Innovation Value Chain Performance Based in Knowledge

Selma Regina Martins Oliveira

S.R.M. Oliveira

Department of Business Administration,
University of São Paulo, São Paulo, Brazil
Av. Arlindo Gomes Rodrigues, 1082
CEP 38406231 – Uberlândia – MG / Brazil

Roberto Sbragia

R. Sbragia

Department of Business Administration,
University of São Paulo, São Paulo, Brazil
Av. Prof. Luciano Gualberto, 908 – City University
CEP 05508-010, São Paulo - SP/Brazil

Abstract

The present paper aims to contribute to the planning guidelines in the innovation value chain management field. Therefore, it addresses the influence of the stakeholders' knowledge on the performance of innovation value chain in product development processes applied to technology-based companies under uncertainty and constraint conditions. Thus, a survey was developed with experts chosen by their technical-scientific criteria and knowledge on the subject. The data were extracted by means of a judgment matrix. To reduce subjectivity in the results, the following methods were used: Law of Categorical Judgment - psychometric scaling (Thurstone, 1927) and Artificial Neural Networking (ANN), Multivariate Analysis statistical methods and method Compromise Programming, Electre III and Promethee II - multi-criteria analysis. The results produced are satisfactory, validating the proposed procedure for Value Chain Management (VCM).

Keywords: Planning Value Chain, Knowledge; Value Chain Performance; Innovation; Product Development Process; Uncertainty and Restraint.

1. Introduction

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. With time, this eventually leads to changes in the configuration of the chain. Consequently, it is considered one of the main challenges of value chain management, which basically consists of creating integrated structures of decision making in an extensive universe containing multiple organizations. This requires an integrated and shared decision structure that involves key business processes, concerning efficient coordination of functional-temporal company-client (Cheng, Yeh, and Tu, 2008; Power, 2005; Blos, et. al., 2009; Fawcett, et. al., 2009; Godsell, Birtwistle, and Hoek, 2010; Halldorsson et. al, 2007; Kim, 2006; Svenson, 2007).

The characteristics of the value chain differ a great deal, therefore becoming the object of analysis equally differentiated. The good practice recommends fulfilling a sequence of articulated actions, which consist of the following phases: (i) planning the necessities; (ii) institutionalization and formation of a project team and determination of the communication procedures; (iii) the objectives' consolidation, results and performance's goal of the value chain; (iv) study of the costs, prescriptions, flows of box; (v) study of the social impacts;

(vii) analysis, allocation and management of risks (preliminary evaluation), etc. Many times the projects are made impracticable still in the act of planning, hence becoming unsustainable. One of the aspects that deserves to be highlighted is the occurrence of errors in the management of the value chain, which often results in a non-fulfillment of the established goals and performance. 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 knowledge may represent a strategic tool, increasing the institutional capacity of the Entrepreneurs in their assignments of formulation, evaluation and execution of such projects (Fletcher, Yiannis, and Polychronakis, 2007; Hanisch et. al., 2009; Kannabiran, 2009; Kayakutlu and Buyukozkan, 2010). The knowledge would work as a facilitator instrument of improvement, contributing for the quality of services and the enhancement of the agility to decide. Monitoring the performance of value chain from a knowledge perspective requires that the appropriate monitoring procedures are in place and operational (Fletcher, Yiannis, and Polychronakis, 2007; Godsell, Birtwistle, and Hoek, 2010; Svensson, 2007). Generally, a keen eye must be kept on the knowledge household of value chain. Especially important is watching the external environment for new events that may have impacts on the way value chain deals with knowledge shown as “incoming” arrows that will influence on the performance of value chain. In order to improve the performance of the entire value chain, it is necessary to cross the boundaries of individual companies and consolidate the entire chain, in other words, a cohesive and integrated system to increase the chain’s knowledge flow.

In this spectrum, the present paper aims to contribute to the planning guidelines in the innovation value chain field. Therefore, it addresses the influence of the stakeholders’ knowledge on the performance of innovation value chain in product development processes applied to technology-based companies under uncertainty and constraint conditions. Innovation events, such as the introduction of a new product or process, represent the end of a series of knowledge models and the beginning of a process of value creation (Ropera, Jun Dub, Love, 2008). Thus, this contribution focuses on the definition of knowledge priorities on the Innovation value chain performance. In the next section of the paper we introduce our conceptual model and detail our hypotheses and their underlying justification. Subsequently we outline our methodological approach and detail our results. We end with a consideration of what has been lessons learned and contributions.

2. Conceptual model: key constructs and hypotheses

This section examines the conceptual model (Figure 1) and develops the theoretically justified hypotheses.

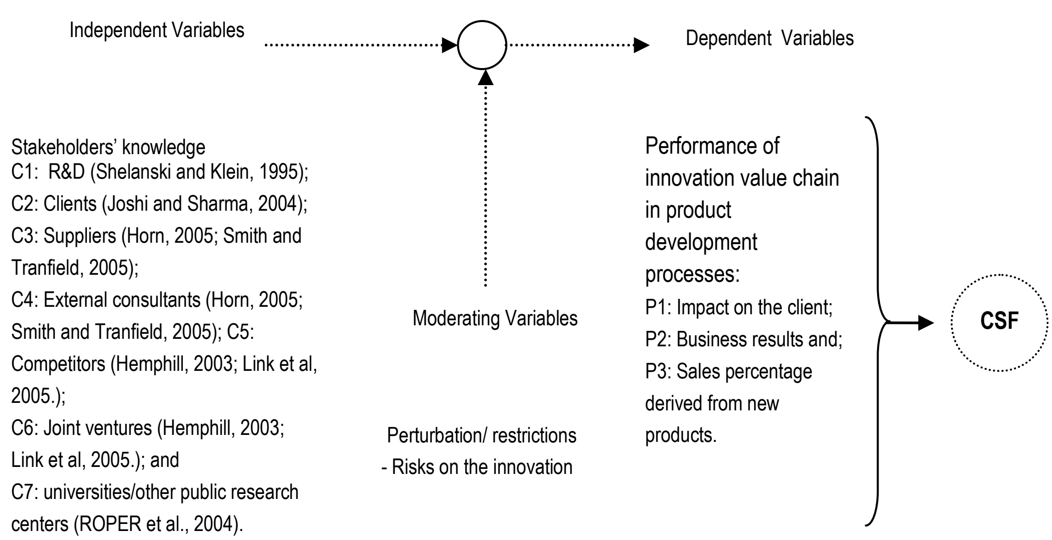


Figure 1: Conceptual model – dependent, moderating and independent variables and Critical Success Factors (CSF)

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. Here, following the proposals of Bukowitz and Williams (2002), knowledge is considered as elaborated, refined information, which is also able to self-evaluate its liability, relevance and importance. Knowledge should be considered as the most important information factor, as it includes precise context, concrete meaning, respective interpretation and reflection, in addition to personal wisdom. It also considers far ranging implications (Davenport And Prusak, 1998). Moresi (1998) proposes a chain comprising the following elements: processed data, elaborated information, knowledge synthesis and finally, intelligence. The knowledge step converts the combined information into knowledge. After this synthesis, the information is gathered in blocks to later be used by specialists who filter it and standardize it in order to apply it to a specific situation. This contribution focuses on knowledge priorities for performance in the innovation value chain. Based on a methodological strategy, explained later, which included interviews with Brazilian specialists, the priorities have been systemized and prioritized. Therefore, the positive relationship between knowledge and performance on the innovation value chain in the product development process under uncertainty and restraint is expected. Thus, the findings are based on that analysis. They are:

H1a: The highest degree of knowledge generated in R&D implies the highest degree of value chain performance in innovation with respect to customers; H1b: The highest degree of knowledge generated from R&D implies the highest degree of value chain performance in innovation with respect to business results. H1c: The highest degree of knowledge generated from R&D implies the highest degree of value chain performance in innovation with respect to sales derived from innovation.

H2a: The highest degree of knowledge generated by external consultants implies the highest level of value chain performance in relation to clients. H2b: The highest degree of knowledge generated by external consultants implies the highest level of value chain performance in relation to business results. H2c: The highest degree of knowledge generated by external consultants implies the highest level of value chain performance in relation to sales derived from innovation.

H3a: The highest degree of knowledge generated in Universities/Research Centers implies the highest level of value chain performance in innovation with respect to customer efficiency. H3b: The highest degree of knowledge generated in Universities/Research Centers implies the highest degree of value chain performance in innovation with respect to business results. H3c: The highest degree of knowledge generated in Universities/Research Centers implies the highest degree of value chain performance in innovation with respect to sales derived from innovation.

H4a: The highest degree of knowledge generated from joint ventures implies the highest degree of value chain performance in innovation with respect to clients. H4b: The highest degree of knowledge generated from joint ventures implies the highest level of value chain performance in innovation with respect to business results. H4c: The highest degree of knowledge generated from joint ventures implies the highest level of value chain performance in innovation with respect to sales derived from innovation. H5a: The highest degree of knowledge generated from customers implies the highest degree of value chain performance in innovation with respect to clients.

H5b: The highest degree of knowledge generated from customers implies the highest level of value chain innovation performance with respect to business results. H5c: The highest degree of knowledge generated from customers implies the highest level of value chain performance in innovation with respect to sales derived from innovation.

H6a: The highest degree of knowledge generated from suppliers implies the highest level of value chain performance in innovation with respect to customers. H6b: The highest degree of knowledge generated from suppliers implies the highest level of value chain performance in innovation with relation to business results. H6c: The highest degree of knowledge generated from suppliers implies the highest level of value chain performance in innovation with relation to sales derived from innovation.

H7a: The highest degree of knowledge generated by competitors implies the highest level of value chain performance in relation to clients. H7b: The highest degree of knowledge generated by competitors implies the highest level of value chain performance in relation to business results. H7c: The highest degree of knowledge generated by competitors implies the highest level of value chain performance in relation to sales derived from innovation. The variables used in this study are classified as independent, dependent and control (Figure 1). The analysis unit defined in this study is Product Development Process (PDP).

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; Smith and Tranfield, 2005); c5: Competitors (Hemphill, 2003; Link et al, 2005); c6: Joint ventures (Hemphill, 2003; Link et al, 2005.); 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); Sansão and Terziovski (1999). 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 moderator or controls variables are the risks and uncertainties of innovation. These involve research, discovery and commercialization. Commercialization is obviously the result of research and this refers to the potential risks of scientific and technological development up to mass production. The market represents the main risks, which are encountered by the market agents engaging in economic activities. When new products enter the market, competitors quickly intervene, which will result in a competitive risk (Wu et. al. 2010). The technological innovation risks refer to the uncertainties of technology, market and benefits for the institutional environment.

Dependent variables: Once it is validated that the performance of innovation value chain in the product development technology (PDT) process contains multifaceted aspects, a construct is used to measure the performance of the innovation value chain in the technology development technology (PDT). 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.

Critical Success Factors (CSF): The CSF (Rockart, 1979), and is itself structured in two stages: (A) identification of CSF and (B) evaluation of CSF. (A) Identification: The identification of CSF is based on the combination of various methods (Bruno and Liedecker, 1984): (a) environmental analysis (external variable: political, economical, legislation, technology, among others.); (b) analysis of the industry structure (users' needs, the evolution of the demand, users' satisfaction level, their preferences and needs; technological innovations); (c) meeting with specialists and decision makers; and (d) the study of literature. (B) CSF Evaluation: After their identification, the CSF is evaluated in order to establish a ranking by relevance. Here the scale model of categorical judgments designed by Thurstone in 1927 has been adopted. hierarchical structure of CSF is obtained. Thus, the CSF in PDP/PDT were extracted from the specialized literature and assessed by experts for confirmation. The results showed the following classification: first, the Market Factor (MK); second, the Political (PO); third, the Judicial Factor (JU); fourth, the Technical Factor (TE); and fifth, the Economical and Financial Factor (EF).

3. Methodology: Steps and Implementation

The objective of the methodological procedures used is to achieve the intended goal and solve the research problem. These procedures can potentialize and attenuate the subjective differences that are included.

Although the procedures are for a specific application (PDT), by detailing and describing the main elements of each procedure established so they may serve as auxiliary material in other applications. Thus, this research is characterized by a combination of sequential qualitative and quantitative approaches. The qualitative analysis provides information to plan and execute the quantitative stage. With the research problem, the study explores the specialized literature on the research subject, which helps identify the variables that comprise the model and formulate the hypotheses of the study. Based on the model outlined (Figure 1), this work proposes a series of hypotheses that show relationships between the knowledge generated from each stakeholder (source) and the performance in the innovation value chain. The data are extracted at two stages, based on the specialized literature to identify the knowledge variables of the stakeholders and performance variables of the PDT innovation value chain. These variables will then undergo confirmation and judgment by the experts, through a survey, in technology-based companies (in Brazil).

Firstly, the degree of influence of the stakeholders' (sources) knowledge on the overall performance of the innovation value chain in technology development process was investigated in technology-based companies under uncertainty and constraints. In a risk situation, future events have probable outcomes (MILLIKEN, 1987). Uncertainty with regards to risk is a condition that renders difficult to predict the likelihood of various future events (Gaur et. al., 2011; Milliken, 1987; Sutcliffe and Zaheer, 1998; Srinivasan, Mukherjee and Gaur, 2011).

It is believed that the presence of risks can increase the positive effects of the stakeholders' knowledge influence on the performance of the PDT innovation value chain. Additionally, an environment of uncertainty can weaken the influence of knowledge on the performance of innovation value chain. In an environment of unpredictability and unexpected change these variations or disturbances can make the results highly subjective. These disorders and unpredictability can specifically result in significant disruptions along the value chain. In this study the risks of innovation as disruption conditions are reaffirmed. To investigate the stakeholders' (sources) knowledge influence on the innovation value chain performance in a global perspective, the law of Categorical Judgment (Thurstone, 1927) - psychometric scaling method was used. This methodology is recommended in conditions of uncertainty and constraint, because they include highly complex and subjective events, in which the experts (judges) are able to express their preferences at different moments. Thus, the data collection instrument (Judgment matrix) is based on Thurstone's Law of Categorical Judgment method - psychometric scaling, submitted to the experts in the Survey, who have technical and scientific knowledge on the study object. This is a mental behavior model that explains the experts' preference structure for a set of stimuli. The model starts with the experts' mental behavior in order to explain the preference structure of a judge (individual) related to a set of stimuli. It should be noted that the judges' preferences are manifested at different moments [...], and the scale values will vary depending on the mental process dynamics. One of the motivations relates to the characteristics of the problem, which through the structures it should solve and explain the preferences of the experts. This mechanism only perceives manifestations that are represented by the choices revealed empirically through the frequencies related to the preferences.

After this procedure, the stakeholders' (sources) knowledge influence on the performance of innovation value chain was examined, considering the dimensions individually (customer impact, return on sales and sales percentage derived from innovation). Therefore, the multicriteria analysis method was used. This methodology is applied to high-subjectivity events as they involve qualitative variables. The support methods used were: Compromise Programming, Electre III and promethee II. And to confirm the reliability of the results produced by the LJC Psychometric Scaling Methods and Multicriteria Method, a Spearman's correlation study was used to verify the influence of independent variables on the dependent variables, conditioned to perturbations (innovation risk). The reliability of the scales was tested using Cronbach's alpha coefficient (Cronbach, 1951).

3.1 Sample and Data Collection

This section details the elements that comprise the sample as well as the data extraction structure used in the study. Thus, the data were first extracted from the specialized literature on the subject under investigation to prepare the scalar-type data collection instrument (assessment matrix), based on Thurstone's law of Categorical Judgment psychometric scaling method. Once the construct and content were defined, the instrument was submitted to the experts' (judges) assessment in order to confirm the scale with regards to construction and content. Thus, the stakeholders (knowledge sources) from diverse backgrounds and scenarios, directly and/or indirectly involved with the technology developing process in the innovation value chain in PDT were identified.

We first identified the following stakeholders (knowledge sources): (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). After the knowledge sources survey, the stakeholders' main spectrum of activities considered in the PDP/PDT were identified. The activities identified were: I – Project Scope; II – Concept Development; III – Prototype Development; IV – Integration of Subsystems; V – Prototype Production; VI – Market introduction; VII – Post Product Launch. It should be noted that the activities presented for the case in question are for the technology development process (PDT). The results obtained are as follows: I – Invention; II – Project Scope; III – Concept Development; IV – Concept Development; V – Technology Optimization; VI – Technology Transfer. After identifying the technology development stages, the next step was to identify the knowledge needed to converge each of the stages in the PDT stages. The results showed the following knowledge according to the PDT steps (Clark and Weelwright, 1992; Clausing, 1993; Cooper and Kleinschmidt, 1987; Reis et al, 2006; Creveling, Slutsky and Antis, 2003): (i) Strategic Planning of the company; (ii) Technology Strategy determination; (iii) technology; (iv) consumer; (v) Generation of ideas; (vi) project scope development; (vii) mapping future plans; (viii) patent survey; (vix) identifying opportunities;

(x) identifying potential ideas under certain conditions through preliminary experiments; (xi) identifying necessary resources and solutions for the shortcomings identified; (xii) projection of product platforms; (xiii) creation of QFD for technology (technology needs); (xiv) conducting available benchmarking technology; (xv) development of partner networks; (xvi) defining new technology functionalities; (xvii) identifying technology impact on the Company; (xviii) documents analysis and generation of technology concepts; (xix) selection and development of the superior technology concept; (xx) definition of commercial products and processes and possible processes; (xxi) decomposition of system functions into subfunctions; (xxii) definition of system architecture; (xxiii) definition of system architecture; (xxiv) use of mathematical models that express the ideal function of technology; (xxv) prototype development and testing; (xxvi) identification of market impact and manufacture of these possibilities; (xxvii) preparation to implement the business case; (xxviii) identification and evaluation of critical parameters; (xxix) technology optimization from its critical parameters; (xxx) analysis of factors that can result in platforms; (xxxi) development of the platform subsystems; (xxxii) carrying out optimizing experiments; (xxxiii) design of integrated subsystems platform; (xxxiv) system performance tests; and (xxxv) defining the technology selection criteria. Thus, the influence of the stakeholders' knowledge on the performance of innovation value chain in PDT under constraint and uncertainty was based on the activities and their respective technology development stages.

Taking into consideration that development projects of new technologies involve high risks and uncertainty (Cooper, 2006). To reduce the risks and uncertainties of innovative projects in this research, the analogy of Cooper (2006) was applied, which proposes executing various activities throughout technology development, considering that there is an organized arrangement among them, hence enabling to better manage the process. These projects are not developed properly, influenced by the instability of technology and markets that change unexpectedly. Furthermore, these projects can be developed as part of product designs, causing conflicts when developing an innovative product (Clark and Wheelwright, 1993; Schulz et al., 2000).

After this procedure, the performance dimensions of the innovation value chain in PDT were identified (based on the literature). The results showed the following dimensions: customer impact, business and sales return derived from innovations. For the case in question, the influence of knowledge on the overall performance of the innovation value chain was considered. Next, we identified the influence of knowledge according to the dimensions individually considered: customer impact, business return and sales percentage derived from innovation. Technology-based companies are organizations that structure their activities in the development and production of new products and/or processes, based on the systematic application of scientific and technological knowledge and the use of advanced and pioneering techniques. These companies have knowledge and technical-scientific information and a high rate of R&D expenditures as their main input. The main element that distinguishes this category of companies from others is the risk of activities that includes innovations. And this is because they operate in specific sectors with non-standard technologies.

The influence of knowledge on the overall global performance is detailed in the next section, using the LJC psychometric scaling method and artificial neural network (ANN), as well as the influence of knowledge according to each performance dimension of the value chain using the Multicriteria Analysis method: Compromise Programming, Electre III and Promethee II. In summary, the results were extracted from the literature and then confirmed and validated by experts that were selected by their technical-scientific criterion on the object, with their experiences/practices and/or knowledge about product development, technological innovation and organizational management in technology-based companies in Brazil. Twelve experts were selected. The instrument was submitted to the experts via e-mail and through personal interviews. The final response rate was of 97%. More than half of the respondents were managers or supervisors, followed by senior managers (general manager or director), representing 40%. The remainder held or hold various management positions in technology innovation and product development.

3.2 Result and Analyses

3.2.1 Influence of Knowledge on Performance in Value Chain Innovation: Thurstone's LJC method

As referenced earlier, the influence of knowledge on overall performance was 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:

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

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

Where πij is an estimator of πij and considering value Z_{ij} such that, $\text{Prob}[N(0,1) \leq Zij] = \hat{\pi} ij$, 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 (Knowledge), 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 Knowledge (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 (knowledge). 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 stakeholders' knowledge influence on the overall performance of the value chain. A pilot test was administered to three experts in order to refine the instrument prior to its final implementation. The reliability of the scales was tested using Cronbach's alpha coefficient (Cronbach, 1951), reaching satisfying confidence values (0.70) (Nunnally, 1978). Once this step was concluded, in other words, with the result of the stakeholders' knowledge influence on the overall performance of the innovation value chain, the next step was to investigate the stakeholders' knowledge influence (independent variables) on each of the performance dimensions of the innovation value chain in PDT (dependent variables).

The data in Table 1 were extracted from the experts' preference assessment regarding the stakeholders' knowledge influence on the overall performance of the innovation value chain (through field research-questionnaire/assessment matrix). The knowledge appears in the form of R&D incentives; Customers; Suppliers; External consultants; Competitors; Joint ventures; and Universities/other public research centers submitted to the ordinal categories $C_{1=}5^{th}$ place, $C_{2=}4^{th}$ place, $C_3=3^{rd}$ place, $C_{4=}2^{nd}$ place and $C_5=1^{st}$ place, which resulted in the following cumulative weighting of the experts' preferences. The results are detailed to follow.

Table 1: Probability Intensity of Knowledge Influence on Performance in the Innovation value chain

Knowledge (Stimulis)	C1	C2	C3	C4	$(\mu i = -\sum_{j=1}^{4} \boldsymbol{Zij}/4)$, TOTAL	Classification
R&D	-1,22067	-1,2207	-1,221	-0,7647	-4,43	1º
External consultants	-1,22064	-1,2206	-0,140	1,22064	-1,36	7º
Suppliers	-1,22067	-1,2206	-0,765	1,22064	-1,99	5º
Joint ventures	-1,22064	-1,2206	-0,431	1,22064	-1,65	6º
Competitors	-1,22067	-1,2207	-1,221	0,43073	-3,23	3º
Clients	-1,22067	-1,2207	-1,221	-0,1397	-3,8	2º
universities/other public research center	-1,22067	-1,2206	-0,765	0,43073	-2,78	4º

The application of Thurstone's LJC method, of mental decision, resulted in the preferences obtained ($\mu i = -\sum_{j=1}^{4} \boldsymbol{Zij}/4$), in order of increasing priority.

The order found was: first the R&D knowledge and in second place the knowledge generated from Customers. Investment policies have been strongly oriented to R&D. R&D has become a strategic development leverage for companies seeking to achieve world class status (Hendry, 1998). This result confirms the hypothesis H1a, H1b and H1c. The confirmation of this hypothesis is a preliminary confirmation of the positive influence of the stakeholders' knowledge on the performance of innovation value chain in PDT. Long considered an innovation indicator, formal research and development activities do not necessarily result in a higher level of product and process innovation ((Tödtling et al., 2009). R&D is still considered useful to develop new products and manufacturing processes, and also to preserve and increase the company's expertise in the field of business intelligence (Karlsson and Olsson, 1998).

The presence of R&D creates an organizational setting that is favorable to questioning, promoting corporate/company flexibility, with an ability to integrate new concepts and adaptability to market changes (Freel, 2000). In addition, the knowledge and past experience gained with R&D, as well as their lasting and not sporadic existence, renders it instrumental to innovation (Brouwer and Kleinknecht, 1996). R&D and innovation are susceptible to sectorial influences [...] (Becheikh et.al., 2006B). Product innovation is considered stronger in high-technology sectors [...] (Subrahmanya, 2005). Moreover, the central element is the internal role of R&D to maximize the benefits of innovation from other forms of knowledge ((Love and Roper, 2008).

It should be noted that companies with a strong customer focus are able to anticipate the needs of current and latent customers (Paladino, 2008). Bastic and Leskovar-Spacapan (2006) state that customer-focused companies focus on Product innovation versus process innovation and continuously collect information on the needs of competitors and target customers, and check their ability to use this information to create superior customer value. A company's strong customer-focus can lead to an emphasis on innovation that is derived from the desire to continually adapt to customer needs (Santos-Vijande and Alvarez-Gonzalez, 2007). Rowley (2002) calls attention to the fact that client knowledge enables the companies' regrouping and creation of incremental value. And within this perspective, Garcia-Murillo and Annabi (2002) show that companies should take every opportunity to interact with customers in order to enrich their customer knowledge base. Consequently, a company can gain a thorough understanding of its customers, thus better able to meet their demands.

3.2.2 Influence of Knowledge on Performance in Value Chain Innovation: Artificial Neural Network (ANN)

The ANN is understood to simulate the behavior of the human brain through a number of interconnected neurons. A neuron executes weighed additions for the activations of the neurons representing nonlinear relations. The ANN has the capacity to recognize and to classify standards by means of processes of learning and training. The training of the net is the phase most important for the success of the applications in neural network. The topology of the net can better be determined of subjective form, from a principle that consists of adopting the lesser intermediate number of possible layer and neurons, without compromising the precision. Thus, in this application, the layer of the entrance data possess 7 neurons corresponding the 7 variable referring to objects of knowledge. The intermediate layer possesses 4 neurons, and the exit layer possesses 1 corresponding neuron in a scale value determined for the ANN. The process of learning supervised based in the Back propagation algorithm applying software Easy NN determines the weights between the layers of entrance and intermediate, and between the intermediate and exit automatically.

The training process was finished when the weights between the connections had allowed minimizing the error of learning. For this, it was necessary to identify which configuration that would present the best resulted varying the taxes of learning and moment. After diverse configurations to have been tested, the net of that presented better resulted with tax of an equal learning 0,4 and equal moment 0,9. The data had been divided in two groups, where to each period of training one third of the data is used for training of net and the remain is applied for verification of the results. After some topologies of net, and parameters got the network that better resulted had presented. The net was trained for attainment of two results' group for comparison of the best-determined scale for the networks. In the first test the total of the judgment of the agents was adopted, however only in as test was gotten better scales, next of represented for method of the categorical judgments. With this, the last stage of the modeling in ANN consisted of testing the data of sequential entrance or random form, this process presented resulted more satisfactory. The reached results had revealed satisfactory, emphasizing the subjective importance of scale's methods to treat questions that involve high degree of subjectivity and complexity.

How much to the topologies of used networks, the results gotten of some configurations of the ANN and compared with the CJT, were observed that ANN 1, is the one that better if approached to the classification gotten for the CJT. The ANN is understood to simulate the behavior of the human brain through a number of interconnected neurons. A neuron executes weighed additions for the activations of the neurons representing nonlinear relations. The ANN has the capacity to recognize and to classify standards by means of processes of learning and training. The training of the net is the phase most important for the success of the applications in neural network. The topology of the net can better be determined of subjective form, from a principle that consists of adopting the lesser intermediate number of possible layer and neurons, without compromising the precision. Thus, in this application, the layer of the entrance data possess 7 neurons corresponding the 7 variable referring to objects of knowledge. The intermediate layer possesses 4 neurons, and the exit layer possesses 1 corresponding neuron in a scale value determined for the ANN. The process of learning supervised based in the Back propagation algorithm applying software Easy NN determines the weights between the layers of entrance and intermediate, and between the intermediate and exit automatically. The training process was finished when the weights between the connections had allowed minimizing the error of learning. For this, it was necessary to identify which configuration that would present the best resulted varying the taxes of learning and moment.

After diverse configurations were tested, the net of that presented better results with tax of an equal learning 0,40 and equal moment 0,90. The data was divided in two groups, where to each period of training one third of the data is used for training of the net and the remaining is applied for verification of the results. After some topologies of networks, and parameters, got the obtained network that showed better results was presented. The network was trained for the attainment of two result groups to compare the best-determined scale for the networks. In the first test the total of the judgment of the agents was adopted, however only in as test was gotten better scales, next of represented for method of the categorical judgments. With this, the last stage of the modeling in ANN consisted of testing the data of sequential entrance or random form, this process presented more satisfactory results. The reached results proved satisfactory, emphasizing the subjective importance of the scale methods to treat questions that involve high degree of subjectivity and complexity. With regards to the topologies of the used networks, the results obtained some configurations of the ANN and compared with the CJT, it was observed that ANN 1, is the one that best approached the classification obtained for the CJT. Thus, even other topologies do not Tenaha been the best ones, it had been come however close in some objects of knowledge of the CJT. The results can be observed in Figure 2 that follows.

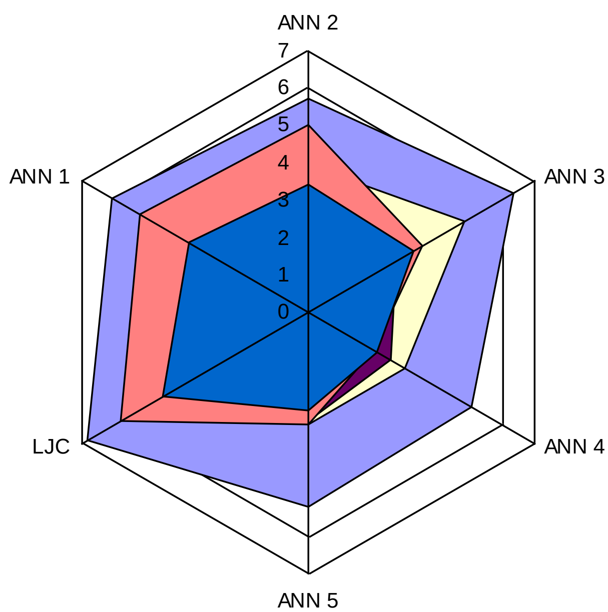


Figure 2: Priority of Knowledge's Objects - ANN and CJT

The prioritized objects for the tool proposals were for value chain knowledge. Artificial Neural Networks (ANN), as well as Psychometric (CJT), was restricted only to the specialists' decisions in projects of raised subjectivity and complexity, needing other elements that consider the learning of new knowledge. However, it is interesting to highlight that the CJT method, as it considers a variable involving a high degree of subjective and complexity and because it works with probabilities in the intensity of preferences, considers the learning of new elements of knowledge. Thus, it can be said that for typology of application, as presented here, it is sufficiently indicated. Thus, even other topologies do not Tenaha been the best ones, it had been come however close in some objects of knowledge of the CJT.

3.2.3 Influence of Knowledge on the Performance of Innovation Value Chain: Spearman's Correlation

Spearman's correlation coefficient is often used to describe the relationship between two ordinal characteristics. Therefore, a set of Spearman' correlation analysis was conducted to identify relationships between the independent variables. and dependent variables.

Table 2: Spearman's correlation matrix between the independent and dependent variables

Stakeholders' knowledge (Sources)	Dimension: Impact on the Client						
	Variables						
	1	2	3	4	5	6	7
R&D	1,00						
Clients	0,12	1,00					
Suppliers	(0,05)	0,13	1,00				
External consultants	(0,47)	(0,63)	(0,36)	1,00			
Competitors	(0,25)	(0,47)	(0,05)	0,12	1,00		
Joint ventures	(0,09)	0,72	0,40	(0,53)	(0,09)	1,00	
universities/other public research center	0,61	(0,29)	0,40	(0,29)	0,10	(0,33)	1,00

The knowledge variables produced by R&D and the Universities and research centers are strongly correlated. It is believed that this partnership is not a recent event in companies (1870) (Sbragia, et al, 2006), although they have been in place longer in universities or government technological institutes. Together, the knowledge from R&D and universities influence the Customer's impact dimension more strongly. Either way, universities are particularly boosted by financial resources coupled with knowledge exchange (Segatto-Mendes; Rocha and Sbragia, 2002). From a business perspective, this can be explained by the need to conduct and redirect R&D to new technologies and patents, development of new products and processes; in addition to product quality improvement. This feedback enhances knowledge innovation. Accordingly, the ability to absorb and process information into knowledge and the conversion of different forms of knowledge will likely determine the company's level of technology and innovation. Moreover, innovation cooperation refers to the company's active participation in R&D joint projects and innovation with another company or institution, hence enabling to leverage resources, mitigate risks, set standards and conduct research.

This gives way to gaining ground for the joint construction between companies and universities if they cooperate and collaborate in the research and development of new products. In this perspective, the generation of new knowledge drives individuals to increasingly specialize in specific knowledge fields and subfields (Berends et al., 2006) making cooperation in R&D projects an indispensable tool to stay abreast in the latest technological trends, especially in the intensive R&D field. In this context, cooperation represents an important opportunity for the supply of knowledge. While industry moves toward development, moving to incremental innovations, the academic institutions are directed to research. Thus, cooperation with academia can contribute to the search of new inventions and provide important stimuli to the development of radical innovations (Fabrizio, 2009) and (Tödtling et al., 2009), especially when a wide range of external sources is taken into account (Chiang and Hung, 2010). From this perspective, research confirms that the number of R&D partnerships has increased recently ((Hagedoorn, 2002; Hagedoorn, 1993; Hagedoorn, 1990; Hagedoorn and Schakenraad, 1992; Henderson and Clark, 1990; Roijakkers and Hagedoorn, 2006).

Table 3: Spearman's correlation matrix between the independent and dependent variables

Stakeholders' knowledge (Sources)	Dimension: Business results						
	Variables						
	1	*2*	*3*	*4*	*5*	*6*	*7*
R&D	1,00						
Clients	(0,30)	1,00					
Suppliers	(0,50)	-	1,00				
External consultants	(0,62)	0,19	0,37	1,00			
Competitors	(0,40)	-	0,32	0,39	1,00		
Joint ventures	0,10	(0,49)	-	-	0,65	1,00	
Universities/other public research center	0,37	(0,11)	0,19	(0,35)	-	0,23	1,00

The knowledge bases generated in joint ventures and competitors are strongly correlated and together have a strong influence on the business return dimension. From a global industry perspective, a country's competitive position is dependent on the relative strength and weakness of other countries ((Porter, 1980; Zou and Cavusgil, 2002). In addition, organizations wishing to establish a global strategy are faced with foreign and domestic competition. However, companies generally benefit from competitors as benchmarking sources and transfer of best practices (Drew, 1997).. Hence, the competitor's knowledge is composed of the main features of rival companies. Furthermore, the competitor's quantity, timeliness and intelligence accuracy can determine a company's ability to respond to competitive moves on a global scale. The competitor's knowledge is evident in the ability to acquire, interpret and integrate information on the global competitive environment. The competitor's knowledge is therefore one of the capacities of the market knowledge that is necessary to be successful in the market, in which a significant positive impact on the company's performance is expected ((Kohli and Jaworski, 1990). Therefore, managers must have detailed knowledge about their competitors and be vigilant to identify threats and opportunities in the market.

Table 4: Spearman's correlation matrix between the independent and dependent variables

Stakeholders' knowledge (Sources)	Dimension: Sales percentage derived from new products						
	Variables						
	1	*2*	*3*	*4*	*5*	*6*	*7*
R&D	1,00						
Clients	(0,27)	1,00					
Suppliers	0,05	0,41	1,00				
External consultants	0,27	(0,58)	(0,12)	1,00			
Competitors	0,67	(0,30)	(0,29)	0,52	1,00		
Joint ventures	(0,27)	0,17	(0,47)	(0,58)	(0,30)	1,00	
Universities/other public research center	0,22	0,09	(0,09)	(0,09)	(0,05)	0,53	1,00

The knowledge generated by competitors and R&D is correlated, and jointly exert a strong influence on return on sales derived from innovation. The resources of a company that are difficult to imitate and that competitors do not have represent competitive advantages (Barney, 1995; Barney and Mackey, 2005; Craighead, Hult, Ketchen Jr, 2009; Howells, 1995; Teece, 1977; Argote; Ingram, 2000).

Tacit knowledge is a competitive advantage and, therefore, its imitation should be avoided by competitors, however it should be allowed for other parts of the organization and, at times, for allied organizations as well. Thus, the ideal is to codify this tacit knowledge to facilitate its transfer within the company and between partners. This standardization, however, facilitates the imitation of these resources by rival companies (Howells, 1995; Kogut; Zander, 2003). Furthermore, innovation is predominantly linked to R&D that is associated with the creation of new products. There are many innovation studies showing that increased R&D leads to innovative products and enables companies to achieve competitive advantages and gain market shares (Armbruster et. al., 2008; Freeman and Soete, 1997). R&D has become a strategic development leverage for companies seeking to achieve world class status (Hendry, 1998). However, to create value it is essential to understand how value is created from the relationships of stakeholders that create knowledge (Blankenburg Holm et. al, 1999; Anderson and Gerbing, 1988).

When checking the correlation of performance in the innovation value chain, from the dimensions perspective, we calculated the degree of Spearman's correlation. The results showed that the dependent variables are significantly correlated. Therefore, efforts should be focused on overall performance, considering that together the results are strongly significant. By establishing the correlation between customer impact and return on business, the degree of correlation reached 0.8651, which shows a strong correlation. By correlating sales percentage derived from innovation, the degree of correlation was 0.8149, also indicating a significant correlation. And finally, by correlating business return to sales percentage derived from innovation, the result was 0.8202. Thus, the effect of knowledge is more significant when performance considers the set of dimensions, instead of considering them individually. To check the stability of the conceptual model, that is, the joint effect of independent variables in relation to the dependent variables, a strong influence of independent variables on the dependent variables was observed, using the F test (calculating F greater than F tabulated). Together, the independent variables explain the conceptual model presented.

3.2.4 Influence of Knowledge on the Performance of Innovation Value Chain and Critical Factor Success

To execute this step the multicriteria method was used: Compromise Programming, Electre III and Promethe II. The multicriteria method was chosen due to its flexibility for the case in question, especially the subjective nature of the variables involved and the problem to be solved. The methods' application anticipates weight inferences to the evaluation criteria, expressing their relative importance. The relationship of significance between the evaluation criteria should reflect the stakeholders' resulting values within the study's scope of application, considering their specific expectations for each criterion. In this spectrum, defining the criteria weights is characterized as a group decision-making problem, which includes identifying the stakeholders' preferences and consensus. The definition of the evaluation criteria weights used in this work proposal was prepared by the experts, through a judgment matrix. With the judgment matrix results, these methods were applied: Promethee II, Electre III and Compromise Programming, to evaluate the stakeholders' knowledge influence on the value chain performance considering each of the performance dimensions. Thus, these are the stakeholders identified: (i) R&D; (ii) Clients; (iii) Suppliers; (iv) External consultants; (v) Competitors (vi) Joint ventures; and (vii) universities/other public research centers, which here are considered as the independent variables. The performance dimensions: customer impact and business return, were considered as dependent variables. The results showed the following classification.

Table 5: Performance of the stakeholders' knowledge on the innovation value chain performance and Critical Success Factor (CSF): Compromise Programming, Electre III and Promethe II

Stakeholders' knowledge (Sources)	Classification		
	Promethee II	Compromise Programming	Electre III
R&D	1ª	1ª	1ª
Clients	1ºª	1ºª	3ª
Suppliers	3ª	3ª	2ª
External consultants	4ª	4ª	2ª
Competitors	2ª	2º	3º
Joint ventures	4º	4º	4º
Universities/other public research center	2º	2º	3º

Both methods (Compromise Programming and Promethee II) indicate R&D Knowledge and Customers as the most relevant to ensure performance of the innovation value chain in PDT, confirming the hypotheses. When comparing the results in terms of performance, the methods Compromise Programinng and Promethee II did not differ in their classifications. As for Electre III, the results were divergent. This is due to the veto threshold p, q and v, respectively, of indifference, strong preference and veto or incomparability, moreover, there is a discrepancy in the structure of its results (classification). Electre III features a solution group with a more flexible hierarchical structure. This calls attention to the method conception itself, as well as the quite explicit consideration of indifference and incomparability between alternatives. As an advantage of this structure of results, an easier consideration of the most difficult aspects to address and an analysis can be concluded, enabling a final less rigid hierarchy, around a small group of alternatives that can also be classified as better options.

The alternatives that exhibited some measures of incomparability were classified as other alternatives, which did not feature the same characteristics, and which were placed in a situation of disadvantage, regarding other criteria. It is observed that such alternatives are not comparable with any other alternative. Similar to the incomparability feature, another important characteristic of the methods Electre III and Promethee II is intransitivity. Considering that Compromise Programming is based on the distance of the alternative evaluated as an "ideal solution" vector, it is then concluded that this method has transitive features. Thus, the methods that better performed to ensure performance of the innovation value chain in PDT are: Compromise Programming and Promethee II, which resulted in the following classification in decreasing order: (^{1st}) R&D customers; (^{2nd}) Competitors and Universities/Research Centers; (^{3rd}) Suppliers; and (^{4th}) External Consultants and Joint ventures. The results referenced by the methods "Promethee II" and "Compromise Programming" reflect the preference, in the experts view, by R&D knowledge and Customers, with 68% and 59% of the preferences, respectively.

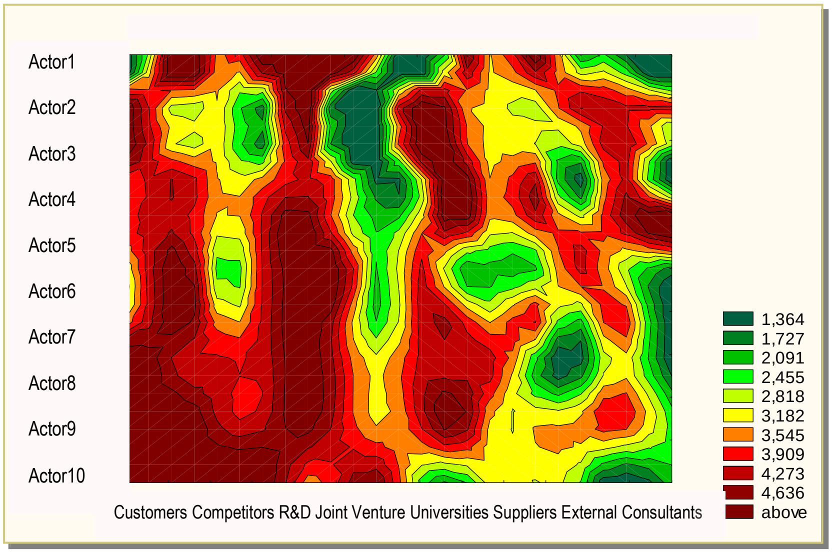
3.2.5 Mental Representation of Probability in the intensity of Knowledge Influence on the Performance of Innovation Value Chain in PDT

The failed attempts to evaluate the performance of the value chain give way to reinforce the importance of their role, taking a leap towards more innovative and mistake risk-free models. It does not mean replacing an absolute control of the activities and actions, nor forsaking what has worked thus far, rather encouraging pragmatism by emphasizing the performance of the value chain in more plausible and feasible ways. Moreover, to measure performance is an important issue because it allows to detect and monitor the effectiveness and failures of efficiency. And one of the major difficulties is the presence of multiple inputs and multiple outputs in the system. In order to improve the performance of the entire value chain, it is necessary to traverse the companies' individual boundaries and consolidate the entire chain, hence a cohesive and integrated system to increase the knowledge flow in the chain. The results obtained confirm the state of the art shown in previous studies about the positive influence of knowledge on company performance (ZAHRA and DAS, 1993; CAPON et. al.., 1990; Souder and Sherman, 1994; Calantone et. al., 1995). The influence of the stakeholders' knowledge on the overall performance of the innovation value chain is acknowledged in a plausible and workable manner. It is a reading of the inputs and outputs, which are indicative, because the decisions context is dynamic and highly subjective. In this spectrum, the LJC psychometric scaling method gains emphasis and moves satisfactorily to the problem at hand, as it considers the experts' mental behavior to explain the structure of preferences in relation to stimuli, in a dynamic context in which decisions are made.

The model evaluates each stimulus by its scale value. This mental process is called "modal discrimination processing" and the preferences are explained through comparisons with the scale values. This is an unconscious mental mechanism and perceived only through its noticeable manifestations, which are represented by the choices revealed empirically through the relative frequencies of the preferences. A relevant aspect is the psychophysical nature of the method. The preferences occur in different moments, and thus the scale values will vary according to the dynamics of its own mental process. Thus, in view of the randomness of the scaling process of the stimuli, the notion of preference must be replaced by the preference probability. Figures 2, 3 and 4 show the results of probability in the intensity of knowledge influence on the performance of innovation value chain in PDT, according to the stakeholders (experts). The goal in building up a mental map is to make the decision makers of projects on product development understand the decision context better.

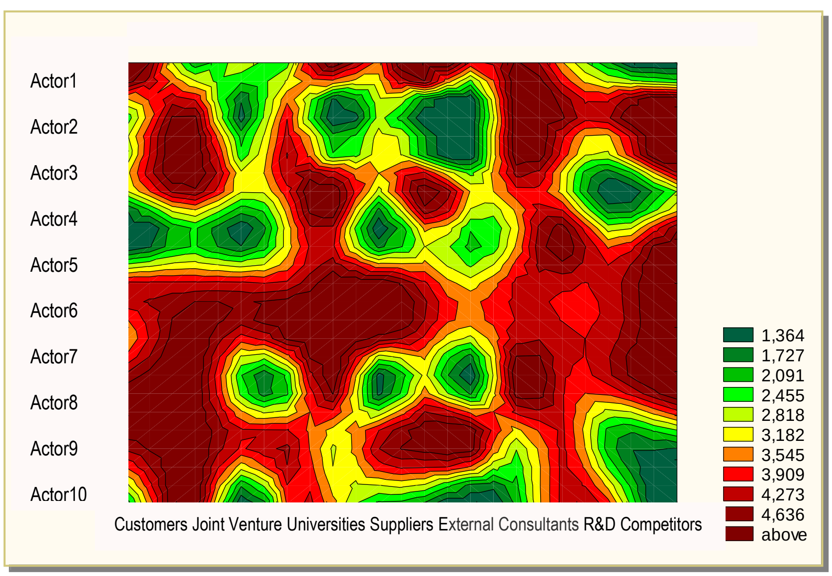
The data to be mapped out is extracted by various means, in this case, we have worked using semi-structured interviews, considered as a highly valuable instrument to identify the hierarchical structure and the dimensions of the judgment underlying the processes of classification. In this classification, the manner in which the specialists organize or structure this knowledge is described.

Figure 3: Probability in the intensity of Knowledge influence on Performance of the PDT innovation value chain - Customer Impact Dimension



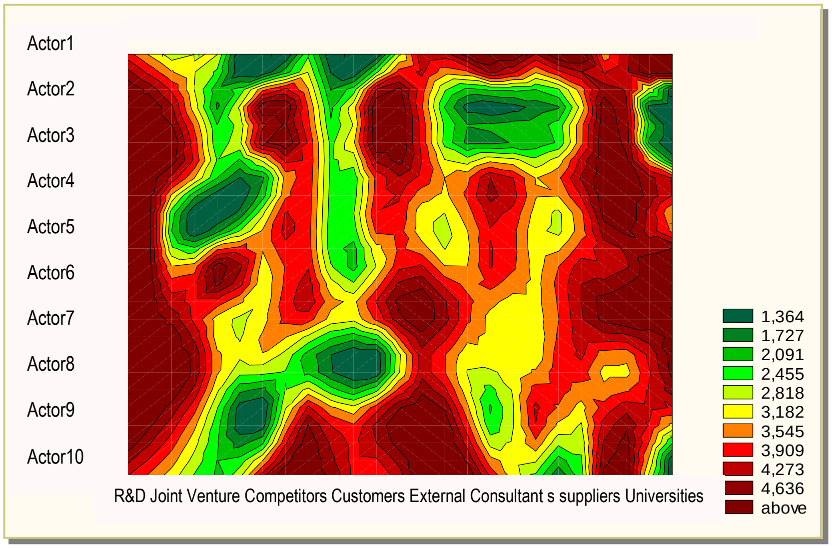
A strong relationship is evident between the dependent and independent variables, considered in this study, even under constraints. Many studies have referred to the positive influence of knowledge of customers, suppliers, R&D, Competitors, Universities and Research Centers on the performance of innovation value chain in PDP/PDT.

Figure 4: Probability in the intensity of Knowledge influence on Performance of the PDT innovation value chain - Business Return Dimension



This paper empirically investigated the stakeholders' knowledge impact on the performance of innovation value chain in PDP/PDT, in which the first insight is represented by the knowledge generated from R&D regarding the performance of innovation value chain in PDP/PDT, particularly radical innovations, which are strongly encouraged and supported by cooperation with Universities and Research Centers (Todtling, Lehner, Kaufmann, 2009), which confirmed the hypothese H1.

Figure 5: Probability in the intensity of Knowledge influence on Performance of the PDT innovation value chain - Sales Percentage Dimension Derived from Innovation



Identifying knowledge generated from the knowledge sources and their effect on the incremental value of PDT can enable the stakeholders to support their strategic knowledge acquisition decisions, as well as assist governments with similar decisions on innovation policies at local and national levels. Innovative efforts in new product development should be pursued. This is a complex and difficult business. The reasons for these difficulties are the unexpected risks and their impact, as well as the inability of companies to efficiently defend themselves against these risks. The risks cause instability in product development projects due to unexpected occurrences and the less effective responses taken against them

5. Final Words: Lessons Learned

Decision-making processes play an important role in product innovation processes. In every stage of the process decisions are made about the progress of the project (Cooper, 1983). The high demand for innovative products has been treated as a challenge for the adoption of traditional project management (PM) practices and methods, specially those ones developed in turbulent and complex business environments. Product development process (PDP) has received special attention from companies due to it is recognized as a source of competitive profits. Continued innovation of products, services, technology and the organization itself, has been one way to keep a business on its feet during the turbulent 1990s (Cozijnsen, Vrakking, and IJzerloo, 2000). Through its systematization companies can reduce theirs costs and development time and increase their product quality. The dream scenario for thousands of businesses would be to gain the ability to get their products to market faster, and to know with some certainty that their product-development projects would be completed on schedule. Thus, The present work intends to contribute to the innovative planning guidelines in the field of product development. The knowledge may represent a strategic tool, increasing the institutional capacity of organisations and the Entrepreneurs in their assignments of formulation, evaluation and execution of such projects. The knowledge would work as a facilitator instrument of improvement, contributing for the quality of services and the enhancement of the agility to decide.

Within this spectrum, this paper investigated the influence of the stakeholders' knowledge on the performance of the innovation value chain in product development process applied to technology-based companies. Several conclusions can be drawn from the results of this research. It is essential to measure the contribution of knowledge in the value chain performance. The performance of the value chain is an interdisciplinary and multidimensional concept that considers several areas of knowledge. The sample data supported the conceptual model derived from the literature. The confirmation of the general model proposed was important because it empirically evidenced that knowledge from R&D sources is considered the greatest influence on the performance of innovation value chain. Even if it is simply the probability intensity of the influence of this knowledge on the PDT innovation value chain.

The results obtained have been satisfactory, validating the proceeding proposed for assembling and prioritizing critical knowledge for research and development (R&D), as well as for comprising other elements of performance in the innovation value chain. Thus, this paper is aimed at an important area in Brazil. The current challenge is to develop knowledge systems to collect, distribute and disseminate information/knowledge to enable and facilitate policy development for the early implementation of innovation projects in product development. In this scenario, our methodological contribution is highlighted, because it provides support to the critical priorities in order to implement this project, and is also directed to building up knowledge as a key element for product development. We look forward to a more practical and efficient orientation that supports its long-term goals, thus assuring national competitiveness concerning the category of priorities. By gathering the cognitive elements, it can be seen that this strategy requires a priority dynamics, which depends on the initial state of product development process, on the concrete characteristics of the projects and on an innovation policy and cognitive problems that emerge during practice, always placing in view new contents. For this, priority research must be permanently and recurrently applied. Moreover, it is important that this method be used in other applications. Also, it is recommended testing the hypothesis by giving the decisions environment of that category of projects an intelligent treatment, by means of this research's systematic knowledge, which makes decisions more efficient concerning the development and management of product development projects.

Few studies have investigated the influence of knowledge on PDP under constraint conditions. It is hoped that this study will stimulate a broad debate on the issue and it is acknowledged that more studies are needed to build more robust results in the near future. In addition, the study is limited to technology-based companies, opening the possibility for significant results. Moreover, the measurement of qualitative variables is a highly subjective factor. All data were collected transversally, and therefore what can be concluded is that the variables and their effects are related to a single point in time, thereby showing a limiting factor.

Finally, there may errors deriving from various origins such as incomplete sampling bases, among others. Some key priorities are proposed for future studies. We acknowledge the importance of replicating this study and repeating this testing model approach, using a completely new sample from other sectors. Interesting comparisons could also be carried out, as for instance applying the procedure adopted here in another country, in order to compare the results. Within this spectrum, this methodology does not claim to be complete, but it is our intent to make it a generator of strategic elements for the development of innovation projects. This is where the knowledge Management becomes important, since it is a key instrument for project development in such a complex issue, as it is the case of product development.

References

Amit, R. E P.J.H. Schoemaker, P.J.H., 1993. Strategic assets and organizational rent, *Strategic Management Journal* Vol. 14. Nº 1, pp. 33–46.

Anderson, J.C. E Gerbing, D.W., 1988. *Structural equation modeling in practice: a review and recommended two-step approach,* Psychological Bulletin, Vol. 103 No. 3, pp. 411-23.

Armbruster, H.; Bikfalvi, A.; Kinkel, S.; and Lay, G., 2008. Organizational Innovation: The Challenge of Measuring Non-technical Innovation in Large-scale Surveys. Technovation, vol 28, p.644-657.

Aryee, G., Naim, M.M. and Lalwani, C. (2008) 'Supply chain integration using a maturity scale'.*Journal of Manufacturing Technology Management*. Vol. 19, Issue: 5, pp. 559 – 575.

Barney, J. B., 1995. Looking inside for competitive advantage. The Academy of Management Executive, v. 9, n. 4, p. 49-61.

Barney, J.B., Mackey, T.B., 2005. Testing resource-based theory. In: Ketchen, D.J., Bergh, D.D. (Eds.), Research Methodology in Strategy and Management. Elsevier JAI, Oxford, United Kingdom, pp. 1–13.

Bessant, J.,; Lemming, R.; Noke, H.; E Phillips, W., 2005. Managing innovation beyond the steady state, Technovation, Vol. 25, pp. 1366-76.

Blos, M.F., Quaddus,M., Wee, H.M. and Watanabe, K. (2009) 'Supply chain risk management (SCRM): a case study on the automotive and electronic industries in Brazil'. *Supply Chain Management: An International Journal*. Vol. 14, Issue: 4, pp. 247 – 252

Calantone, R.J., Chan, K. and Cui, A.S., 2006. Decomposing product innovativeness and its effect on new product success, *Journal of Product Innovation Management*, Vol. 23 No. 5, pp. 408-21

Calantone, R.J.; Vickery, S.K;. E Dro¨Ge, C., 1995. Business performance and strategic new product development activities: an empirical investigation, *Journal of Product Innovation Management,* Vol. 12, pp. 214-23.

Cheng, C. E Shiu, E., 2006, *Re-innovation – what is it and what could influence its performance?*, Conference Paper No. 254, Academy of Marketing Conference, London, UK.

Cheng, J., Yeh, C., Tu, C. (2008) 'Trust and knowledge sharing in green supply chains', *Supply Chain Management: An International Journal*, Vol. 13 No.4, pp.283-95.

Chow, G.; Heaver, T.D.; and Henriksson, L.E 1994. Logistics performance: definition e measurement. *International Journal of physical Distribution & Logistics Management*, Vol..24, n.1, p.17-28.

Cooper, R.G. 1983, A process model for industrial new product development, IEEE Transactions on Engineering Management, Vol. 30 No. 1, pp. 2-11.

Cooper, R.G. E Kleinschmidt, E., 1987. Success factors in product innovation, *Industrial Marketing Management,* Vol. 16 No. 3, pp. 215-33.

Cooper, R.G. E Kleinschmidt, E.J., 1987. New products: what separates winners from losers*?*, *The Journal of Product Innovation Management*, Vol. 4 No. 3, pp. 169-84.

Cozijnsen, A.J, Vrakking, W.J., IJzerloo, M.V., 2000.. Success and failure of 50 innovation projects in Dutch companies". European Journal of Innovation Management. Volume 3 . Number 3. pp. 150-159.

Craighead, C. W., Hult, T. M., Ketchen Jr, D. J., 2009. The effects of innovation–cost strategy, knowledge, and action in the supply chain on firm performance. Journal of Operations Management 27 405–421

Cronbach, L.J., 1951. Coefficient alpha and the internal structure of tests. *Psychometrika* 16, 297–334.

Davenport, T. E Prusak, L., 1998. Working knowledge: How organizations manage what they know, *Harvard Business School Press,* Boston.

Drew, S. A. W., 1997. From knowledge to action: the impact of benchmarking on organizational performance. *Long Range Planning*, Vol. 30. Nº 3: 427-441.

Evangelista, R.; Iammarino, S.; Mastrostefano, V.; E Silvani, A., 2001. Measuring the regional dimension of innovation. Lessons from the Italian Innovation Survey, *Technovation,* Vol. 21 No. 11, pp. 733-45.

Fabbe-Costes, N., Jahre, M. 2007 'Supply chain integration gives better performance – the emperor's new suit?', *International Journal of Physical Distribution & Logistics Management*, Vol. 37 No.10, pp.835-55.

Fawcett, S.E., Allred, C. , Magnan,G.M.; and Ogden, J. 2009 Benchmarking the viability of SCM for entrepreneurial business model design. *Benchmarking: An International Journal*, Vol. 16, Issue: 1, pp. 5 – 29

Fletcher, L., Yiannis E. Polychronakis, Y. E. 2007 Capturing knowledge management in the supply chain. *EuroMed Journal of Business*. Vol. 2, Issue: 2, pp. 191 – 207

Freeman, C.; Soete, L., 1997. The Economics of Industrial Innovation, 3ª ed., Londres: Pinter.

Godsell, J., Birtwistle, A. and Hoek, R.V.(2010 'Building the supply chain to enable business alignment: lessons from British American Tobacco (BAT)'. *Supply Chain Management: An International Journal*. Vol. 15, Issue: 1, pp. 10 – 15

Grant, R. M., 1996a. Prospering in Dynamically Competitive Environments: Organizational Capability as Knowledge Integration, Organization Science, Vol. 7, No. 4: pp. 375- 387

Grant, R. M., 1996b. Toward a Knowledge-Based theory of the Firm", Strategic Management Journal, Vol. 17 (Winter Special Issue): pp. 109-122.

Green Jr, K.W., Whitten, D. and Inman, R. A.. 2008 The impact of logistics performance on organizational performance in a supply chain context. *Supply Chain Management: An International Journal*. Vol. 13, Issue: 4, pp. 317 - 327

Griliches, Z., 1990. Patent Statistics as Economic Indicators: A Survey, *Journal of Economic Literature* 28: 1661-1707.

Gupta, A, Wilemon, D., Atuahene-Gima, K. 2000. Excelling in R&D. *Research Technology Management Vol.*43. Issue 3, 52-59.

Hagedoorn, J. 1990. Organizational modes of inter-firm co-operation and technology transfer", *Technovation*, Vol.10, pp.17-30.

Hagedoorn, J., 1996. Trends and patterns in strategic technology partnering since the early seventies. *Review of Industrial Organization*, v. 11, p. 601-616.

Hagedoorn, J., 2002. Inter-firm R&D partnerships: an overview of major trends and patterns since 196, *Research Policy*, Vol. 31, pp.477-492.

Hagedoorn, J.; Narula, R., 1996. Choosing organizational modes of strategic technology partnering: international and sectoral differences. *Journal of International Business Studies*, pp. 265-284, Second Quarter.

Hagedoorn, J.; Schakenraad, J., 1992. Leading companies and networks of strategic alliances in information technologies, *Research Policy*, v.21, p.163-190.

Hagedoorn, J.1993. Understanding the rationale of strategic technology partnering – interorganizational modes of cooperation and sectoral differences. *Strategic Management Journal*, v. 14, n. 5, pp. 371- 385.

Halldórsson, Á., Kotzab, H., Mikkola, J.H. and Skjøtt-Larsen, T. 2007 'Complementary theories to supply chain management', *Supply Chain Management: An International Journal*, Vol. 12 No.4, pp.284-96.

Hamel, G. E Prahalad, C.K., 1994. *Competing for the Future*, Harvard Business School Press, Boston, MA.

Hanisch, B., Lindner, F., Mueller, A. and Wald, A..2009 *Knowledge management in project environments*.V. 13, pp. 148-160.

Hemphill, T.A., 2003. Cooperative strategy, technology innovation and product development in industrial companies. *International Journal of Production Economics* Vol. 69, 169–176. Horn, P.M.

Henderson R.M.; Clark, K.B., 1990. Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms", *Administrative Science Quarterly,* Vol. 35, pp.9-30.

Horn, P.M., 2005. The changing nature of innovation. *Research Technology Management* Vol. 48, 28–33.

Johannessen, J. A; Olsen, B.; and Lumpkin, G. T., 2000. Innovation as newness: What is new, how new, and new to whom? *European Journal of Innovation Managemen*t, Vol. 4. Nº 1, 20–31.

Johannessen, J., Olsen, B., 2010.. The future of value creation and innovations: Aspects of a theory of value creation and innovation in a global knowledge economy. *International Journal of Information Management* Vol. 30 502–511.

Johannessen, J.; Olsen B.; Olaisen, J., 1999. Aspects of innovation theory based on knowledge-management. *International Journal of Informaiton Management* 19, p. 121-139, 1999.

Joshi, A.W., Sharma, S., 2004. Customer knowledge development: antecedents and impact on new product performance. *Journal of Marketing* 68, 47–59.

Kannabiran, G. 2009 'Process and content dimensions of Knowledge Management Strategy planning: an exploratory study'. *International Journal of Knowledge Management Studies* - Vol. 3, No.1/2 pp. 79 - 96

Kayakutlu, G. and Buyukozkan, G. 2010 'Effective Supply Value Chain Based on Competence Success'. *Int. Journal: Supply Chain Management: An International Journal*, Vol: 15, Issue: 2

Kim, S.W. 2006 'The effect of supply chain integration on the alignment between corporate competitive capability and supply chain operational capability', *International Journal of Operations & Production Management*, Vol. 26 No.10, pp.1084-107.

Kohli, Ajay K.; Jaworski, Bernard J., 1990. Market orientation: the construct, research propositions, and managerial implications. *Journal of Marketing,* Vol.54, Nº2, pp.1-18.

Leonard-Barton, D. 1995. Wellsprings of Knowledge - Building and Sustaining the Sources of Innovation, *Harvard Business School Press*, Boston, Massachusetts.

Likert, R., 1967. *The Human Organization: its Management and Value,* McGraw-Hill Book Company, New York, NY.

Love, J.H., Roper, S., 2001. Location and network effects on innovation success: evidence for UK, German and Irish manufacturing plants. *Research Policy* Vol. 30, pp. 643–661.

Love, J.H.,Roper, S., 1999. The determinants of innovation: R&D, technology transfer and networking effects. *ReviewOf Industrial Organization* Vol. 15, pp. 43–64.

Martin, C. R., Horne, D. A., and Schultz, A. M. 1999. The business-to-business customer in the service innovation process. *European Journal of Innovation Management,* Vol 2. Nº 2, 55-62.

Milliken, F. 1987. Three types of perceived uncertainty about the environment: State, Effect and Response Uncertainty, *Academy of Management Review*, 12, 133-143.

Nelson, R.; Winter, S., 1982. An evolutionary theory of economic change. Cambridge, Mass.: *Harvard University Press.*

Neuman, J. and Samuels, C. 1996 Supply chain integration: vision or reality? *Supply Chain Management, Bradford*, V. 1, n. 2, p. 7-10..

Nonaka, I. ; Takeuchi, H., 1995. The Knowledge-Creating Company, Oxford University Press, New York, NY.

Nunnally, J.C., 1967. Psychometric Theory. New York: McGraw-Hill.

Porter, M.E., 1980. *Competitive Strategy: Techniques for Analyzing Industries and Competitors,* Free Press, New York, NY.

Power, D. 2005 'Supply chain management integration and implementation: a literature review', *Supply Chain Management: An International Journal*, Vol.10, pp 252-63

Roper, S., Hewitt-Dundas, N., Love, J.H., 2004. An ex ante evaluation framework for the regional benefits of publicly supported R&D projects. *Research Policy* Vol. 33, pp. 487–509.

Ropera, S., Dub, J., James H. and Love, J.H., 2008. Modelling the innovation value chain. *Research Policy* Vol. 37. pp 961–977.

Sbragia, R.; Andreassi, T.; Campanário, M. A. ; and Stal, E. 2006. Inovação: como vencer este desafio empresarial. São Paulo: Clio Editora.

Segatto-Mendes, A.P.; Rocha, K.C.; and Sbragia, R. 2002. O processo de cooperação universidade-empresa em universidades brasileiras. *Revista de Administração da USP*, Vol. 37. Nº. 4, pp. 58-71.

Shelanski, H.A., Klein, P.G., 1995. Empirical research in transaction cost economics: a review and assessment. Journal of Law, Economics and Organization Vol.11. pp. 335–361.

Souder, W. and Sherman, J. 1994. *Managing New Technology Development.* McGraw-Hill, New York.

Svensson, G. 2007 'Aspects of sustainable supply chain management (SSCM): conceptual framework and empirical example'. *Supply Chain Management: An International Journal*. Vol. 12, Issue: 4, pp. 262 – 266

Souza, J. 1988. Métodos de Escalagem Psicossocial. Vol. V, Brasília: Thesaurus.

Teece, D.J., 1986. Profiting from technological innovation. *Research Policy* Vol. 15. Nº 6, 285–305.

Thurstone, L. L ., 1927. A law of comparative judgment. Psychological *Review*. England.

Tushman, M. L.; Nadler, D. A., 1986. Organizing for innovation. *California Management Review,* Vol. 28. Nº 3, 74– 92.

Utterback, J.J., Abernathy, W.J., 1975. A dynamic model of product and process innovation. Omega Vol. 3. Nº 6, 639–656.

Van der Vorst J., 2005. Performance measurement in agri-food supply chain networks. An overview, in Ondersteijn, C.J., Wijnands, J.H., Huirne, R.B., van Kooten, O. (eds) *Quantifying the Agri-food Supply* Chain Springer, Dordrecht.

Wheelwright, S. and Clark, K. 1992. Revolutionising *Product Development.* Free Press, New York.

Wu, Y., Balasubramanian, S. and Mahajan, V., 2004. When is a preannounced new product likely to be delayed?', *Journal of Marketing,* Vol. 68 No. 2, pp. 101-13.

Zhang, Q.; Lim, J.S.; e Cao, M., 2004. Innovation-driven learning in new product development: a conceptual model, *Industrial Management & Data Systems,* Vol. 104 No. 3, pp. 252-61.

Zou, S.; Cavusgil, S. T., 2002. The GMS: A Broad Conceptualization of Global Marketing Strategy and Its Effect on Firm Performance, *Journal of Marketing*, 66 2002 (October), pp. 40-56.