization of some property rights about a physic object,

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but it incorporates the knowledge transfer and the required practices for its performance".

The technology transfer is any process by which the basic knowledge, the information and the innovations are moved of a university, institute or a governmental lab, towards an individual or for enterprises in the private or semiprivate sectors [4].

B. Knowledge Management

Since the mid-1990s, individuals and organizations began to think seriously about manage what they know. This movement came to be known as knowledge management. Some enterprises understand by knowledge to the codified information with a high proportion of human value added, including intuition, interpretation, context, experience, wisdom, among others. The information related with personnel manuals, corporative procedures, are not significant in the knowledge management, but most also include more knowledgeable content: best practices, lessons learned, and insights about customers, competitors, and business partners [6]. In the organizational environment, the knowledge management refers to the practices of generating, capturing, collecting, disseminating, and reusing know-how internally created.

Knowledge management is defined as ¨the effective learning processes associated with exploration, exploitation and sharing of human knowledge (tacit and explicit) that use appropriate technology and cultural environments to enhance an organization's intellectual capital and performance¨ [7].

C. Tacit and Explicit Knowledge

According to Nonaka and Konno [8], there are two kinds of knowledge: explicit knowledge and tacit knowledge. Explicit knowledge can be expressed in words and numbers and shared in form of data, scientific formulae, specifications, manuals, and the like. This kind of knowledge can be readily transmitted between individuals formally and systematically. On the other hand, tacit knowledge is highly personal and hard to formalize, making it difficult to communicate or share with others. Subjective insights, intuitions, and hunches fall into this category of knowledge. Tacit knowledge is deeply rooted in an individual´s action and experience as well as in the ideals, values, or emotions he or she embraces.

Knowledge creation is a spiraling process of interactions between explicit and tacit knowledge. These interactions lead the creation of new knowledge. Nonaka and Konno presents a model that serves as an outline for knowledge creation and the idea of self-transcendence is quite abstract. This model involves four steps in the knowledge conversion process: socialization, externalization, combination and internalization. Socialization involves the sharing of tacit knowledge between individuals. In this phase the tacit knowledge is exchanged through joint activities, such as being together, spending time, and living in the same environment. In practice, socialization involves capturing knowledge through physical proximity. Externalization requires the expression of tacit knowledge and its translation into comprehensible forms that can be understood by others. Dialogue, ¨Listening and contributing to the benefit of all participants; as well as translating the tacit knowledge of customers or experts into readily understandable forms, strongly supports externalization. Combination involves the conversion of explicit knowledge into more complex sets of explicit knowledge. This phase relies on three process. Capturing and integrating new explicit knowledge is essential. This might involve collecting externalized knowledge from inside or outside the company and then combining such data. Second, the dissemination of explicit knowledge is based on the process of transferring this form of knowledge directly by using presentations or meetings. In the last process, the editing or processing of explicit knowledge makes it more usable, such as plans, reports, and market data. Finally, the internalization of newly created knowledge is the conversion of explicit knowledge into the organization´s tacit knowledge. The process of internalizing explicit knowledge actualizes concepts or methods about strategy, tactics, innovation or improvement [8].

D. Technology Management

Based on White and Bruton [9] management of technology is defined as linking "engineering, science, and management disciplines to plan, develop, and implement technological capabilities to shape and accomplish the strategic and operational objectives of an organization.

The Technology Management is designed to manage technological capability in which technology is very critical and argue to have crucial effects to the firms' competitive advantage. Thus, managing the technology is very critical under volatile environment which means the sustainability of the technological capabilities is very significant issue for technology management [10]. Technology Management implements the following innovative strategy in education and cognitive management: science→ innovations→ production → competitive products → market → profit → science. This chain has the following meaning: without science there is no innovation, without innovation there is no production, without production there are no competitive products, without competitive products there is no profit, without profit there is no science [11]. According to Syryamkin y Syryamkina [11] the technology management involves business strategy in a high-tech enterprise, identifying and evaluation of engineering capacities, transfer and commercialization of new technologies, marketing, intellectual property, legal protection strategies commercialized scientific research results, research planning and management of a high-tech enterprise, the methods of economic evaluation of innovative projects, regulatory authorities and cooperation with them, export control of technologies, international co-operation, the basis of economic and technological security.

E. Innovation

In a technological progress or in a dynamic economy, the development of the human capital plays an important role; in consequence the people with a high educational level generates good innovators, thus, the education speed up the

process of technological diffusion and as is well known since the economic view, the people are an important part of the nations wealth [12]. An Innovation System is the socio-institutional interaction, in which the knowledge and abilities are shared to the development and diffusion of the new technologies to create an innovation environment [13]. As reported by Jasso [14] the innovation process and the technology transfer in the Innovation Systems besides involving the purchase and importation of capital goods and applying techniques and handbooks to operate a specific plant, it includes efforts and results whose origin is the knowledge accumulation and abilities, or specific conditions of appropriation, or the knowledge features in which companies cooperate and/or compete.

Based in the Oslo Handbook, Innovation is considered as the introduction of a new or significantly improved product or process, or the introduction of a new commercialization or organizational method applied to the business practices, to the work organization or to the external relations [15]. Innovations are to an increasing extent seen as the result of an interactive process of knowledge generation, diffusion and application [16].

III. Methodology

This study is exploratory, descriptive and non-experimental. According with the literature review, this research proposes a survey to be applied to teachers of public universities, to identify the factors that benefit or hinder the university-industry relation. For that reason, it presents a model (Fig. 1) to indicate the relation between the following variables: knowledge management, technology management, innovation, and technology transfer. Therefrom, the survey is designed to be applied to a sample of teachers of public universities in Baja California, Mexico.

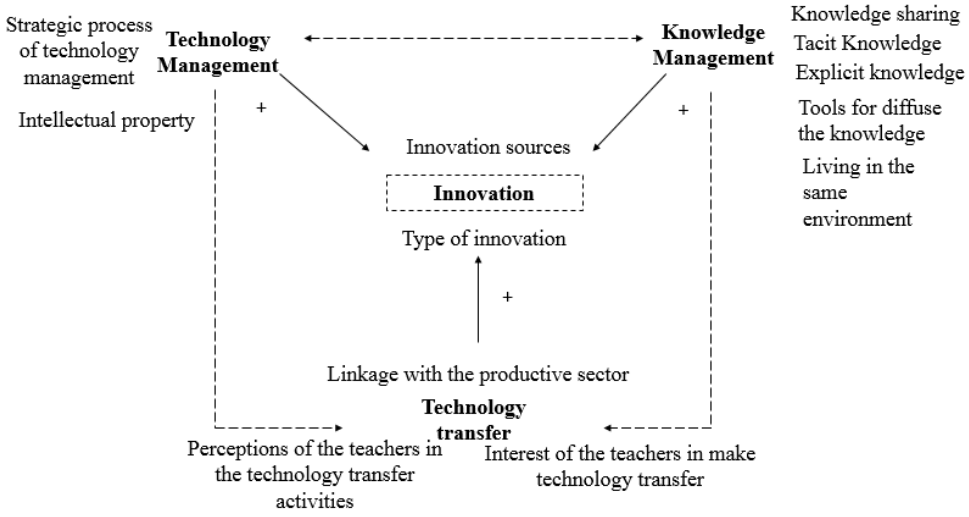

Fig. 1 Proposed model

The proposed model shows the relation between the variables object of this study, and the elements considered significantly to obtain data to analyze the current situation in the public universities of Baja California, Mexico, to improve the interaction university-industry.

Initially the proposed survey, was integrated by 99 questions, but before to be applied to the sample, the survey was shared with seven experienced researchers in the topic, and they evaluated each question under the following judgement: essential, important/not essential, and not important according with the Lawshe Model [17] modified by Tristán [18]. The main purpose with this evaluation is to obtain an improved survey to collect valid data.

IV. Findings

After the evaluation made by the group of researchers, it was calculated the Content Validity Ratio (CVR and CVR') for each question, and once obtained the CVR and CVR' values, it was calculated the Content Validity Index (CVI) of the whole survey, described in the Lawshe Model [18], using:

$$CVI = (\Sigma_{i=1}^{M} CVRi) / M \quad (1)$$

The *CVRi* is the Content Validity Ratio of the acceptable questions according with the Lawshe criterion, and *M* is the total acceptable questions of the survey.

The value of the Content Validity Index (CVI) considering the total number of questions is 0.38, and the obtained value considering just the questions whose CVR' is higher than 0.58, according with Tristán [18] is 0.80. It can be understood that the questions that obtained a weak score in the evaluation made by the researcher, is because they are not significant for the study. Since the analyses, and considering the literature, it was necessary to remove 52 questions, those whose CVR' was lower than 0.58. Hence, the final version of the survey is integrated by 47 questions.

Based on the literature review, in the objectives of this research, and in the Content Validity Analysis results, the technology transfer variable is integrated by 3 dimensions, 12 indicators, and 10 questions (Table I).

TABLE I
TECHNOLOGY TRANSFER VARIABLE

Dimension	Indicator	Question	Author
Interest of the teachers in make technology transfer	Journal publications Additional payment per Project Funding for academic assistants Funding for postdoctoral fellows Funding for lab equipment	7	[19]-[21]
Linkage with the productive sector	Background of the linkage	1-2, 6	[22]
	Linkage type	3	[5], [4], [20], [23]-[25]
	Patent area	4	[22]
	Technology Transfer Office	5	[21]
Perceptions of the teachers in the technology transfer activities	Industry linkage activities procedures	8	
	Business and Marketing experience	9	[26], [19]
	Acknowledgement	10	

This table shows the dimension, indicator, number of question and the source where the information was obtained to construct the technology transfer variable.

TABLE II
KNOWLEDGE MANAGEMENT VARIABLE

Dimension	Indicator	Question	Author
Living in the same environment	Academic teams	11	[8]
	Project teams	12	
Tacit knowledge	Conferences	13-14	[8], [7]
	Work reunions	15	
Explicit knowledge	Plans y reports	16	[8], [7]
	Simulations and experiments	17-18	
Knowledge sharing	Trust	19	[7]
	Websites		
Tools for diffuse the knowledge	Research catalogs offer		
	Technological platforms		[20]
	Participation in forums, conferences and fairs	20	

This table shows the dimension, indicator, number of question and the source where the information was obtained to construct the knowledge management variable.

TABLE III
TECHNOLOGY MANAGEMENT VARIABLE

Dimension	Indicator	Question	Author
Strategic process of technology management	Planning	21-22	
	Implementation	23-30	[21], [27], [9]
	Evaluation and Control	31-32	
	Merchandising	33-37	[28], [29]
Intellectual property	Financial resources	38	[30], [31], [20]
	Public value	39	[32]
	Market impact	40	[32]

This table shows the dimension, indicator, number of question and the source where the information was obtained to construct the technology management variable.

In the case of the Knowledge Management variable, it's integrated by 5 dimensions, 11 indicators, and 10 questions (Table II).

The technology management variable has 2 dimensions, 7 indicators, and 20 questions (Table III).

The innovation variable is integrated by 2 dimensions, 7 indicators and 7 questions (Table IV).

TABLE IV
INNOVATION VARIABLE

Dimension	Indicator	Question	Author
Type of innovation	Product	41	[14], [33]
	Process	42	
	Organizational	43	
	Marketing	44	
Innovation sources	Looking for the customer needs.	45	[34]
	Internal processes needs	46	
	Looking for the market changes	47	

This table shows the dimension, indicator, number of question and the source where the information was obtained to construct the innovation variable.

V. CONCLUSIONS

The survey proposed, whose main objective is to measure relevant aspects of the technology transfer, innovation, knowledge management and technology management, performed by the administrative support areas of the public universities of Baja California, México; according to the Lawshe Model [17] modified by Tristán [18] showed a Content Validity Index (CVI) of 0.80, indicating that the survey presents acceptable psychometric properties to be used as an evaluation tool. Based in the CVR' of each question, and continuing with the Lawshe criterion, it was necessary to decrease the number of questions in the proposed survey, originally the survey was integrated by 99 questions, after the evaluation, the questions that obtained a CVR' less than 0.58 were eliminated, i.e. 52 questions. In consequence, the final survey is integrated by 47 questions; these questions contain the best valued elements according with the researchers' evaluation. Nevertheless, with the purpose of propose a survey that allows to pursue the objectives of this research, as well as of future researchers on university-industry technology transfer, we recommend to make a new review and arrangement of the questions, to be applied to a specific sample an obtain valid data for the study variables.

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