Reverse Knowledge Transfer Barriers and Innovation Value Chain Performance in the New Product Development under Uncertainty and Unpredictability

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Abstract

The present paper aims to contribute to the planning policy in knowledge transfer in Multinationals Enterprises. To achieve that, it presents a multi-model proposal to assess the effects of knowledge transfer process barriers on the innovation value chain performance in product development process (PDP) under uncertainty and unpredictability, according to the following phases: Phase 1: Modeling to assess the performance of knowledge transfer barriers in relation to the overall knowledge in innovation value chain (Multinationals Companies); Step 1: Identification of knowledge; Step 2: Identification of knowledge transfer barriers; and Step 3: Evaluation of the performance of knowledge transfer barriers in relation to the overall knowledge in innovation value chain in PDP - Multinationals Companies. And Phase 2: Modeling of the Optimal Efficiency Rate effective of Reverse knowledge transfer of innovation value chain (Multinationals Companies). The research focus was developed based on the literature and involved the intervention of experts on the study subject, which were selected using technical-scientific criteria. The data were collected through an assessment matrix, which the experts used to issue their opinions on all variables. To reduce subjectivity in the results, the following methods were used: Law of Categorical Judgment - psychometric scaling (Thurstone, 1927); Compromise Programming, Electre III and Promethee II - multi-criteria analysis; and Neurofuzzy Technology. The mains results obtained demonstrated that.

Keywords: Assessment; Knowledge transfer barriers; Innovation value chain; Multinationals.

Introduction

Recently, relevant changes have made organizational boundaries more fluid and dynamic in response to the rapid pace of knowledge diffusion (Abrahamson, 1991; Griliches, 1990; Teece, 1986), and innovation and international competition (Chesbrough and Rosenbloom, 2002; Christensen, 2003; Damanpour, 1996). This helps to reconsider how to succeed with innovation (Teece et. al., 1997; Teece, 1986; Wheelwright and Clark, 1992). Thus, innovative companies make use of their capabilities to appropriate the economic value generated from their knowledge and innovations (Griliches, 1990; Teece, 1986). Therefore, the supply of innovative products is presented as a quality standard in the race for pressing demands. It is true that a new product or process can represent the end of a series of knowledge initiatives and the beginning of a process of value creation, which, under conditions imposed by various parties, can produce efficient results in the global performance of the value chain, reaching not only businesses that innovate, but also correlated companies.

The value chain management – VCM has for quite some time presented challenges within a wide diversity of extremely complex events, all of which in an unsure and risky context that can affect the flux of decisions and the desired levels of performance, hence frustrating expectations for stability. It must be acknowledged that risks can be brought about from different origins and scenarios. (Cheng, Yeh, and Tu, 2008; Power, 2005; Blos, et. al., 2009; Fawcett, et. al., 2009; Godsell, Birtwistle, and Hoek, 2010). The characteristics of the value chain differ a great deal, therefore becoming the object of analysis equally differentiated. It is imposed thus that the efficiency in the planning of the value chain propitiates more efficient decisions, diminishing the improvisation and improvement of the involved team. Traditionally, the planning phase "sins" when it is elaborated without support of the knowledge that really is essential in the management of the value chain. The present paper aims to contribute to the planning policy in knowledge transfer in Multinationals Enterprises.

Whilst recent research in the management domain presents an extensive overview of possible knowledge transfer facilitators and barriers (Argote, 1999; De Long and Fahey, 2000; Gupta and Govindarajan, 2000; Kogut and Zander, 1996; Michailova and Husted, 2003; Minbaeva et al., 2003; Riege, 2005; Riege, 2007). Thus, the knowledge is crucial for a multinational enterprise to enhance its competitiveness and to differentiate itself from the competition. Therefore, the multinational enterprise is required to continuously create, implement and leverage knowledge efficient and effective across the organisation (Teece et al. 1997).

Historically, knowledge has been transferred from headquarters to subsidiaries in a forward knowledge transfer (Patel and Pavitt 1991; Vernon, 1966). However, scholars recognised that multinationals enterprises are required to fully exploit skills and capabilities of national subsidiaries in order to remain competitive by combining the capabilities of the whole network (Kogut and Zander 1992). Subsidiaries are able to tap local markets for new knowledge which will be diffused and exploited within the multinationals enterprise innovation value chain. This knowledge can help the multinational enterprise to define and influence global strategies. Knowledge transfer crosses borders and is evident in significant benefits frequently quoted in theoretical excerpts, frequently turned into return in the investments made; market participation and efficiency in the production process (Kaplinsky, 1976; Niosi, Hanei e Fiset, 1995). Knowledge transfer can be distinguished between an individual, an intra-organizational, and an inter-organizational level. It is a fact that the opportunities come along with risks and uncertainties that come from factors unfavorable to the knowledge transfer process (KTP), which, frequently confronted with social-economic and political problems are not so easily identified (Reisman, 2006; Glass and Saggi, 1998; Pack and Saggi, 2001; Madu, 1988; Madu and Jacob, 1989). These factors are structurally dependent and, as such, have to be analyzed according to the reality of each country (Madu, 1989; Kaplinsky, 1976). The survival capacity of the new knowledge will also depend on how well it will deal with the host system; moreover, it is feasible that the new knowledge may present a common incremental value to the countries. This also depends on the capacity of the integration of the knowledge to the cultural systems and values of the host country, which in its usual form are complex and require careful analysis. To achieve that, it presents a multi-model proposal to assess the effects of knowledge transfer process barriers on the innovation value chain performance in product development process (PDP) under uncertainty and unpredictability. The work is divided according to the following sections: Methodology; Conceptual model verification and underlying analyses, Managerial implications, and Final words.

Methodology

Conceptual Model: Constructs and hypotheses

This section examines the conceptual model (Fig. 1) and presents the hypotheses to be tested throughout this work.

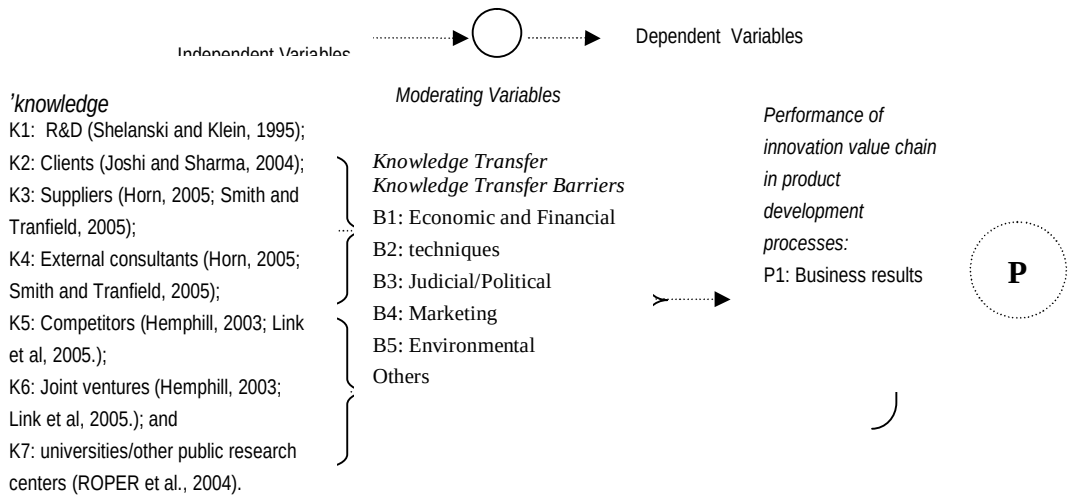

Fig 1: Conceptual model

The building-up and managing of the value chain require highly complex analytical approaches, which include subjective elements. Hence, the technical mastery of various technological, legal, financial and political aspects and procedures are required.

Knowledge can represent a strategic tool, increasing the institutional capacity of both the Public Sector and the Entrepreneurs to assign the formulation, evaluation and execution of such projects. The Knowledge factor could work as an instrument that facilitates improvement, contributing to the quality of services and enhancing the agility to decide. Thus, the knowledge transfer from the developed countries or multinational corporations to less developed countries has received increased attention as evidenced by the numerous publications in this area. The success of the introduced knowledge in satisfying the stated needs and objectives will be an incentive for further advancement in knowledge can only be achieved through innovation and research and development. The objectives and perspective of "success" in knowledge transfer process are defined differently by the different actors involved in the transfer process in the innovation value chain (customers, competitors, suppliers, government, others enterprises). Studies of knowledge transfer have, traditionally, cited the following major factors as affecting the success of the knowledge transfer process: environmental characteristics of the knowledge transferor and acquirer, the mechanism of knowledge transfer, and the nature and sophistication of the knowledge itself.

The identification and analysis of barriers in the process of knowledge transfer requires a comprehensive concept of knowledge transfer to not obstruct the view of potential transfer barriers a priori. In multinationals enterprises, knowledge can be generated in various parts and transferred to diverse parts of an interconnected network of organisational units (Bartlett and Ghoshal, 1989; Hedlund, 1986; Holm and Pedersen, 2000). Transferring knowledge between units and people can create significant learning benefits and is a ‘‘powerful mechanism for improving an organisation’s productivity and increasing its survival prospects’’ (Argote, 1999). In spite of this, there are numerous examples where knowledge transfer practices have not accomplished their objectives to manage firms’ intangibles, including knowledge, which is mainly due to the large diversity of barriers. A large number of authors identified diverse barriers to transferring knowledge within and across organisational units (e.g. Argote et al., 1990; Baron and Markman, 2000; Davenport and Prusak, 1998; De Long and Fahey, 2000; Riege, 2007).*Independent Variables:* The independent variables were extracted from the specialized literature and assessed by experts for confirmation. The following independent variables were identified: Stakeholders’ knowledge: C1: R&D (Shelanski and Klein, 1995); c2: Customers (Joshi and Sharma, 2004); c3: Suppliers (Horn, 2005; Smith and Tranfield, 2005); c4: External consultants (Horn, 2005); c5: Competitors (Hemphill, 2003; Link et al, 2005); c6: Joint ventures (Hemphill, 2003.); and c7: universities/other public research centers (Ropper et al., 2004). For the Customer dimension, the construction used is based on Joshi and Silva (2004). For the suppliers variable (Horn, 2005; Smith and Tranfield, 2005), the content was derived from the construction used by Dow et al. (1999) and Forza and Filippini (1998). For the R&D variable, the construct was mainly derived from Shelanski and Klein (1995); GUPTA, Wilemon, and Atuahene-Gima (2000) and Chiesa et al. (1996), which capture two important R&D aspects: capabilities and connections. As for the variable External Consultants, the construct is based on Horn (2005); Smith and Ranfield (2005). The variable Competitors is based on Hemphill (2003); Link et al (2005). Finally, the variable Joint Ventures is based on Hemphill (2003) and Link et al (2005).

Moderating Variables: The dimensions extracted from the specialized literature for the moderating variable were as follows (Niosi, Hanel e Fiset, 1995), B1: Economic and Financial; B2: techniques; B3: Judicial/Political; B4: Marketing; and B5: Environmental.

Dependent variables: Once it is validated that the performance of innovation value chain in the PDP contains multifaceted aspects, a construct is used to measure the performance of the innovation value chain in the PDP. The dimensions extracted from the specialized literature for the dependent variable - Performance of the innovation value chain in PDT - is as follows: P1: Customer Impact; P2: Business results and; P3: Sales percentage derived from new products. The following hypotheses were formulated using the conceptual model:
Hypothese: The Knowledge Transfer Barriers have effect on the performance of innovation value chain in the process development product, in innovation value chain (Multinationals Companies).

Sample and Data Collection

The objective of this study is to identify the effect of reverse knowledge transfer barriers on the innovation value chain performance in product development process (multinationals companies). This research treated Brazil’s high-tech industries as the empirical targets. The researcher selected the more well-known firms. The data collection was performed using a scale/matrix assessment questionnaire.

The technique used was the stated preference, taking into account that these methods work with the preferences of the decision makers, revealed by the choice made among the alternatives selected from a set of real alternatives, or not. In this classification framework, the research interviews and consultations with the experts are highlighted. With this procedure, the information collected can be set apart in different parts by adjusting the phases and steps of the model. In the data set collected it was necessary to apply a removal cleaning procedure called filtering, to first eliminate inconsistent and incomplete data, and secondly, to discard data that are irrelevant to the model. This enabled a better analysis of the variables involved, and also to obtain improvement in the quality of the data provided to the model. This removal procedure used the psychometric scaling method of the Law of Categorical Judgments. All of the variables were measured by multiple questions to ensure reliability, and were measured with a Thurstone scale whenever possible.

Before applying the final collection instrument, a pretest was conducted with five experts to clarify whether the instructions were clear and objective; to verify that the questions were objective and without interpretation ambiguity; and to investigate possible comprehension problems by the experts on the expected responses. There were few adjustment suggestions. Next, a survey was conducted with 20 experts, selected according to their technical-scientific criteria. The researcher regarded the new product project managers, experienced product planning personnel, innovation managers, organizational managers, R&D managers, knowledge managers, planning, and modeling managers. The targeted respondents of the survey were senior product development managers, vice presidents and directors. The background education of most engineers is in engineering, business administration, economics, engineering and management, business administration and economics, engineering and economics, their ages ranged between 27 and 65. They were requested to fill out the questionnaire. A general mapping of the specialists was conducted in order to ensure better accuracy and consistency in the quality of the results to be achieved with the answers, and also to ensure plausible outcomes. Cury (1999) recommends a sample of twenty to thirty experts. The data collection instrument was sent to thirty-five experts. Of this total, twenty returned answered.

Conceptual Model Verification and Underlying Analyses

This section presents the verification procedures for the conceptual model. The procedures are systematized in the following steps:

Phase 1: Modeling to assess the performance of knowledge transfer barriers in relation to the overall knowledge in innovation value chain (Multinationals Companies);

Step 1: Identification of knowledge;
Step 2: Identification of knowledge transfer barriers; and
Step 3: Evaluation of the performance of knowledge transfer barriers in relation to the overall knowledge in innovation value chain in PDP - Multinationals Companies.

Phase 2: Modeling of the Optimal Efficiency Rate effective of Reverse knowledge transfer of innovation value chain (Multinationals Companies).

The procedures are detailed below:

Phase 1; Modeling to assess the performance of reverse knowledge transfer barriers in relation to the overall knowledge in innovation value chain. This section evaluates the performance of reverse knowledge transfer barriers in relation to the overall knowledge in innovation value chain. The procedures are systematized in the following steps:

Step 1: Identification of knowledge: Thus, the data were first extracted from the specialized literature. Thus, the knowledge from diverse backgrounds and scenarios, directly and/or indirectly involved with the PDP in the innovation value chain in PDP were identified: (i) research and development - R&D (Shelanski and Klein, 1995); (ii) Customers (Joshi and Silva, 2004); (iii) Suppliers (Horn, 2005; Smith and Tranfield, 2005); (iv) External consultants (Horn, 2005; Smith and Tranfield, 2005); (v) Competitors (Hemphill, 2003; Link et al, 2005.); (vi) Joint ventures (Hemphill, 2003; Link et al, 2005.); and (vii) universities/other public research centers (Roper et al., 2004).

Step 2: Identification of knowledge transfer barriers: The barriers were extracted from the theoretical excerpts and combined with several methods, in which more than 290 titles were selected thus, a systematic review of international theoretical excerpts on the investigated topic was conducted, in which experiences and study cases, either successful or failed, in knowledge transfer were analyzed. Soon after this procedure of identification of barriers, the next step was the application of filters and organization of the barriers in clusters for a better comprehension. The clusters and their sub-elements were submitted to trial by specialists with knowledge on the object of study, selected by techno-scientific criteria. The data were extracted by means of a scalar-type matrix of judgement, in which the experts put their impressions, establishing priorities by importance, designating values to the barriers. Parallelaly to the theoretical excerpts, the following methods to identify the barriers in the knowledge transfer were used: *Environmental analysis; Structural analysis of the industry; Consult with experts (business); and Time /intuitive factors.* The research was oriented to multinationals companies. It should be highlighted that the intervention made by experts was determinant in the judgment of the barriers. It was identified over 245 barriers in knowledge transfer. After this procedure, the next step was to group the barriers in the knowledge transfer conducted by means of the Thurstone's LJC psychometric scaling method.

The method allows a scale by importance. Thus, let πij = Prob [O_i Î C_1 U C_2 U ... U C_j], the probability of stimulus Oi located in one of the j first categories ordered increasingly C_1, C_2, ..., C_j. It can be written that πij = Prob [O_i Î C_1 U C_2 U ... U C_j] = Prob [ei £ nj]. With the hypotheses formulated, it follows that:

$$\pi ij = Prob[\varepsilon i - nj] = Prob\left[\frac{(\varepsilon\varepsilon - nj) - (\mu\mu - cj)}{\sqrt{V(\varepsilon(-nj)}} \le \frac{(\mu\mu - cj)}{\sqrt{V(\varepsilon(-nj)}}\right]$$

$$\pi ij = Prob\left[\boldsymbol{N(0,1)} \le \frac{(\mu\mu - cj)}{\sqrt{V(\varepsilon(-nj)}}\right]$$

That is:

Where πij is an estimator of πij and considering value Z_{ij} such that, $Prob[N(0,1) \le Zij] = \hat{\pi} ij$, we have

$$\frac{(\mu\mu - cj)}{\sqrt{V(\varepsilon(-nj)}} = -\boldsymbol{Zij}$$

, Where μμ is value of scale.

The experts (judges) express their preferences with pairs of stimuli (knowledge), and these were submitted to the ordinal categories C1=5th place; C2=4th place; C3= 3rd; C4=2nd place; C5=1st. These events occur in different moments, in which the scale values vary depending on the dynamics of their own mental process, which result in replacing the idea of preference for the probability of preferences. The procedures to apply the instrument are systematized in the following steps: Step 1: Determining the frequencies of preferences for pairs of stimuli (reverse knowledge transfer barriers), where O_i is equal to Knowledge and O_j to the experts – $O_i]O_j$.

The systemized data were extracted from the experts' preference regarding barriers (through field research using an assessment questionnaire/matrix). Knowledge appears as stimuli submitted to the ordinal categories. Step 2: Determination of the frequencies of ordinal categories, based on the data extracted from the previous step. The matrix [πij] of the cumulative relative frequencies is then calculated. The results are classified in ascending order of importance. To better understand the technique, we recommend the following literature (Souza, 1988; Thurstone (1927). Step 3: To determine the matrix [πij] of the cumulative relative frequencies from the results of the frequencies of ordinal categories we calculate the matrix of the cumulative relative frequencies. Step 4: To determine the inverse of the standard normal cumulative frequencies (INPFA), from the results obtained in the previous step, calculate the inverse of the standard normal cumulative frequencies.

The results reflect the experts' preference probabilities in relation to stimuli (barriers). Considering that C1 contains less intense stimuli than C. In a psychological continuum the stimuli are translated by scale values of μi and the categories (C1, C2, C3...), by an interval partition of the real line, such that C1 is represented by the interval (-∞, C1) and C2 represents the interval (m-1, + ∞). The result of preferences is then presented in order of increasing importance.

The scale showed the experts' intensity probability of the preferences, by importance, regarding the knowledge transfer barriers on the innovation value chain in PDP. The next step was to group the barriers in the knowledge transfer for better comprehension and interpretation. The rearrangement was made by clusters or pairing, meeting the "principle of arborescence", which allows the unfolding of the barriers in the reverse knowledge transfer in different processes or involved areas, but always observing the pertinence relations. The results are detailed to follow - *Grouping of barriers:* B1: Economic and Financial; B2: techniques; B3: Judicial/Political; B4: Marketing; and B5: Environmental (Figs. 2 – 6).

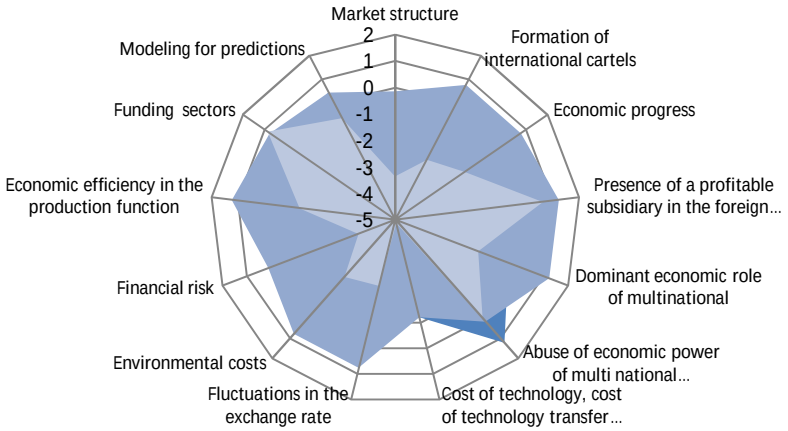

Fig. 2: Economic and Financial – Reverse Knowledge Transfer Barriers

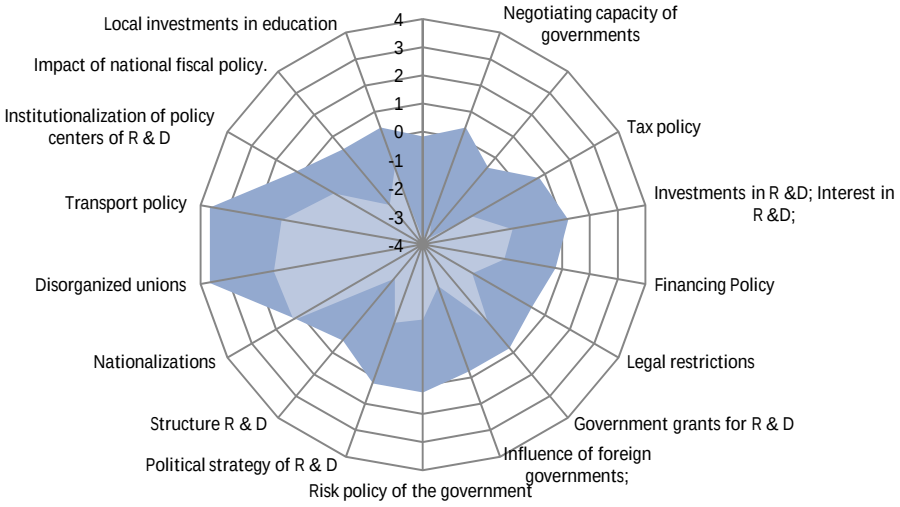

Fig. 3: Political – Reverse Knowledge Transfer Barriers

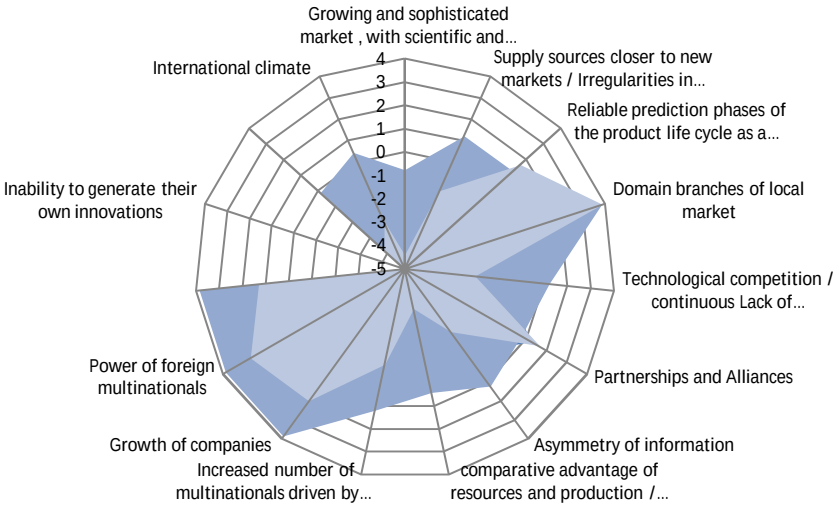

Fig. 4: Marketing – Reverse Knowledge Transfer Barriers

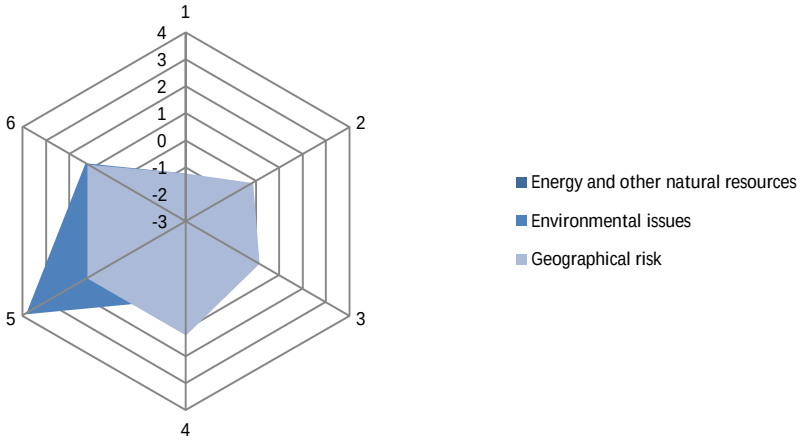

Fig. 5: Environmental – Reverse Knowledge Transfer Barriers

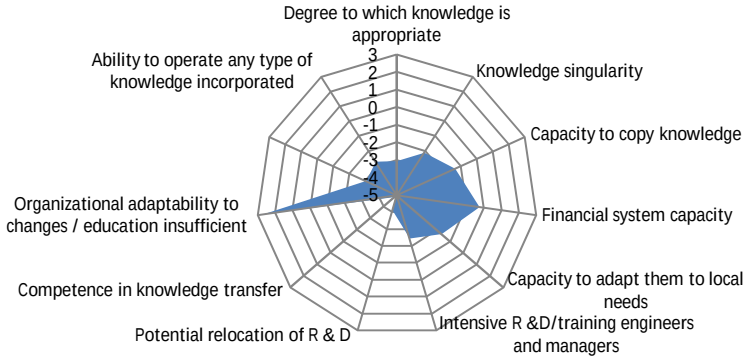

Fig. 6: Technical – Reverse Knowledge Transfer Barriers

Knowledge transfer has been proclaimed as one of the most critical activity between subsidiaries and multinationals. Factors such as socio-political and cultural value systems affect knowledge transfer. The emphasis on the socio-political and cultural value systems of the receiving countries shows that structural factors can influence the success or failure of technology transfer. Factors that lead to the successful transfer of knowledge (Madu, 1989): The *Needs and Objectives* have to be realistic and achievable. Clarity in the objectives further improves the ability to implement and evaluate. *Capabilities:* The capabilities identified can be in terms of human resources, capital, natural resources, land and others. Some of these capabilities will enhance the growth of particular industries and make it cheaper to transfer certain forms of technology. A nation should also consider its weaknesses and explore the possibilities of improving them over time. *Education, Training, Research and Development: The* educational system adopted has to be appropriate to the needs of the developing country. Stresses the barriers of culture and language differences. R & D is important and demands adequate attention if knowledge transfer is to succeed. *Identification and Implementation of Appropriate Knowledge* This issue has received great attention; as has often happened, the multinationals are blamed for transferring inappropriate knowledge.

This is because the technology is often capital intensive and ill-suited to the local production needs.' The success or failure of knowledge transfer also depends on the ability of the receiving nation to identify the right technology for its needs. Management Process . *The management process* is a very important aspect of knowledge transfer. An effective management of knowledge and the knowledge process is necessary if the knowledge is to succeed. By this is meant the management of processes (i.e. production processes), of human resources, and of capital. An effective management will lead to an efficient utilization of limited resources. Innovation through R & D can also be enhanced through effective management. The knowledge transfer is a function of the corporate culture and management culture of the firm. *The Role of Public Policy* Some have argued that public policy affects the transfer of knowledge, Governments can therefore have a signiftcant impact on promoting or hindering the transfer process.

The extensive literature in this area shows the great importance of R & D to the successful transfer of knowledge. Knowledge transfer is strongly affected by the relationship between source and recipient. On the one hand, it has been proved that cultural factors affect the transfer of knowledge. Culture variances in behavior can be easily observed whenever it comes to cross-cultural interaction in business or in private issues; this is also true for the transfer of knowledge. Culture in this sense is a system of collectively held values. Knowledge transfer between individual people, suppliers, client and others, as well as subsidiaries and multinationals enterprises often form a key component of knowledge management programs and can create significant short- and long-term operational and learning benefits. Further, there is evidence that multinationals enterprises that effectively manage and transfer their knowledge are more innovative and perform better. The robust results indicate that reverse knowledge transfer barriers to subsidiary increases the knowledge transfer process performance and innovation value chain, in PDP, multinationals enterprises.

Step 3: Evaluation of the performance of knowledge transfer barriers in relation to the overall knowledge in innovation value chain in PDP - Multinationals Companies

This step evaluates the performance of knowledge transfer barriers in relation to the overall knowledge in innovation value chain in PDP - Multinationals Companies. This procedure was developed using the multi-criteria analysis (Fig. 7).

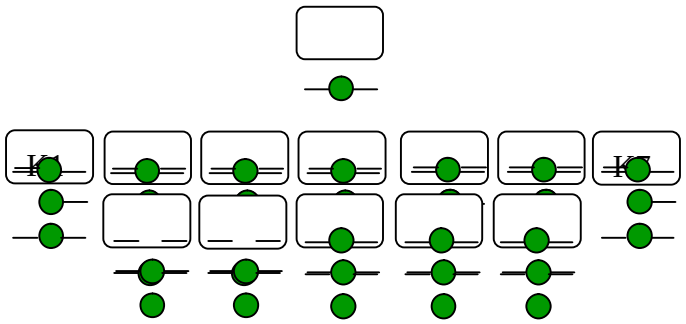

Fig. 7: performance of knowledge transfer barriers in relation to the overall knowledge in multinationals enterprises

The methods used were *Compromise Programming, Electre III and Promethee II*. The results achieved confirm *Hypothesis 1:* The knowledge transfer barriers have effect on the performance of innovation value chain in PDP, multinationals companies, and assigning values to each criterion, we arrive at a matrix of Criteria x Alternatives that together with the vector weights provides the necessary support to apply the multicriteria methods. In other words, one applies the selection and classification methodology of alternatives, using the *Compromise Programming, Promethee II and Electre III* methods. The *Compromise Programming* due to its wide diffusion and application simplicity and understanding renders it an alternative to evaluate problems as referenced in this application. The problem solution compromise is the one that comes closest to the alternative. This method was designed to identify the closest solution to an ideal one; therefore it is not feasible, using a predetermined pattern of distances. In *Promethee II* there is a function of preferences for each criterion among the alternatives which must be maximized, indicating the intensity of an alternative to the other one, with the value ranging from 0 to 1. Of the *Electre* family *(I, II, III, IV and V), Electre III* is the one considered for the cases of uncertainty and inaccuracy to evaluate the alternatives in the decision problem. All these methods enable to analyze the discrete solution alternatives, and taking into consideration subjective evaluations represented by numerical scores and weights. As these are problems involving subjective aspects, the methods that best fit the situation of this research are the methods of the family Electre and Promethee.

It should be mentioned that although the Compromise Programming method is not part of this classification, it has similar characteristics, showing much simplicity in order to understand its operation, which makes it feasible for this application. Within this perspective, the multicriteria methods are viable instruments to measure the reverse knowledge transfer barriers for the performance of innovation value chain, in multinationals companies. The results produced by this prioritization enable managers to better focus their efforts and resources on managing the capacities that perform best, which results in achieving the goals sought by the companies The structure of this prioritization (classification by hierarchical analysis) is proposed at three planning levels in a judgment matrix, in which at the first hierarchical (P1: Performance - Business results) structure level it defines the goal, which is to achieve the performance of the companies that will feed the system; the criteria are in the second level, which are the performances of the companies – Knowledge: K1: R&D (Shelanski and Klein, 1995); K2: Clients (Joshi and Sharma, 2004); K3: Suppliers (Horn, 2005; Smith and Tranfield, 2005); K4: External consultants (Horn, 2005; Smith and Tranfield, 2005); K5: Competitors (Hemphill, 2003; Link et al, 2005.); K6: Joint ventures (Hemphill, 2003; Link et al, 2005.); and K7: universities/other public research centers (ROPER et al., 2004). The dimensions of knowledge transfer barriers are in the third level, the alternatives, which are – Reverse knowledge transfer barriers: B1: Economic and Financial; B2: techniques; B3: Judicial/Political; B4: Marketing; and B5: Environmental. The prioritization process obeys the judgment of the evaluators (experts). With the results of the judgment matrix, the methods were applied: *Promethee II, Electre III and Compromise Programming* to evaluate the innovation capacities in relation to the performance of the companies. Tab. 1 shows the results produced.

Tab. 1: Assessment of preferences – Reverse knowledge transfer barriers x Performance of Innovation value chain - multionationals companies

REVERSE KNOWLEDGE TRANSFER BARRIERS	CLASSIFICATION		
	PROMETHEE III	COMPROMISE PROGRAMMING	ELECTRE III
B3: Judicial/Political	1ª	1ª	1ª
B4: Marketing	2ª	2ª	3ª
B1: Economic and Financial	3ª	3ª	2ª
B2: techniques	4ª	4ª	2ª
B5: Environmental	4ª	4ª	3ª

The results produced by the methods demonstrate the reverse knowledge transfer barriers political and marketing as the most significant ones to ensure the performance of the value chain/in multinationals. In view of past experiences in the international and Brazilian scope, the high-level of Political Factor preferences is justified. Undoubtedly, political instability brought forth discontinuity of great and sound projects.

Oftentimes, political instability has created immeasurable systematic crisis, thus planting public policies, investments, projects, programs and State guidelines in second place. The lack of political guidelines to make viable infra-structure investments, together with strong fiscal restrictions has caused the State to be left in an unbearable situation. This has resulted in growing patrimony degradation and installed an efficiency loss, thereby rendering the country to an obvious deterioration of economic infra-structure, resulting in the loss of efficiency and competitiveness, thus jeopardizing national growth and development. With this scenario, having defined the political factor and its components, it is possible to understand the information that is included in the macro guidelines defined by public policies; the strategic decisions of the governing body, regulating agencies and its qualified entities to regulate, legislate and hire, among others.

To sum it up, by developing this factor, it is possible to understand information referring to: (i) the guidelines for strategic planning of infra-structure development, supporting the partnership proposals; (ii) the strategic objectives to be reached by PP; (iii) the national politics of knowledge transfer, within the context of other options for infra-structure financing: the institutional organization (central and decentralized units of knowledge transfer; (iv) commitments of the different levels of government with the objectives, guidelines and instruments of the knowledge transfer policy;(v) assurances of effective cost and risk advantages for the government; (vi) maintenance of government policy and space for public policies; (vii) the process of communication and accountability (viii)matters of transition and working rights in sectors predominantly operated by public servants; (ix)political stability guaranties of contracts: implementation of consumer rights within the knowledge transfer utilization criteria; participation and transparency of the process, support to user's organization; (xi) the partner's profile and technical and financial capacity; (xii) adequate management of social and environmental impacts. The political priorities are: political stability, economic policy, investment policy, restrictions in direct investments, restrictions to imports, inability of resisting to external shocks, and culture of trust. In addition to these questions, there is the policy so that the process can be implemented in a plausible way. The main *Legal barriers* are contracts and licences combined in diferents ways, protection against Market failures, nationalization and excessive regulation; protection to license practice; of intelectual property; concessions or licences to use patent formulas, drawings, models, procedures or specific parts of technological knowledge. There is predominance in the barriers: Growing and sophisticated Market, with adequate scientific and technical infra-structure, International competiton; Market structure, industrial concentration, distribution channels, capability of integration with other markets and fragmentation of International markets. Soon after this procedure, the Issues performance was determined (global performance assessemnt) according to the type/category of each technology. Within this spectrum, it was possible to verify the global performance of the barriers in relation to each category of knowledge transfer.

When comparing the results in terms of performance, the Compromise Programming and Promethee II methods did not differ in their classifications. For Electre III, the results were incompatible. And this is because the p, q and v veto thresholds, respectively, of indifference, strong preference and veto or incomparability have a discrepancy in the structure of their results (classification). Electre III presents a set of solutions with a more flexible hierarchical structure. This is due to the conception of the method, as well as the quite explicit consideration of the indifference and incomparability aspect between the alternatives. The results referenced by the Promethee II and Compromise Programming methods reflect the preference, according to the experts, for Political and Marketing barriers. The essence of the knowledge transfer process is the accumulation of knowledge over time. The technique *adapts to the case in question.*

Phase 2: Modeling of the Optimal Efficiency Rate effective of Reverse knowledge transfer of innovation value chain (Multinationals Companies) – OERKT

This phase focuses on determining the optimal efficiency rate (OERKT) *of reverse knowledge* transfer of innovation value chain (Multinationals Companies) – OERKT using Neurofuzzy modeling. It is a process whose attributes usually possess high subjectivity characteristics, in which the experience of the decision maker is very significant. Thus within this spectrum there is the need for a tool that allows adding quantitative and qualitative variables that converge towards a single evaluation parameter (Cury and Oliveira; 1999; Von Altrock, 1997).
This model combines the Neural Networks and Logic Fuzzy technology (neurofuzzy technology). Here this model supports the planning of reverse knowledge transfer of multinationals companies, as it allows evaluating the desirable rate toward the acceptable performance of multinationals companies.

The model shown here uses the model of Cury and Oliveira (1999). Based on the Neurofuzzy technology, the qualitative input data are grouped to determine the comparison parameters between the alternatives. The technique is structured by combining all attributes (qualitative and quantitative variables) in inference blocks (IB) that use fuzzy-based rules and linguistic expressions, so that the preference for each alternative priority decision of the optimal rate of reverse knowledge transfer determinants, in terms of benefits to the company, can be expressed by a range varying from 0 to 10. The model consists of qualitative and quantitative variables, based on information from the experts. The Neurofuzzy model is described below.

Determination of Input Variables (IV): This section focuses on determining the qualitative and quantitative input variables (IV). These variables were extracted (15 variables) from the independent variables (dimensions of technological innovation capacity of the companies). The linguistic terms assigned to each IV are: High, Medium and Low. Accordingly, Figures 2-6 shows the IVs in the model, which are transformed into linguistic variables with their respective Degrees of Conviction or Certainty (DoC), with the assistance of twenty judges opining in the process. The degrees attributed by the judges are converted into linguistic expressions with their respective DoCs, based on *fuzzy* sets and IT rules (aggregation rules), next (composition rules).

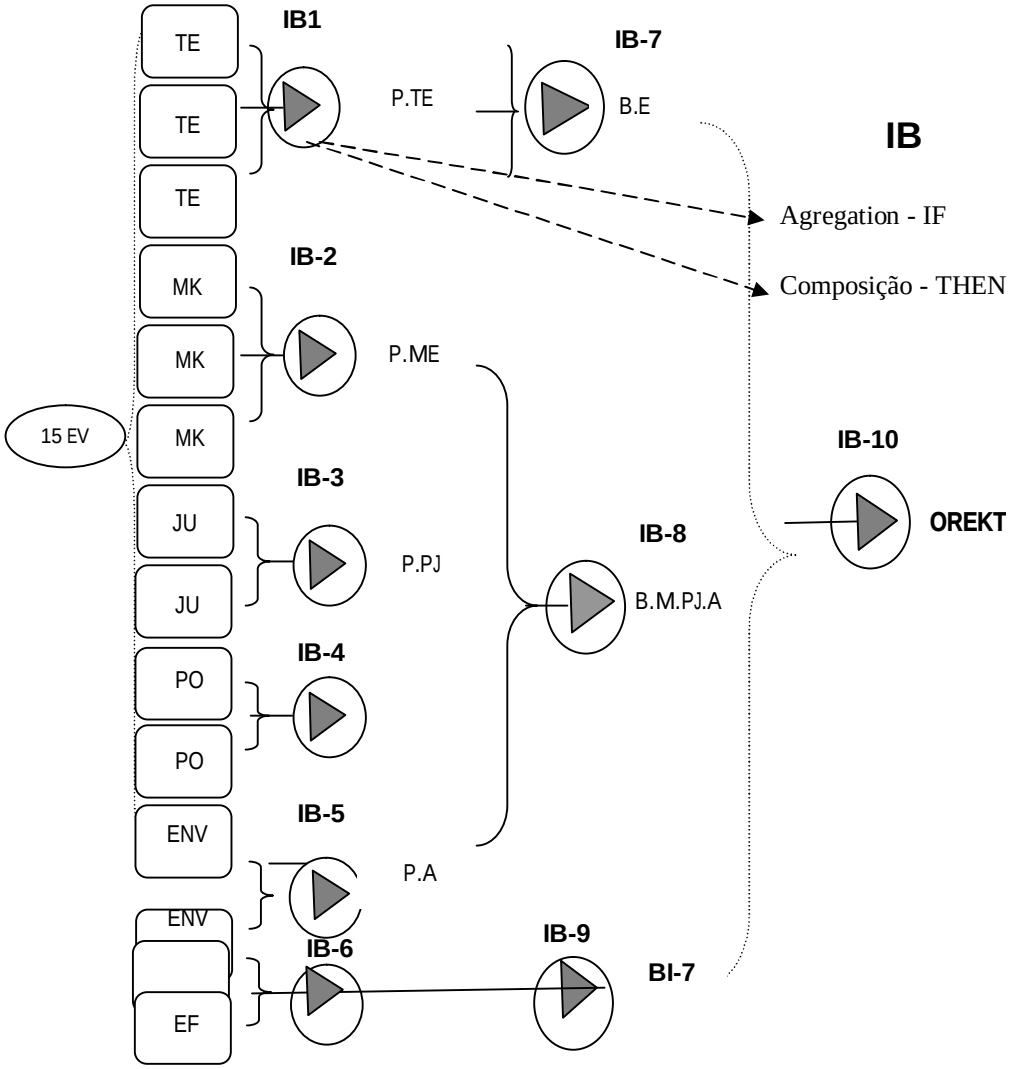

Fig 8: Neurofuzzy Model

Determination of Intermediate Variables and Linguistic Terms: The qualitative input variables go through the inference fuzzy process, resulting in linguistic terms of intermediate variables (IVar). Thus, the linguistic terms assigned to IVar are: Low, Medium and High. The intermediate variables were obtained from: Marketing Performance; Political Performance; Judicial Performance; Technical Performance; Economic and Finance Performance; and Environment Performance.

The architecture proposed is composed of eight expert fuzzy system configurations, four qualitative input variables that go through the *fuzzy* process and through the inference block, thus producing an output variable (OV), called intermediate variable (IVar). Then, the IVars, which join the other IVar variables form a set of new IVars, thereby configuring a sequence until the last layer in the network. In the last layer of the network the output variable (OV) of the *neurofuzzy* Network is defined. This OV is then subjected to a defuzzification process to achieve the final result: Optimal Efficiency Rate of Reverse Knowledge Transfer on the innovation value chain in PDP, multinationals companies. In summary, the fuzzy inference occurs from the base-rules, generating the linguistic vector of the OV, obtained through the aggregation and composition steps. For example, when the experts' opinion was requested on the optimal efficiency rate for the technological innovation capacity performance of company A, the response was 8.0.

Then the fuzzification (simulation) process was carried out, assigning LOW, MEDIUM and HIGH linguistic terms to the assessment degrees at a 1 to 10 scale. Degree 8, considered LOW by 0% of the experts, MEDIUM by 55% and HIGH by 45% of the experts. In summary, the expert's response enabled to determine the degree of certainty of the linguistic terms of each of the input variables using the fuzzy sets. The results confirm the *H2:* The optimal efficiency rate depends on the combination and interaction of the innovation capacities of the high-tech companies. The generic fuzzy sets were defined for all qualitative IVars, which always exhibit three levels of linguistic terms: a lower, a medium and a higher one. After converting all IVars into its corresponding linguistic variables with their respective DoC, the *fuzzy* inference blocks (IB), composed of IF-THEN rules, are operated based on the MAX-MIN operators, obtaining a linguistic value for each intermediate variable and output variable of the model, with the linguistic terms previously defined by the judges. With the input variables (features extracted from product development projects), the rules are generated. Every rule has an individual weighting factor, called Certainty Factor (CF), between 0 and 1, which indicates the degree of importance of each rule in the *fuzzy* rule-base. And the *fuzzy* inference occurs from the rule-base, generating the linguistic vector of OV, obtained through the aggregation and composition steps.

Determination of Output Variable – Optimal Efficiency Rate of Reverse Knowledge Transfer

The output variable (OV) of the neurofuzzy model proposed was called Optimal Efficiency Rate of Knowledge Transfer multinatonals companies. The fuzzification process determines the pertinence functions for each input variable. If the input data values are accurate, results from measurements or observations, it is necessary to structure the fuzzy sets for the input variables, which is the fuzzification process. If the input variables are obtained in linguistic values, the fuzzification process is not necessary. A fuzzy set A in a universe X, is a set of ordered pairs represented by Equation 1.

$$A=\{(\mu_A(x),x)|x \in X\} \quad (1)$$

Where (x) is the pertinence function (or degree of pertinence) of x in A and is defined as the mapping of X in the closed interval [0.1], according to Equation 2 (PEDRYCZ and GOMIDE, 1998).

$$\mu_A(x):X \rightarrow [0.1] \quad (2)$$

Fuzzy Inference: The fuzzy inference rule-base consists of IF-THEN rules, which are responsible for aggregating the input variables and generating the output variables in linguistic terms, with their respective pertinence functions. According to Von Altrock (1997), a weighting factor is assigned to each rule that reflects their importance in the rule-base. This coefficient is called Certainty Factor (CF), and can vary in range [0,1] and is multiplied by the result of the aggregation (IT part of inference). The fuzzy inference is structured by two components: (i) aggregation, i.e., computing the IF rules part; and (ii) composition, the THEN part of the rules. The Degree of Certainty (DoC) that determines the vectors resulting from the linguistic processes of aggregation and composition are defined with Equation 3.

$$DoC;:max[FC_1 . min\{GdC_{A11},GdC_{A12},...,GdC_{1n}\},...,FCn . min\{GdC_{An1},GdC_{An2},...,GdC_{Amn}\}| \quad (3)$$

Defuzzification: For the applications involving qualitative variables, as is the case in question, a numerical value is required as a result of the system, called defuzzification. Thus, after the fuzzy inference, fuzzification is necessary, i.e., transform linguistic values into numerical values, from their pertinence functions (Von Altrock, 1997). The IT Maximum Center method was popularized to determine an accurate value for the linguistic vector of OV. Based on this method, the degree of certainty of linguistic terms is defined as "weights" associated with each of these values.

The exact value of commitment (VC) is determined by considering the weights with respect to the typical values (maximum values of the pertinence functions), according to Equation 4 presented below (Von Altrock, 1997; Cury and Oliveira, 1999).

$$OV = \frac{\sum_{i=1}^{n} DoC_i \cdot X_i}{\sum_{i=1}^{n} DoC_i \cdot X_i} \quad (4)$$

Where i DoC represents the degrees of certainty of the linguistic terms of the final output variable and i X indicates the end of the typical values for the linguistic terms, which correspond to the maxima of fuzzy sets that define the final output variable. By way of demonstration, using assigned IT (average) hypothetical (Company A) enters-IT into the calculation expression of TPCITj with GdCi of the following linguistic vector of the output variable, also hypothetical: LOW=0.30, MIDDLE=0.49, HIGH=0.14. The numerical value of OERP at a 0 to 1 scale corresponds to 0.7352, resulting from the arithmetic mean of the values resulting from the defuzzification of each of the simulated twenty judges. This value corresponds to an average value for OERP. With this result (optimal efficiency rate: 0.7352) produced for a better combination and interaction of strategic Reverse Knowledge Transfer Barriers, that converged toward a single parameter, it is feasible to assert that this combination of knowledge transfer barriers of the firm at this time, can at least ensure the performance desired by the firm at that time. It is plausible that the company maintains at least this value (0.7352), which ensures the desired performance. It is also plausible to state that, to some degree, there is efficiency in the management of those planning knowledge in this category of companies.

Managerial Implications

Our findings have some interesting managerial implications as well. Subsidiaries firms are widely considered as crucial actors in reverse knowledge transfer to multinationals enterprises, especially when Less Developed Countries are considered as recipient economies. Some knowledge transfer occurs involuntarily through human capital mobility and through the imitation of the managerial practices of global buyers. Important knowledge assets are also transferred voluntarily by subsidiaries to multinationals in their efforts to increase the efficiency. However, not all value chain relationships are equally conducive to knowledge transfer. Literature has emphasized a number of characteristics of foreign firms which may favor linkages. While all value chain relationships do imply some transmission of information between the parties, the extent to which knowledge is actually created, transferred and adopted along the value chains varies dramatically. The different typologies of value chain relationships thus correspond to different modes of organizing (international) knowledge transfer and diffusion. In fact they differ in terms of nature and quantity of knowledge being transferred, in terms of directions in which it flows, and in terms of the autonomous contribution of both the buyer and the supplier to knowledge development.

In order to effectively connect individuals with different capabilities of organization, management must design procedures to limit the barriers to knowledge transfer. This can be underpinned through the development of a culture. In light of the findings, it is clear that the building of trust requires that actors (suppliers, clients, others enterprises) have a confidence in the ability of each other to make the right decisions. This confidence in other people's abilities can provide the reassurance about any points of doubts and leads to a willingness to respect the other party's sincerity. Hence trust leads to a shared. Common understanding, but is constructed by the actors involved and is context specific. As many knowledge managers are required to focus on environmental scanning, and longer-term strategic direction, they may overlook some important internal technological capabilities. This implies that they should better assess these capabilities to see what skills are lacking before they begin to look for partnerships within the subsidiaries and multinationals enterprises. Thus an evaluation of their organization's capacity to learn from knowledge transfer might highlight inadequacies in this area, because staff have not been encouraged or taught to transmit or receive knowledge. Thus, we believe that we have made a contribution to several areas of business and managerial practice. On a more conceptual level, we opened the floor for a contingency perspective on knowledge flows by focusing on the barriers of knowledge transfer and we are confident that more insights in this area will follow in due course.

In particular, studies investigating potential reinforcing effects of the development of mechanisms and knowledge transfer effectiveness may constitute fruitful avenues for further research.

Final Words

Conclusions and Implications

The present paper aims to contribute to the planning policy in reverse knowledge transfer barriers in the innovation value chain in PDP, in perspective from subsidiaries to Multinationals Enterprises. To achieve that, it presents a model proposal to assess the effects of reverse knowledge transfer barriers on the innovation value chain performance in product development process (PDP) under uncertainty and unpredictability. Here, knowledge transfer is the application of prior knowledge to new learning situations (McKeough, 1995; Riege, 2007)) Thus, the study strived to fill a gap in the existing literature on innovation planning from the perspective of reverse knowledge transfer barriers. Transferring knowledge in the innovation value chain can create significant learning benefits and is a ‘‘powerful mechanism for improving an organisation’s productivity and increasing its survival prospects’’ (Argote, 1999). In spite of this, there are numerous examples where knowledge transfer practices have not accomplished their objectives to manage firms’ intangibles, including knowledge, which is mainly due to the large diversity of barriers (Riege, 2007). Thus, this research provides useful insights for practitioners wanting to minimize barriers and optimize knowledge transfer across the innovation value chain, from subsidiaries to multinationals enterprises. Also it serves as a useful basis for researchers to expand further research into barriers of knowledge transfer.

This facilitates decision making within a context of uncertainty. This proposal is an additional tool available to managers, which helps to greatly reduce the uncertainty of technological innovation decisions. There are of course several issues to be further explored in other such studies, and is hoped that it contributed to a plausible methodological discussion, with much still to be explored. Innovation admittedly poses significant challenges to both research and practice, requiring the need for active learning in multinationals companies. Of the different dimensions, the results show a predominance of R&D efforts. Therefore, the innovation policy for companies in this category should be anchored by efficient planning. These criteria are measured quantitatively and qualitatively. However the innovation decision capacities refer to the capacity to enforce innovative technology decisions in the company. These capacities include the degree of R&D innovation, the collaboration intensity with other companies or R&D centers (Lefebvre et al, 1998; Achilladelis and Antonajis, 2001), the R&D capacity to share knowledge (Guan and Ma, 2003), forecasting and evaluating technological innovation (Yam et al, 2004; Burgelman et al., 2004), and business innovation initiatives (Guan and Ma, 2003). These capacities are evaluated subjectively. Marketing resources indicate a solid capacity to promote and sell products based on demand, which is primarily influenced by the market (Manu and Sriram, 1996), degree of competitiveness of new products, monitoring of market forces (Guan and Ma, 2003), marketing specialized unit (Achilladelis and Antonajis, 2001), and the percentage of exports (Sterlacchini, 1999; OEDC, 1992/1996; Guan and Ma, 2003).

Limitations of the Study and Future Perspectives

In the research, cross-sectional data used in this study may not be appropriate to establish fundamental relationships between variables, but as referenced by Kenny (1979), the relationships that use cross sections are satisfactory and popularly accepted in relationship tests. Furthermore, a survey was developed for Brazilian companies in a static context, which may represent a limiting factor. Therefore, it is recommended to reproduce and replicate the model in companies from other countries in order to confirm the results. It is also recommended that the innovation capacity dimensions should be extracted from the state of the art, but strongly confirmed by the state of practice, by the judgment of other experts (from other countries), taking into account that values, beliefs, cultures and experiences are determinants in the assessment, which can overturn the effects on the results. It is also underscored that the methodologies and technical basis of this modeling should undergo evaluation by a multidisciplinary team of specialists permanently and periodically, hence proposing possible additions or adjustments to these methodologies. And also replace some of the technical implementations used herein by others, in order to provide a similar role to verify the robustness of the model.

Of the research findings, the multinationals and subsidiaries industries undertake the ever-fast changes, intense competition and a highly uncertain and risky environment. The effect produced by technology on the development of new products is equally intensive. R&D is crucial for innovation capacity. It confirms the state of the art.

Shanklin and Ryans (1984) suggest that high-tech companies anticipate potential technical and scientific capabilities that provide quick responses to the existing techniques, enabling to meet the market demands to be constructed or altered. It is reasonable to focus efforts on R&D, thereby creating an internal stock of scientific knowledge (Feinberg and Majumdar, 2001; Griliches, 1979; Hall and Mairesse, 1995), which enables to develop and introduce new products, lower production costs, more competitive prices and greater financial return (Kafouros, 2008a, 2008b). R&D has indirect effects on increasing the organizational learning, enables to understand external ideas and technologies and apply them to the ultimate business outcome (Cohen & Levinthal, 1989) and also contributes to identifying areas that are still technologically unexplored (Miller, Samambaia, and Cardinal, 2007). This logic will be maintained, however only through opening spaces for the various strata: partners, suppliers and customers. Nevertheless, the capacity to innovate high-tech companies will have to be anchored in efficient planning policies. One can argue that Brazil's multinationals companies still has a long way to go and also has tremendous growth potential. Hopefully Brazil can become a technological and competitive nation.

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