Developing a Ready-to-Commercialize-Technologies identification Institutional Model

Victoria E. Erosa
International Graduate Center
University of Applied Sciences (Hochshule), Bremen, Germany. International Graduate Center
Pilar M. Pérez
Polytechnics Unit for Business Development and Competitiveness
Instituto Politécnico Nacional, México

Abstract

Universities and research organizations of the kind working under the technology push perspective are facing the challenge of selecting technologies, already at their mature stage, to be transferred to the user by commercialization efforts. In the marketing field language, this action is translated as looking a proper customer for the product insertion in a market. Being technology marketing a new function to be operated, these institutions require the definition of selection criteria and commercialization rules in order to build an operational platform for this activities which involves researchers, managers, institutional officers and agents, as well as regulatory frameworks such as copyright ownership, taxes and ownership transfer contraction. From the buyer perspective, acquiring technology solutions, resulted from research and development activities, becomes of key importance to add to the *collection of resources* inside an administrative framework, that enables a firm to gain competitive advantage (Resource View Theory), considering that it is the particular combination of resources that leads to better performance when contrasted with rivals. The combination of this external environment faced by the Research and Development institution (R&DI) and internal organizational resources both influence their strategy, its missions and goals and how it plans to achieve them. This directly influences the structure, as the lines of authority, communication and information flow adapt to changes in strategy (Contingency Theory). Upon this theoretical framework, a structured institutional Technology Commercialization Readiness Identification Model is described in this paper, explaining its components, stages and operational flows defined to articulate activities, roles and functions of the different actors involved in the commercialization process of technology and innovation research results. In this paper the model is presented from the technology provider being under development research activities to support analysis based on the buyer´s point of view.

Key Words: Technology Commercialization, Innovation Commercialization, Technology Transfer, Technology and Competitiveness

Introduction

Defined as the transfer of systematic knowledge for the manufacture of a product or provision of a service [1] and as the movement of science and technology from one group to another [2], Technology Transfer addresses the assessment, adoption and implementation of technology, is widely understood as the process of transferring technologies, knowledge, skills and production processes among Research and Development (R&D) Centers, universities and other institutions to users who may benefit from it in the form of new products, processes or services from which the firms generate efficiencies, productive growth and market benefits [3], [4]. Higher Education institutions engaged in Research and Development activities either as an educational experience or as a formal venue of expertise development generate a wide array of outcomes that are expected to be commercialized in the industry or the social sector as well. This practice in which the *supply* side seeks for a matching *demand* is identified with the technology push perspective of the technology transfer stage of the innovation life cycle [5], [6], [7]. Literature review supports the notion that research results transfer to the productive arena has been considered as a main issue since the early 60´s [8], contrasting with little disclosure of description of models developed/or used by Universities and R&D institutions to identify ready-to-commercialize technologies in the context of a Technology Transfer structured process [9], [10], [11].

Universities and research organizations of the kind working under the technology push perspective face the challenge of selecting technologies, already at their mature stage, to be transferred to their final user by

commercialization efforts –defined as to manage on a business basis for profit or to exploit for profit [12]-. This complex procedure involving an internal R&D environment considered the *Technology Supply*, and an external business environment in which the *Technology Demand* takes place is presented in Diagram 1. In the marketing field language, this action is translated *as looking a proper customer for the products*. Technology Commercialization definition has received a growing attention in recent years, with a general acceptation either as the process of translating research knowledge into new or improved products, processes and services, and introducing them into the market place to generate economic benefits [13], the full spectrum of activities required to move a new technology, product or process from its conceptual stage to market place [14], or widely understood in its broad definition as the process of developing a product from its concept, through feasibility and implementation, to its successful introduction to a given marketing, being involved the understanding of product design, production process planning, marketing, supply chain management, financial management, accounting, and legal and regulatory management [15].

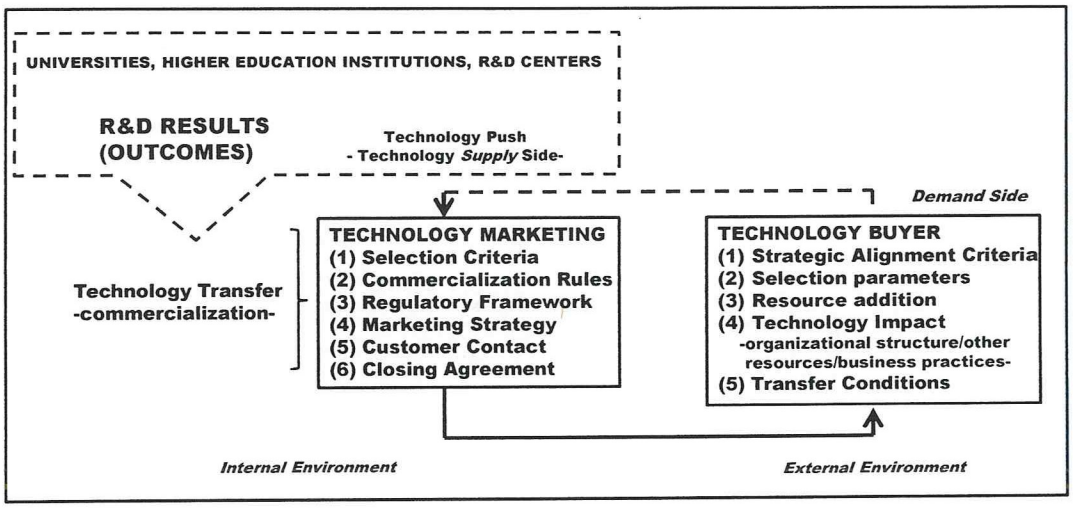

DIAGRAM 1. Technology Commercialization under the Technology Push perspective

Being technology commercialization or marketing a new function to be operated, the institutions with research outcomes must fix selection criteria and commercialization rules to follow, in order to build an operational platform for this activity which involves researchers, managers, institutional officers and agents, as well as regulatory frameworks such as copyright ownership, taxes and ownership transfer contraction. From the buyer perspective, acquiring technology solutions, resulted from research and development activities, becomes of key importance to add to the *collection of resources* inside an administrative framework [16], [17], [18], [19], which enables a firm to gain competitive advantage (Resource View Theory), considering that it is the particular combination of resources that leads to better performance when contrasted with rivals. The interaction of this external environment faced by the Research and Development institution (R&D) with the internal organizational resources both influence their strategy, its missions and goals and how it plans to achieve them. This directly impact the structure, as the lines of authority, communication and information flow adapt to changes in strategy, because technologies directly determine differences in such organizational attributes as span of control, centralization or authority, and the formalization of rules and procedures as Contingency Theory supports [20], [21], [22]. Upon this conceptual framework, a Ready-to Commercialize Technologies identification Model is described in this paper, explaining its components, stages and operational flows defined to articulate activities, roles and functions of the different actors involved in the commercialization process of technology and innovation research results.

Theoretical Framework

Embedded in the Technology Transfer concept exist a complex theoretical framework comprising Economic Theory [23], [24], [25], as the source of basic market principles such as supply and demand from which commercialization activities are explained at micro level. In the *supply* side, a second level takes the

framework to Management of Technology Theory [26] as supporter of the view of technology as a *strategic business* resource, and to the Technology Transfer (TT) concept that state that TT addresses the assessment, adoption and implementation of technology, being widely understood as the process of transferring technologies, knowledge, skills and production processes among Research and Development (R&D) Centers, universities and other institutions to users who may benefit from it in the form of new products, processes or services from which the firms generate efficiencies, productive growth and market benefits [3], [4]. On the *demand* side, Resource View of the Firm Theory provide the perspective of technology as a firm resource [16], [17], [18], [19] and Contingency Theory [20], [21], [22], as the explanatory basis for the impact of a technology in the organizational structure, processes and practices. The adequate interaction of this theoretical platform leads to the buyer decision for technology investment and to take the actions required for the technology assimilation in business practices. As Diagram 2 shows, if supply and demand matching is successful a Technology Transfer Mode is selected to close the deal. The Theoretical Framework structure explained in Diagram 2 supports the explanation of the reasons that a firm has to engage in the valuation and further selection of a particular R&D outcome to benefit with efficiencies or/and competitive advantage creation. Upon the basis of this theoretical framework, the conceptual framework presented previously is operationalized by the following Research Questions:

RQ 1. Which is the Technology Transfer Model used by a Higher Technology Education Institution, when is operating under a Technology Push perspective?

RQ 2. How is structured the institutional ready-to-commercialize identification model, -used for technology transfer purposes-, in a Higher Technology Education Institution operating with a technology push perspective?

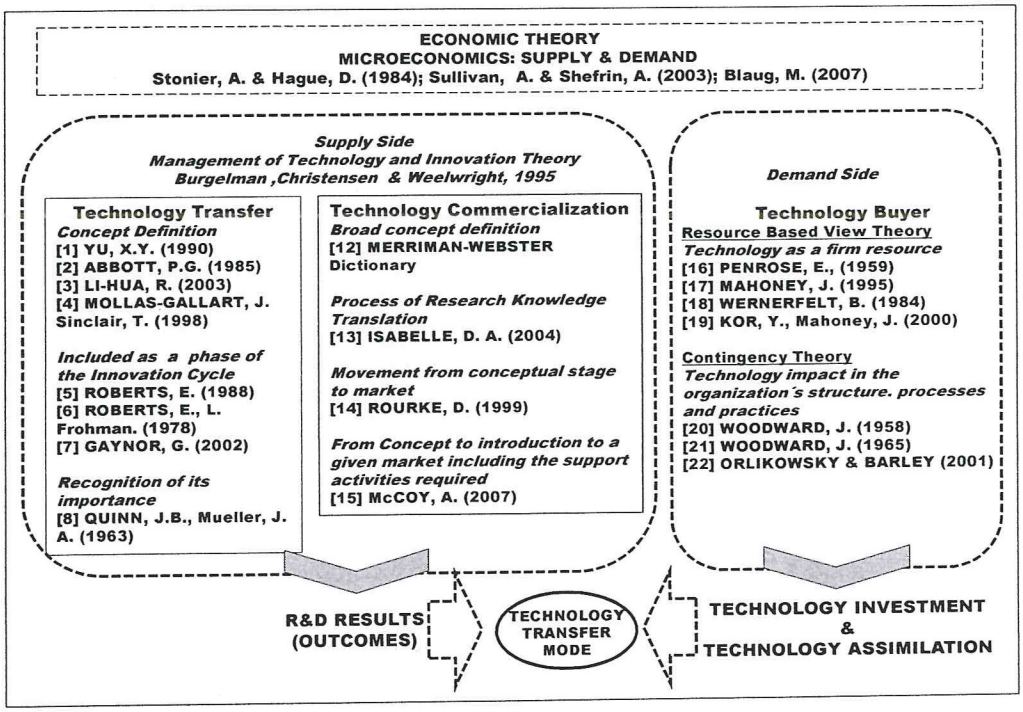

DIAGRAM 2. Theoretical Framework for Technology Transfer Model analysis

Methodology

Following Yin's [27] single case method used when empirical social research is oriented to investigate a contemporary phenomenon within its real-life context, in special when are not clearly defined the boundaries between the phenomena and the context, a Higher Technology Education Institution operating with a technology push perspective was selected as *unit of analysis*. Working at the *Institution* level of analysis is

required due to the stated characteristics of analysis related to R&D outcomes generation from the technology push perspective, technology transfer practices in operation, an organizational structure devoted to attend the liaison and technology transfer activities, operations and negotiations, and a full organizational structure working in the national territory as an operational means to manage technology and innovation efforts of researchers, students and faculty staff involved in R&D activities [28]. Due to the nature of the Research Questions, description method is used to provide clarity to the identified relationships, this method do not predetermine dependent variables but instead is focused in the complexity of the phenomenon under study as new components appear [29], [30]. Based on data analysis to develop explanations (Explanation Building) for the phenomenon studied through careful analysis of the processes identified, basic Technology Transfer activities were mapped as a Diagram and interactions among them were identified. Data collection methods included a first stage of semi structured interviews to first top level managers who attend technology transfer activities at the selected Unit of Analysis. A second stage of data collection refers to intense revision of policy documents as well as marketing information used in printed and web media, and official released data regarding TT results of the Unit of Analysis. Each set of data from the different collection methods was grouped in meaningful dimensions using Content Analysis technique to build a Condensed Roadmap Diagram from the obtained results to provide an answer to RQ 1., and a Diagram representing the Model to be described for RQ 2.

Results

The use of the Theoretical Framework as analytical means allows considering that as a component of the Management of Technology function, Technology Transfer activities are subject of managerial processes such as planning, organization or structure, integration or resources allocation, direction and control or monitoring. Considering that any Liaison and Technology Transfer Model require a basic organizational structure to be operated, in this paper this topic is considered as part of the model to be identified. Following the Management Process path in such an institution as the selected unit of analysis, the planning process leads to internal approval agreements of organizational unit creation, which are operated under the general institutional budget umbrella. Technological products derived from R&D results (tangible in nature such as consumer goods, equipment and process design) and technological services (intangible in nature as certification, technical tests, advisory, technical assistance and training) are the transfer or commercialization *subject*.

The Institutional platform for Liaison and Technology Transfer

Organizational Structure. A dynamic environment surrounding the organizational position of the Liaison and Technology Transfer activities is identified in the Unit of Analysis, suggesting the growing importance of this function. Formal activities for the transfer of R&D outcomes were initiated in 1979 with the creation of a third organizational level structure with two operating branches. The structure was modified in 1983 and in 1986 was re-structured transforming to the Academic and Technology Liaison Direction, gaining a Divisional status during 1988. After several changes in the authority chain, in 2000 acquired the *Coordination* level status with four main functions: (1) Liaison and Technology Transfer, (2) Metrology, Norms and Industrial Quality, (3) Liaison and business formation and (4) Strategic Studies. In 2001 the Technology Based Business Incubator Institutional Program was created, and in 2004 the Polytechnics Unit for Business Development and Competitiveness started operations. After several re-definition of its functions, in April of 2010 the current functions definition for the Polytechnics Unit for Business Development and Competitiveness approved works through an organizational structure leaded by a (1) *Direction* (third institutional level after the Institute´s General Direction and a Liaison Secretariat) with three direct dependencies: Internal Projects Committee, Liaison Unit and a Department of Administrative and Technical Services. In a second level are the (1.1) *Vice Direction of Enterprise Acceleration* -with the Department for Diagnosis and Enterprise Solutions and the Department of Commercial and Export Positioning- and the (1.2) *Vice Direction of Technology Development Transfer* operating the Departments of (1.2.1) Valuation and Liaison, and of (1.2.2) Technology Adoption and Assimilation and (1.3) Vice Direction of Enterprise Quality and Competitiveness. The organizational structure operating exclusively for TT purpose, presented in Diagram 3, reveal the high level of commitment of the unit of analysis in the matter. Integration has to do with resources, here, either the structure as the authority level or position of the TT Unit reveals the importance of the activity to the parent institution. This importance is also identified by the amount of financial resources required for an organizational structure of the kind.

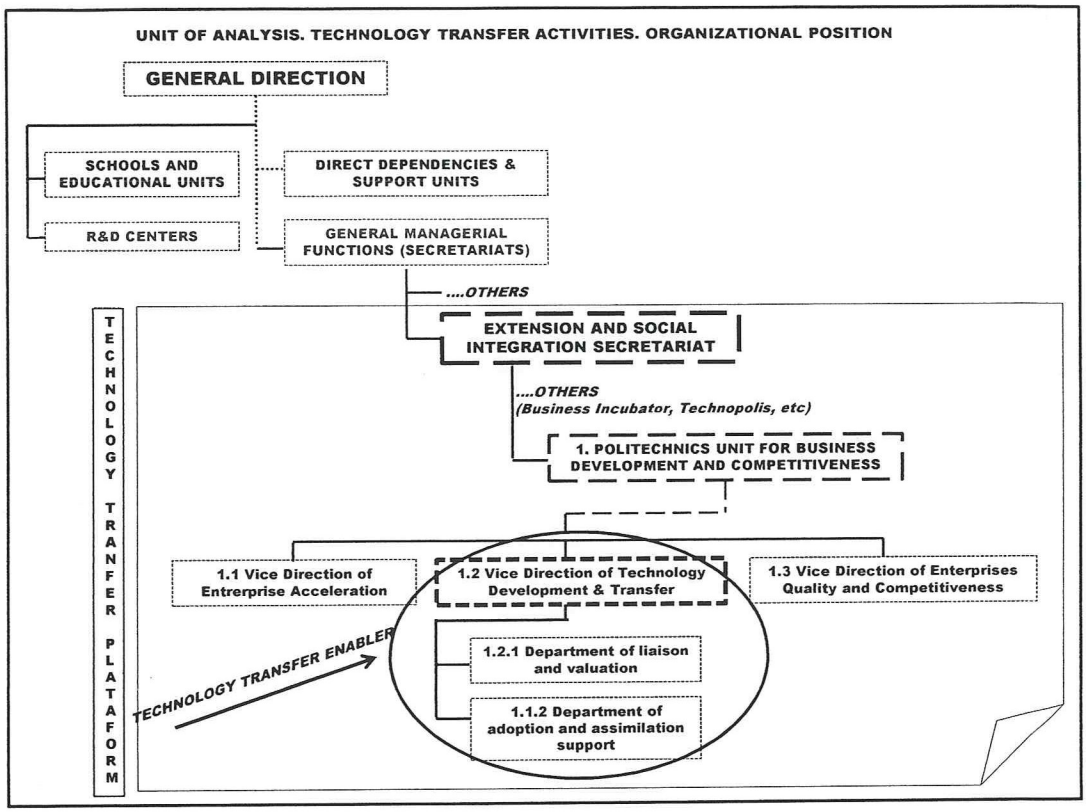

DIAGRAM 3. Technology Transfer Model operational components. Organizational Structure

Funds Sourcing and Incentive Structure for Liaison Activities. Under the Science and Technology Law (1999), the Research and Technology Development Institutional Trust was created as a means of R&D activities raise founding. Additionally 15% of the total income of each project transferred goes to this Trust. According to data provided by the TD&T Vice Director, this policy is translated to a meaningful amount of USD 235 million sourced by 1 250 Liaison Agreements signed in the time period of 2000 to 2008. In 2011 the Trust registered a growth of 48.7% in regard to the previous year, and for 2012 the growth rate was 49.5% with an estimated amount of USD 155 million in the year. This amount represents 95% of the operational budget of the Institution.

What is transferred? Liaison activities lead to the transfer of technology products and equipment organized as a technology portfolio, as well as technological services such as outsourced R&D, technical assistance, test and laboratory essays, training, quality services and consultancy among others grouped in a services catalog. This marketing tool is promoted online. As part of the transfer process, intellectual property registration services are provided to- protect ownership of technologies with commercialization potential- by the dedicated organizational unit. Technology commercialization activities are related to technology partners´ gatekeeping, development and/or revision of legal documentation and requirements for the transference of technologies and for collaborative activities as well, intangible value studies, contractual terms follow-up, technical visits to technology licensees, training and advisory, feedback to academic units for improvement development, among others. Formal transfer modes are collaboration agreement, alliances, services contract and sales contract. Market targets for the technologies available for transfer as industries such as aeronautics, cars, chemistry, Information Technology, Electric and Electronics, alternative energies, food and beverages, medical equipment, biotechnology and transportation among others. This set of activities is consistent with stages (5)-Project outcome evaluation and (6)-Project transfer of the innovation life cycle proposed by authors included on the Theoretical Framework of this paper [5], [6], [7]. Transfer activities on the matter reveal the presence of human resources playing roles of entrepreneurial championship (business opportunities identification), project leading, technical gatekeeping and market gatekeeping, following Roberts and Fusfeld findings [31]. No evidences were found regarding technology forecast, technology gatekeeping and/or written transfer regulations..

Managing R&D outcomes as Technology Supply and Potential Technology Buyers as Technology Demand

Compliance of the assigned function of the Liaison and Technology Transfer organizational unit requires following a defined operational procedure due to the complex task of managing the supply side in parallel to the demand side management. Considering that a model is the reality representation of a concept, relations, interactions and/or a phenomenon using abstractions, is feasible to develop a model of the technology transfer process followed by the unit of analysis, to be used as a Roadmap. As modeling tools include graphics, process specification tables, flow diagrams and mathematical models among others, the referred procedure can be represented using a diagram format to identify and explain its components, stages and operational flows defined to articulate activities, roles and functions of the different actors involved in the commercialization process of technology and innovation research results of 11 Regional R&D Centers, 4 Local R&D Centers and 35 Engineering/Technical Schools served by the TT platform of the unit of analysis.

The basic TT Model is presented in Diagram 3, shows four basic activities to perform in the supply side, related to marketing the liaison and technology transfer services *provided by the vice direction among the academic and R&D units engaged in R&D activities*, due to their R&D outcomes sourcing nature. As technology commercialization requires, Technology Valuation services are provided as well as Intellectual Property registry. Here is important to make clear that according to Mexican Law Intellectual Property registry is separated in two legal venues: Industrial Property (deals with patents, invention, trademarks, etc) and proper Intellectual Property focused on the ideas expression protection (books, pictures, software, etc). As seen in the Diagram, parallel to the internal activities the commercialization activities are performed, in a balancing act that covers from promotion to contact management, transfer terms negotiation, agreement/contract closing and technology adoption and assimilation. The basic Model provides a *structured representation* of eight activities performed randomly -reacting to an open and scattered supply- by the dedicated organizational units. Data collected do not provide any evidence of the existence of a strategic plan or program or agenda to carry on these activities.

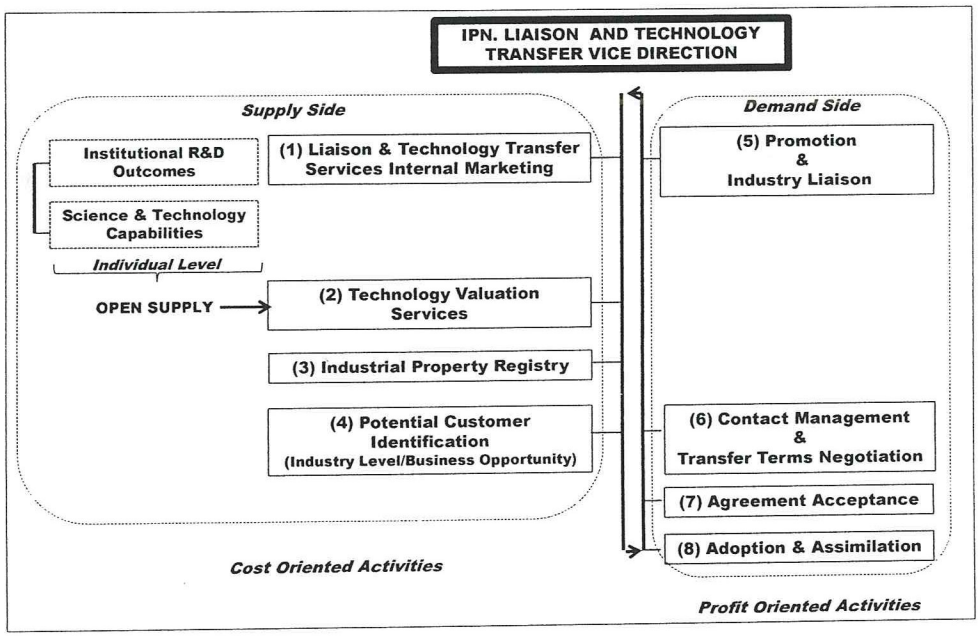

DIAGRAM 3. Basic Technology Transfer Model identified

Moving into the analysis, the basic technology transfer model identified was adjusted and detailed at operational activity level. The complexity of managing simultaneously the supply and demand sides jumps to the view in Diagram 4, where the amount of work load can be clearly appreciated giving attention to the number of organizational units (51) that are the TT universe to work with. This number suggests that a visiting agenda for all units could fill a year on a weekly basis visit, making the geographical dispersion of them an optimistic

consideration a year period for internal marketing of the services in the form of workshops, conferences, seminars and personal assistance, mainly if the specialized nature of this type of activity is bring into consideration. Parallel promotion and industry liaison activities are performed on the demand side of the model, clearly a different and expensive marketing strategy to be followed by the same organizational unit, suggesting a functional overlapping risk.

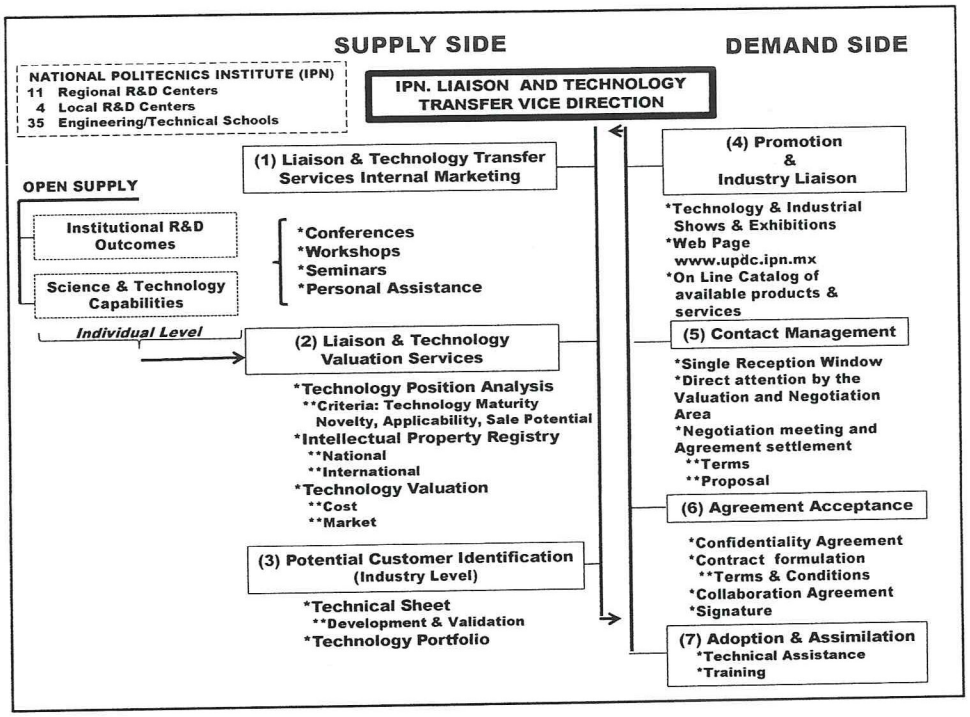

DIAGRAM 4. Detailed Technology Transfer Model identified

Within box 2, Diagram 4 provides evidence of the use of operational criteria for ready-to-commercialize R&D outcomes identification. Technology maturity, novelty, applicability and sales potential are considered as main R&D results components to enter into the commercialization process, which starts with technology valuation based on cost and market prices, if is the case. Technology value is adjusted to the identified capabilities of the potential buyer. Technology Position Analysis relates to the identification of the technology readiness to be transferred into the productive phase in order to be introduced into the market or to be used to gain efficiencies in the business processes. The *maturity* criteria relates to productive operations, while the *novelty* criteria focus on competitive advantage creation for a first user of an innovation, introducing a market notion. *Applicability* stands for the technical feasibility of the R&D outcome use and to the easiness of use by the operators during the business and production processes. A final complex criteria is *Sales Potential*, which far from the market notion of a matching demand, considers the profitability potential of the R&D outcome to be transfer. Providing a structure to these criteria is possible to develop a model to identify ready-to-commercialize technologies derived from R&D results, as is shown in Diagram 5.

The model considers that results of R&D activities are ready to enter into commercial processes when the four Production, Market, Technical and Financial business perspectives are covered, failure in any of them must be taken with caution when commercialization decision making takes place, and ethical attitudes must prevail. As observed, the four perspectives became a *set of fundamental principles* common to all R&D results aspiring to be commercialized: (1) Production Principle is the initial requirement to be considered, is the Technology Maturity parameter denoting the conclusion of the innovation life cycle and the beginning of the product life cycle on the market entering into the Market Principle domain where competitive issues take place. Parameters of the (2) Market Principle refers to a) Technology Novelty required for firms engaged in market leadership strategies to create and sustain competitive advantages over their competitors due to the uniqueness of

the technology acquired [32]; b) Technology Applicability considered as in Davis´[33], [34] Technology Adoption Model (TAM) premises in which Perceived Usefulness and Perceived Ease of Use drive potential users´ intention to adopt technology as business processes enabler. These premises relate to the firm´s intentions to reach their strategic goals and to Technology Easiness to implement and to use by the final operational user. So far the Model has gone through a Technology Maturity-Technology Novelty-Technology Applicability continuum, follows the Technical Principle identified by a single complex parameter of Technical Feasibility for implementation and routine operations. At the end of the continuum is the Financial Principle in which the parameter to be consider is the sales potential. Here this parameter is ahead of potential customers or market consideration, stands for the *profitability* potential to be harvested from a unique sales operation, license agreement, royalties from use or any/the best Technology Transfer mode. The four Principles articulate the Model and the five Parameters provide a valuation framework to identify the ready-to-commercialize- Technological outcomes of the R&D activities performed under technology push conditions.

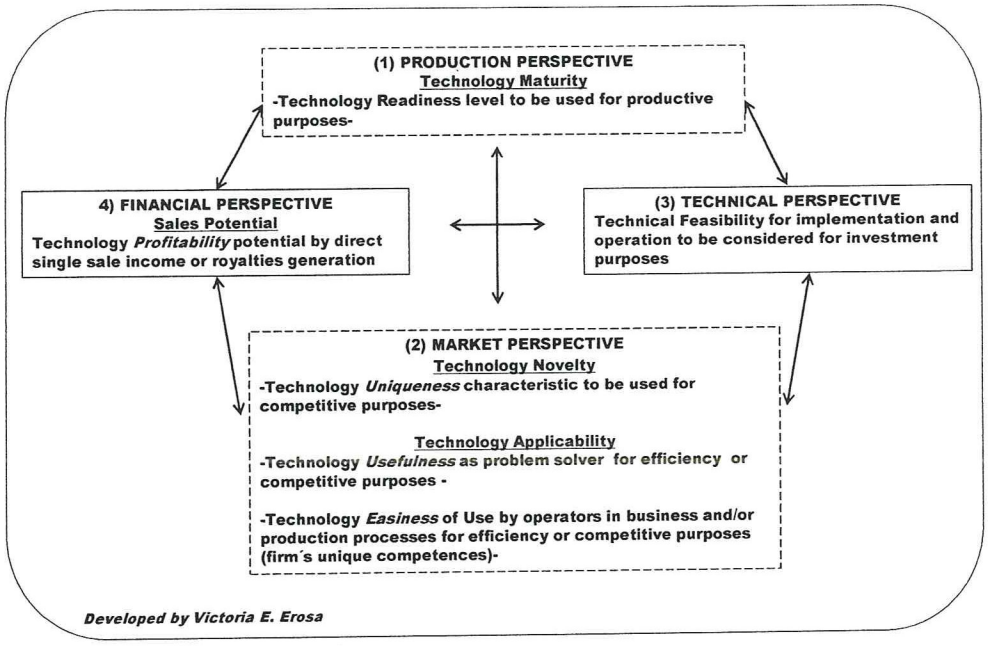

DIAGRAM 5. Principal Components of the Technology Commercialization Readiness Identification Model

Conclusion

This paper explores the Technology Transfer concept application under a context of technology push. Presenting a model from the technology provider, as an initial action followed currently, by research activities that will provide support to analysis based on the buyer´s point of view. Upon the basis of a complex theoretical framework as analytical means, a dual model dealing with the supply side and the demand side in parallel was identified, suggesting a functional overlapping in the operational process. This finding answers RQ 1. As both supply and demand are two types of organization: R&D/academy and Industry/Firms, it is expected that each one´s objectives differ creating a mismatch atmosphere for the transfer process, as identified by recent research results [35] that shows for the industry a culture profile market focused with core values settled in competitiveness and productivity, while Academic Institutions performance suggests the presence of a strong type of culture related to risk aversion and reactive behavior consistent with technology *Hierarchy Culture type* based on rules, specialization, separate ownership and impersonality, that support their structured operations.

Supported by a complex Theoretical Framework, the analysis reveals that the an institutional ready-to-commercialize identification model -here termed as Technology Commercialization Readiness Identification

Model- is a component of a general Technology Transfer Model that includes an operational organizational structure for dedicated resources management, a financial mechanism with defined operating rules and as well as a legal support to deal with Transfer Modes and intellectual property issues. The general model is focused on TT *managerial processes*, finding consistent with the broad definition of Technology Transfer considered as the process of developing a product from its concept, through feasibility and implementation, to its successful introduction to a given marketing, being involved the understanding of product design, production process planning, marketing, supply chain management, financial management, accounting, and legal and regulatory management [15].

Focusing conclusions on RQ 2., analysis results conducts to the modeling of an structured institutional Technology Commercialization Readiness Identification Model, described in this paper, based on the a set of principles regarding production, market, technical and financial perspectives. Upon this structure a derived set of parameters plays as operational means for the performance indicators definition for each case under decision. The Model is focused on the *characteristics* of the R&D outcome for transfer decision making, *being a component* of the General institutional TT Model, as presented in Diagram 6.

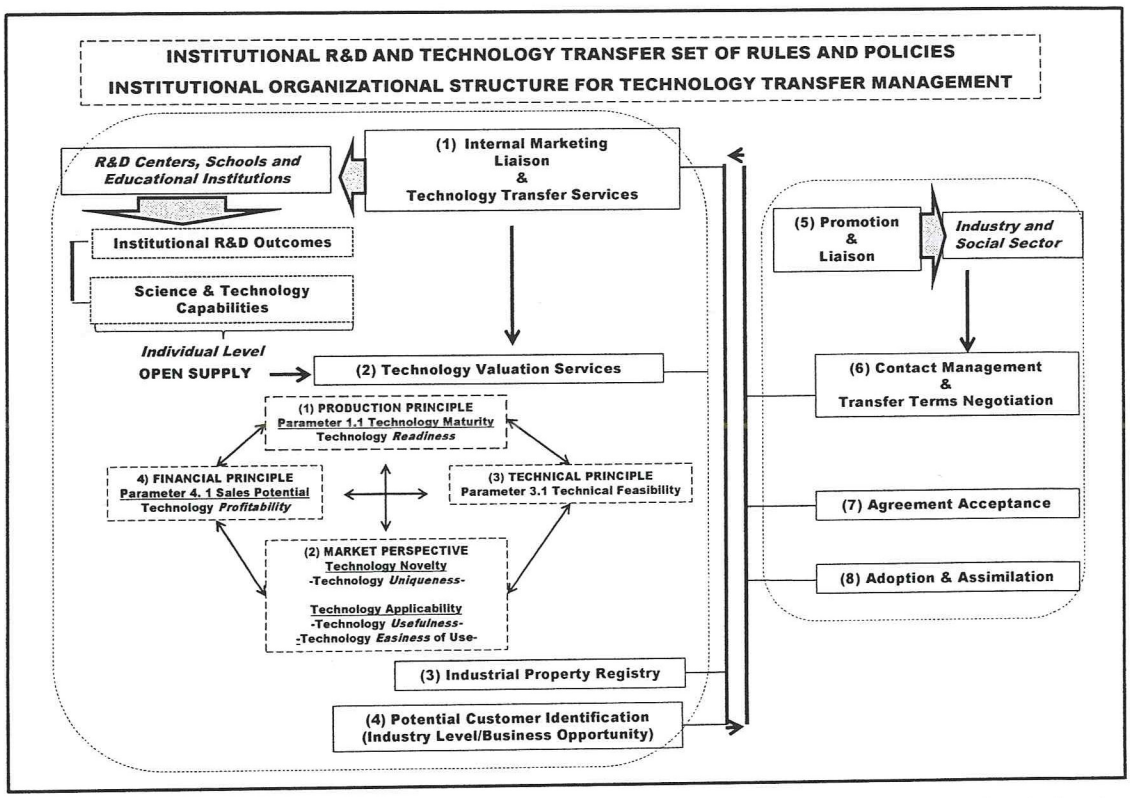

DIAGRAM 5. Position of the Model to identify ready-to-commercialize Technology results derived from R&D activities in the General Institutional Technology Transfer Model

Implications for Further Research

Research in Technology Transfer field is a wide opportunity area to learn about the array of practices followed for technology commercialization. Recognizing that no single model applies for all R&D contexts or business environment, understanding the models typology and the differences in applications is a key issue to create knowledge for Management of Technology Theory. As a first contribution of the kind, replicas of this research may be conducted in other countries, and extended research for intensive analysis of the model´s components interactions, performance indicators development and the exploration of technology transfer models operating under the demand pull perspective are in the agenda.

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