ISSN: 2278-3369
International Journal of Advances in Management and Economics
Available online at www.managementjournal.info

RESEARCH ARTICLE

Multi-Model for Planning High Complexity Environment using Hybrid Intelligent Architecture

Oliveira SRM*

Department of Administration, University Federal Tocantins, Tocantins, Brazil.

*Corresponding Author: E-mail:*selmaregina@webmail.uft.edu.br*

Abstract

The present paper aims to contribute toward the Planning High Complexity Environment using Hybrid Intelligent Architecture. Therefore, a modeling for the decision of the building up and the management of the innovation value chain (VC) in product development process (PDP) has been developed based on the Knowledge Theory, that considers a sequence of systematic procedures in the following phases:: Phase 1: Modelling the needs of information in Value Chain Management; and Phase 2: Determination of the Critical Knowledge in Value Chain Management. Several support instruments were used in the modeling elaboration in order to reduce subjectivity in the results: psychometric scales - Thurstone's Law of Comparative Judgment (LCJ), multi-criteria Compromise Programming, Electre III, and Promethee II; Artificial Neural Networking (ANN); Neurofuzzy networks. The results produced are satisfactory, validating the proposed procedure for VCM.

Keywords: *Innovation, Knowledge, Modeling Planning, Product Development Process, Value Chain Performance.*

Introduction

Today's relevant changes have transformed organizational boundaries, making them more fluid and dynamic in response to the rapid pace of knowledge diffusion [1,2], innovation and international competition [3-5], thereby urging to reconsider how to prevail using innovation [1,6,7]. Thus, innovative companies began to focus more on their own abilities to adapt to the economic value generated from their knowledge and innovations [1, 2]. The companies that can supply their products to customers faster and more efficiently will probably be in better conditions to create a sustainable competitive advantage [8-10] gained from knowledge and innovation in order to create new products [6] as the main source of economic income [10-12]). 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, which may result in business performance improvement [13] based on the ability to counteract the vulnerability of globalization in business operations [14] and the ability to design and supply innovative products with great added value to customers in a timely matter, promoted by the value chain, to transform and make use of knowledge. 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 [15-18]. Moreover, 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 deserve 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 [19-22]. 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 [19, 23]. 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. The companies that can supply their products to customers faster and more efficiently will probably be in better conditions to create a sustainable competitive advantage [8,9,10,24, 25] gained from knowledge and innovation in order to create new products [6] as the main source of economic income [10,11]. Thus, innovative companies began to focus more on their own abilities to adapt to the economic value generated from their knowledge and innovations [1, 2].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 deserve 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 [19-22]. 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 [19, 23]. 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 toward the Planning High Complexity Environment using Hybrid Intelligent Architecture. Therefore, a modeling for the decision of the building up and the management of the innovation value chain (VC) in product development process (PDP) has been developed based on the Knowledge Theory, that considers a sequence of systematic procedures in the following phases: Phase 1: Modelling the needs of information in Value Chain Management; and Phase 2: Determination of the Critical Knowledge in Value Chain Management.. Thus, this contribution focuses on the definition of knowledge priorities on the Innovation value chain performance in PDP/PDT. In the next section of the paper we introduce the modeling and results [26].

Modelling and Discussion

The objective of the modeling 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. The building-up and the management of a Value Chain require highly complex analytical approaches, which include subjective elements. Thus they demand the technical mastery of various technological, human, environmental, technical, legal, financial and political aspects and procedures. Knowledge t may represent a strategic tool, increasing the institutional capacity of the Entrepreneurs in their assignments of formulation, evaluation and execution of such projects [19-22]. Monitoring the performance of VCM from a knowledge perspective requires that the appropriate monitoring procedures are in place and operational [19, 27]. These procedures will of course depend on the kind of measures taken earlier and must be tailored to them. But it is not only improvement plans that must be monitored. Generally, a keen eye must be kept on the knowledge household of VCM. Especially important is watching the external environment for new events that may have impacts on the way VCM deals with knowledge shown as "incoming" arrows that will influence the execution of the knowledge [28]. 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. The modeling for the decision of the building up and the management of the innovation value chain (VC) in product development process (PDP) has been developed based on the Knowledge Theory, that considers a sequence of systematic procedures in the following phases.Phase 1: Modelling for determination of the needs of information in Value Chain Management and Phase 2: Determination of the Critical Knowledge in Value Chain Management. These different stages are detailed here.

Phase 1: Modeling the needs of Information in Value Chain Management-PDP/PDT

This phase is structured in three stages: Stage 1: determination of the Critical Success Factors (CSF); stage 2: determination of the information areas; and stage 3: prioritization of the information needs starting from the crossing of CSF and the Areas of Information.

Stage 1: Determination of the Critical Success Factors (CSF)

This step is focused on determining the CSF, 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: (a) environmental analysis (external variable: political, economical, legislation, technology and 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. This model starts form mental behavior to explain the preference of a judge (individual) concerning a set of stimuli $\{O_1, O_2,..., O_n\}$. Thus, the evaluation of the CFS is systematized in the following steps: Step 1: determination of the frequencies by pairs of stimuli. Step 2: determination of the frequencies of ordinal categories. Step 3: calculation of the matrix $[\pi ij]$ of the relative frequencies accumulated. It is highlighted though that the results to be achieved in Step 3 reflect the probabilities of the intensity of the specialists' preferences regarding the stimuli, the Critical Factors of Success in this work. As a result, a hierarchical structure of CSF is obtained. Determining the CSF is the goal. The CSF in VCM are: first, the Market and Political Factors; second, the Technical Factor; third, the Economical and Financial Factor; and fourth, the Judicial Factor.

Step 2: Determination of the Areas of Information

The CSF having already been defined, the information areas are delimited with respect to the different CSFs. After determining the CSF, the determination of the areas of information ensues. The goals of the areas of information define specifically what must be achieved by these areas to meet one or more objectives from the projects (business), contributing for the enhancement of the project performance as to quality, productivity and profitability. We first identified the following stakeholders (information sources): (i) research and development - R&D [29] (ii) Customers [30] (iii) Suppliers [31] (iv) External consultants [31] (v) Competitors [32]; (vi) Joint ventures [32]; and (vii) universities/other public research centers [33]. After the information 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 information needed to converge each of the stages in the PDT stages. The results showed the following knowledge according to the PDT steps [7,34] (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. The result has allowed defining four groups that represent the areas of information: first, the Governmental Area on Public Policies; second, the Economical and Financial Area; third, the Technical Information Area; fourth, the Market Area.

Stage 3: Prioritization of the Information needs Starting from the Crossing of CSF and the Areas of Information

Again, these information areas are ranked by application of the same Categorical Judgment Method of Thurstone (1927) and put into relation with the CSF. At this moment the following tools have been adopted: (a) Multi-objective utility – multi-attribute, in this case Compromise Programming ™, which represent mathematically the decision makers' preference structure in situations of uncertainty; (b) selective, taken on account for the situation, Promethee II ™ and (c) Electre III ™. These methods rendered their contributions in determining the performance in the areas of information, which led to the identification of Mercadology Area as the most important ones in order to globally ensure the overall critical success factors. The critical knowledge for VCM is determined in the sequence.Aiming to know which area of the VCM the decision makers must develop a "strong management", the prioritization of information needs takes place. The results shown by the Methods Compromising Programming, Electre III and Promethee II have pointed out the Mercadology Area as the most relevant one to guarantee the CSF. The gathering, analysis and processing of information must be to strongly reinforce the set of activities that comprise his area, specially in what concerns the information about actions on: (a) to monitor the political, economical and social environment, risks that impact directly or not the organizations; (b) the best choice decision as for the contractual negotiation, specially the rights and duties between partners; (c) the best choice of partners; (d) the best build-up and management of the project; (e) the best definition of the competition policy; (f) the best definition of service levels: availability; punctuality; reliability; flexibility; managing the defect recuperation system; (g) the best definition of the costs structure; (h) the best definition policies of managing holdings; (i) the best choice of quality and productivity for policies on the Value Chain; (j) competitive strategy; (k) analyze strategic planning on defense against competition; (l) monitoring and control of the environment; (m) the best choice criteria, organization, proceeding and monitoring of projects; (n) monitor risks of the project; (o) attend to demands; (p) define the best investment policy; (q) search for better innovation practices and new managing methods and models (demand and offer); (r) define better capital and finance structure; (s) follow-up of supply markets of input; (t) define better partnerships and alliances; (u) define planning policies and control social and environmental impacts and their mitigation; (v) the best financial engineering management; define the goals to be met; etc. In order to do so, the data gathered from the specialists were used.

Phase 2: Determination of the Critical Knowledge in Innovation Value Chain Management-PDP/PDT

This phase has been subdivided as follows: Step 1 -Identification and Acquisition of Knowledge; Step 2-Determination of the Effective Rate of Knowledge Priority in Decision of the Value Chain Using Neurofuzzy Modeling. This proceeding is shown in details as to its structure.

Step 1: Identification and Acquisition of Knowledge

This stage determines the concept of knowledge to be taken into account in the development of this work. So, for the operational goals of this work, we have adopted them as "contextual information" and the "theoretical framework and concepts". Initially, information topics which have been already identified will be elaborated, analyzed and evaluated in order to be understood by the decision makers during the formulation and the VC. Following this, they will be reviewed and organized and validated by VC specialists. Afterwards, relevant theories and concepts are determined. With respect to the acquisition procedures, the different procedures of the process of acquisition represents the acquisition of the necessary knowledge, abilities and experiences to create and maintain the essential experiences and areas of information selected and mapped out ([28]). Acquiring the knowledge (from specialists) implies, according to [35], [19], the obtaining of information from specialists and/or from documented sources, classifying it in a declarative and procedural fashion, codifying it in a format used by the system and validating the consistence of the codified knowledge with the existent one in the system. Therefore, at first, the way the conversion from information into knowledge ([36]) is dealt with, which is the information to be understood by and useful for the decision making in VC. First the information is gathered. Then the combination and internalization is established by the explicit knowledge (information) so that it can be better understood and synthesized in order to be easily and quickly presented whenever possible (the information must be useful for the decision making and for that reason, it must be understood). In this work, we aim to elaborate the conversion of information into knowledge. The conversion (transformation) takes place as follows: first, the comparison of how the information related to a given situation can be compared to other known situations is established; second, the implications brought about by the information for the decision making are analyzed and evaluated; third, the relation between new knowledge and that accumulated is established; fourth, what the decision makers expect from the information is checked. The conversion of information into knowledge is assisted by the information maps (elaborated in the previous phase by areas, through analysis and evaluation of the information). We highlight that the information taken into account is both the ones externally and internally originated. The information from external origins has as a main goal to detect, beforehand, the long-term opportunities for the project. The internal information is important to establish the strategies, but it has to be of a broader scope than that used for operational management, because besides allowing the evaluation of the performance it also identifies its strengths and weaknesses. Following from this, the proceedings for the acquisition of theoretical background and concepts are dealt with. Such proceedings begin with the areas of information, one by one, where the concept and the theory on which is based the performance of the actions (articulations) developed in those areas that allow to guarantee the feasibility of the VC projects are identified. In other words, which knowledge and theory are required to be known in order to ensure the success of projects on Value Chain in that area. Then, the analysis of surveys in institutions about the job market for these institutions takes place bearing in mind the demands of similar areas studied in this work. As for the offer, we intend to search for the level of knowledge required by the companies and other organizations in those areas, as well as what concerns technical improvement (means) for the professionals. This stage determines the concept of knowledge to be taken into account on the development of this work. So, for the operational goals of this work, we have adopted them as the "contextual information" and the theoretical framework and concepts. The results showed the following knowledge according to the PDT Clusters (Fig. 1) By gathering the cognitive elements, it can be seen that this strategy requires a priority dynamics, which is dependent on the initial state of knowledge, on the concrete characteristics of the projects and a policy of development product and cognitive problems that emerge during the practice, always

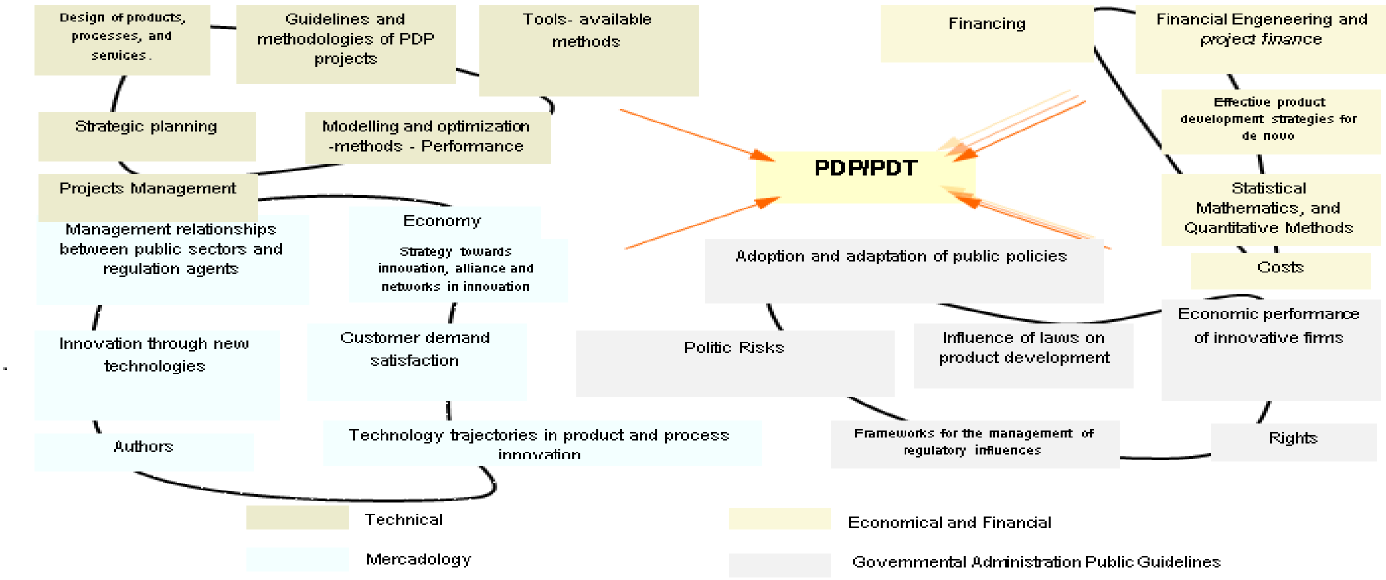


Fig. 1: Thematic priorities of knowledge

putting in view new contents. For this, priority researches must be permanently and recurrently applied. As it is such a relevant theme in our country's current historical context, we recommend that this study, given the demonstrated feasibility of the method, be continued and updated on an ongoing basis, enabling the monitoring of changes taking place in the context regarding the projects. 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 development product projects on the innovation value chain. After identification and acquisition of Knowledge the objects of knowledge, the build-up of cognitive map take place, assisted by the software Statistic.. The results of the decision makers' intensity about the objects of knowledge can be seen in Fig. 2.

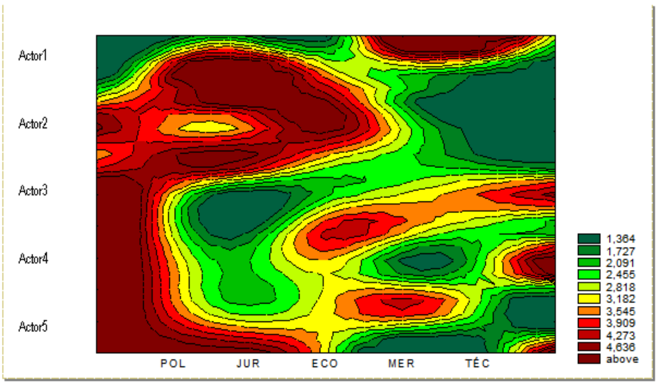


Fig. 2: Clusters -Intensity of the objects of knowledge in PDP on innovation value chain

With this, it becomes necessary to emphasize knowing the priority knowledge presented, bearing in mind they have to take on an essential role in managing PDP projects. With regards to Policies and Instruments of competition, the legal elements of protection are sought, such as defending competition. 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 supporting the partnership proposals; (ii) the strategic objectives; (iii) assurances of effective cost and risk advantages for the government; (iv) maintenance of government policy and space for public policies; (vi)political stability guaranties of contracts: (vii) the partner's profile and technical and financial capacity.

Knowledge Evaluation using Method of Categorical Judgments of Thurstone (1927) and Artificial Neural Network (ANN)

After being identified and acquired, the knowledge is evaluated, with the aid of the Method of Categorical Judgments of [37] and artificial neural network (ANN).

Evaluation for the Method Categorical Judgments' Laws (1)

Stages: As referenced earlier, the influence of knowledge on overall performance management was conducted by means of the Thurstone's LJC psychometric scaling method. The method allows a scale by importance. Thus, let π_{ij} = 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:

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

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

Where πij is an estimator of πij and considering value Z_{ij} such that, $Prob[N(0,1) \leq Zij] = \hat{\pi} ij$, we have $\frac{(\mu\mu - cj)}{\sqrt{V(\varepsilon(-nj)}} = -Zi_j$, 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. Thus, the achievement method of the research results with the specialists of VCM, who revealed their preferences for pairs of stimulation (in the case, the objects of knowledge, and these submitted the ordinal categories C1 = 5º place, C2 = 3º place and C3 = 4º place). The evaluation of objects of knowledge (LJC) happened in three stages: In the stage (1), one determined the frequencies for pairs of stimulations, where Oi is equivalent to objects of knowledge and Oj the specialists. The data had been extracted from the preferences of the specialists in relation to objects of knowledge, attributing weights to the cognitive elements. After that (stage 2), the preferences of the specialists are determined in relation to the stimulations (knowledge). The results were obtained by means of the ordinal frequencies from the results of the previous stage. Finally (stage 3), the accumulated relative frequencies were calculated first. The results obtained here reflect the probabilities of preferences intensity of the specialists in relation to the stimulations (theoretical bases and concepts). The result of the preferences, then, is presented in an upward order of importance. In order to demonstrate the application of the methodological proposal, the results of the objects of knowledge on the "Market Area " were dealt.

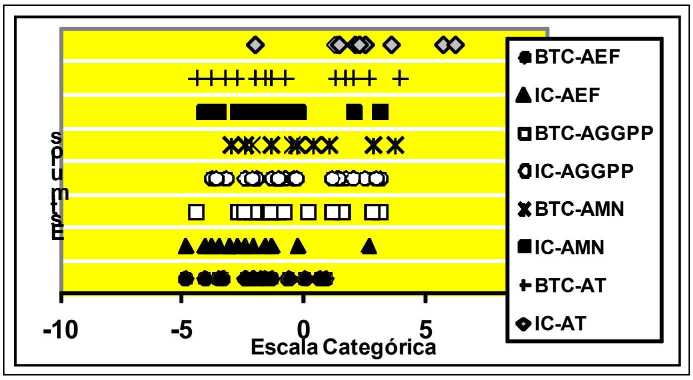


Fig. 3: Variation of Preference Dispersion of the Decision Makers

Prior to the compared analysis of knowledge, it is important to mention that the results wee extracted from the four categories of the following areas: Public Policies Government Management (PPGM), Economic and Financial (EF), Technical (T), Marketing/Business (MB). Firstly, we established a comparison of all the theoretical bases and concepts (TBC) and context information (CI), denominated as stimulus by the areas. Thus, generally we tried from this analysis to understand the behavior of the preference intensity of the decision makers regarding stimulus. Secondly, we compared all the sets of theoretical babes, analyzing the preference intensity of the specialists regarding the theories and concepts. Thirdly, we analyzed the behavior of context information, broaching the preference intensity of the decision makers with relation to the theories and concepts. Lastly, we discussed individually the categories (areas) to understand how the theories, concepts and context information behave. This procedure was performed with the support of the scale model of categorical judgments. With all of the various dimensions of Knowledge Objects (theoretical basis and concepts and context information), the results show that there is no great predominance of another type of knowledge, and this should be considered in VCM. However, there are those with more relevancies in the decision maker's preference. Therefore, the best decision is sought, considering the background of each Supply Chain category. Furthermore, one should consider that each one has its own peculiarity, hence demanding differentiated knowledge, since we are dealing with highly subjective questions. Hence; the reason why it is wise to choose those that fit best the reality of each project of the Value Chain. With regards to theoretical bases and concepts and context information, the "Market" category presents the following knowledge objects in an upward order of importance: (1) institutional organization for policies on VCM; (2) quality and productivity for policies on the Value Chain; (3) competitive strategy; (4) strategic planning on defense against competition; (5) administration of projects; (6) monitoring and control; (7) criteria, organization, proceeding and monitoring of projects; (8) engineering of the knowledge and technologies of the information; (9) actors; (10) risks of the project; (11) attendance the demand; (12) civil and commercial contracts; (13) productivity policy. (14) Investments policy; (15) innovation and new managing methods; (16) Financing; (17) Follow-up of costs and of supply markets of input; (19) Partnerships and Alliances; (20) Monitoring methods and techniques of the best success practices in Value Chain projects; (21) Quality Engineering – Quality Patterns; (22) Effective Engineering; (23) Technical and Human Resources; (24) Analysis of social and environmental impacts and their mitigation; (25) Information technology; (26) Indicators used by the market; (27) Monitoring the competition; (28) Profitability of the industry; and (29) New methods for forecasting and simulating the demands. The results obtained have been satisfying, validating the proceeding proposed for assembling and the prioritization of critical knowledge for VCM, as well as for the constitution of other elements of the intellectual capital in VCM.

Evaluation of Knowledge's Objects using the Artificial Neural Network (ANN) (2)

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 15 neurons corresponding the 15 variable referring to objects of knowledge. The intermediate layer possesses 7 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 0,30 and equal moment 0,80. 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 15 neurons corresponding the 15 0 variable referring to objects of knowledge. The intermediate layer possesses 7 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 0,30 and equal moment 0,80. 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 Fig. 4 that follows.

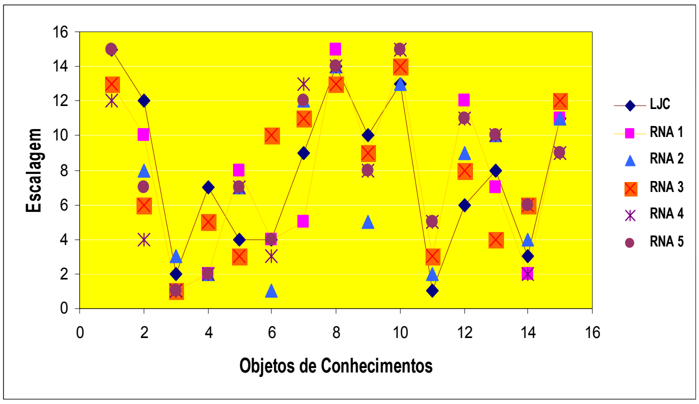
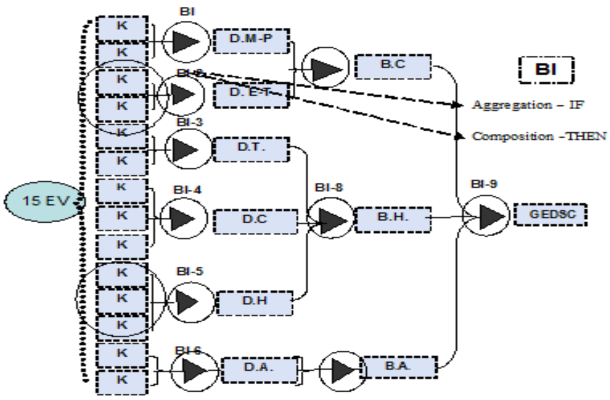


Fig. 4: Priority of Knowledge's Objects - ANN and CJT

The prioritized objects for the tool proposals were for VCM 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.

Step 2 :Determination of the Effective Rate of Knowledge Priority in Decision of the Value Chain using neurofuzzy Modeling

This stage focuses on determining the Rate of Decision Effectivity (RDE) on knowledge in Value Chain managing, with regards to using the Neurofuzzy Modeling. Seeing that it is a process whose attributes mostly have characteristics of subjectivity and the experience of the decision-maker is quite significant, there is a need for a tool that allows the association of quantitative and qualitative variables converged to a single evaluation parameter [38-40]. This model (Figure 5) adds the technology of Neural Networks to the Fuzzy Logic (Neurofuzzy technology). Here, this model supports the value chain managing and is adapted from the model of [38, 39].



Fig, 5: Modeling Neurofuzzy

In such Neurofuzzy, the entry data can be quantitative and qualitative and are grouped to determine the comparison parameters between the alternatives. Since the exact models suitable for this type of calculation have a complex application, the Neurofuzzy methodology enables and simplifies the human decision of reproducing the process. This methodology is structured from a combination of all of the attributes in blocks of inference that use base fuzzy rules and linguistic expressions, so that the preference for each alternative of knowledge priority decision, in terms of benefits in Value Chain, can be expressed by means of a "grade" varying from 0 to 10.Within this spectrum, this stage presents a modeling to evaluate objects of knowledge to provide support to the value chain chain performance, based on quantitative information and also on the specialist's qualitative information, using the Neurofuzzy technology. The qualitative parameters are difficult to measure and may indicate high levels of subjectivity, hence justifying the application of methods that allow the convergence of these parameters to a single coefficient, therefore enabling the decision-making taking into account all of the relevant attributes. The stages of the model are described to follow:

Determination of the Entry Variables and Linguistic Terms

It focuses on determining the entry variables (EV). These variables are categorized according to the quantitative or qualitative types. Also, the linguistic terms attributed to each EV are presented: High, Medium and Low. Thus, the EVs shown in the Model are: Guidelines of: Investments; Fiscal; Environmental; Risks; Regulations – Legislation; Client Service/quality; Quality; Productivity; Costs structure; Financial Return; Liquidity; Debt level; Financial Risk Managing, Investments and Financing Assessment; Assets Managing; Capital Structure; Best Quality Engineering and VCM Productivity practices, Competitive strategy; Criteria, organization, proceeding and monitoring of projects; Actors; Negotiation, Partnerships and Alliances; Economy; Risks of the project; Meet demand; Competition; Innovation and new managing methods (demand and offer); Follow-up of Supply Markets of input; Offer and Demand of Human Resources; Effective Engineering; Technical and Human Resources (offer and demand); Analysis of Social and Environmental impacts and their mitigation; Information Technology (Best Practices); Indicators practiced by the market; and Monitoring the competition.

Determination of the Intermediary Variables and Linguistic Terms

The entry variables go through the process of fuzzy inference, resulting in linguistic terms of Intermediary Variables (IV). Thus, the linguistic terms attributed to the IV were: Low, Medium and High, including some variables: Slow, Moderate, Fast – Bad, Regular and Good. The extracted intermediary variables were: Political Performance; Economic and Financial Performance; Market Performance; and Technical Performance.ConfigurationTechnical-Mercadology Benefit–(RDE). The proposed design is made up of seven configurations of fuzzy specialist systems, two entry variables (EV) that go through the fuzzy process and through the inference block, therefore producing an exit variable (EXV), designated intermediary variable (DV). In turn, such DV joins with another DV, hence forming a set of new EVs, consequently configuring a sequence until the last layer of the network. In the last layer, the definite variable EXV of the Neurofuzzy Network is produced. This EXV then undergoes a de-fuzzing process to achieve the final result: the value chain decision (RDE).

Determination of the Exit Variable – Effective Rate of Knowledge Priority in Decision and Performance of the Value Chain

The Exit Variable (EXV) of the Neurofuzzy model proposed was denominated Effective Rate of Decisions in Value Chain Performance, resulting in the processes of Fuzzyfication: This process includes determining the functions for each of the entry variables. If the entry data, the calculation results and observations are precise values, then it is necessary to perform the structuring of the fuzzy arrangement for the entry variables, which consists of the fuzzyfication process. In case the entry variables are obtained in linguistic values then the fuzzification process is not necessary.

The fuzzy arrangements can be characterized as a generalization of the Boolean sets, where the pertinency function can assume values at fixed intervals. Usually, the interval [0, 1] is considered, when it is not correct to assume that an element belongs to a specified set, but that it does indeed present a certain degree of pertinency. Therefore, a fuzzy set, besides an X universe, is a set of orderly pairs represented by Eq. 1.

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

Where $\mu_A(x)$ is a function of pertinency (or degree of pertinency) of x in A and is defined as the mapping of X in the closed interval [0,1], in agreement with a Equation 2 (Pedrycz and Gomide, 1998).

$$\mu_A(x): X \rightarrow [0,1] \quad (2)$$

Fuzzy inference: The ground rules of fuzzy inference is made up of the IF-THEN type, which are responsible for the association of the entry variables and the generation of the exit variables in linguistc terms, with their respective pertinency functions. The fuzzy inference is structured by two components: (i) aggregation, which means the computing from the SE of the rules; and (ii) composition, regarding the THEN part of the rules. The Degrees of certainty (DoC) that determine the linguistic vectors resulting from the processes of aggregation and composition are defined by the Equation 3.

$$GdC_i{:}\max[FC_1 \cdot \min\{GdC_{A11},GdC_{A12},\ldots,GdC_{1n}\},\ldots,FCn \cdot \min\{GdC_{An1},GdC_{An2},\ldots,GdC_{Amn}\} \mid \quad (3)$$

Defuzzification: In some applications the interpretation of a result is enough, as for instance, when a qualitative or verbal response is desired. However, in other applications, a numeric value as a result from the system is deemed as necessary (as for instance, arrangement and comparison). In these cases, after the fuzzy inference, a defuzzification process is necessary, that is, transform the linguistic values from their pertinency [40] functions. Usually, the Maximum Center method to determine an exact value for the Exit Variable linguistic vector is used. From this method, the certainty degree of the linguistic degrees is defined as "weights", associated to each of these values. The exact resolved value (RV) is determined by considering the weights in relation to the typical values (maximum values of the pertinency functions), in agreement with the definition of the Equation [40].

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

Where DoC represent the degrees of certainty of the linguistic terms of the final exit variable and X indicates the typical values for the linguistic terms that correspond to the maximums of the fuzzy sets, which define the final exit variable. The results can be seen in Figure 6, extracted from the Neurofuzzy model, which associates the EVs with its intermediary and exit layers, by means of inference blocks, where the inference rules for each pair of the considered variables are contained. The result of each implementation is the (RDE), defined between 0 and 10, in an increasing scale according to the adequate decision-making on knowledge in the Value Chain managing, regarding benefits for performance. The (RDE) indicates choosing the best alternative to concentrate the endeavors on the Value Chain managing. Meaning, that at first sight, it is vital to focus on monitoring the external ambient (Market and Politics), afterwards, the Technical and Economic and Financial issues (external ambient). It should be taken into account that comparison among variables should take place permanently and recurrently.

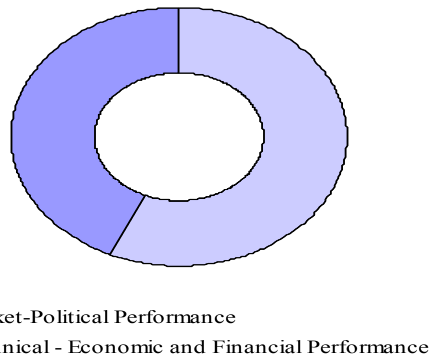


Fig. 6: GEDSC – Degree of Effectivity of Knowledge Priority Decision in Innovation Value Chain – PDP/PDT

Comparatively, the Market alternative demonstrated greater effectivity in the priority decisions of knowledge for performance in Value Chain managing. With regards to the Market and Politics variables, special attention must be given to VC external variables. Allied to this, a space opens up to define the new managing strategies, while seeking to make the decision spectrum more intelligent. For decision choosing, the Neurofuzzy model is a more efficient instrument to compare options. From the association of intervening objective and subjective variables in the decision choosing process, through a hierarchic neural network using a fuzzy inference process to convert information, it is possible to generate a numeric value denominated Rate of Decision Effectively (ROE). The greater the ROE, the more effective the chosen alternative for decision making for the situation hereby presented. By gathering the cognitive elements, it can be seen that this strategy requires a priority dynamics, which is dependent on the initial state of training, on the concrete characteristics of the projects and cognitive problems that emerge during the practice, always putting in view new contents. For this, priority researches must be permanently and recurrently applied.

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 [41]. 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 [42]. 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 in value chain. The knowledge would work as a facilitator instrument of improvement, contributing for the quality of services and the enhancement of the agility to decide. The approach of this work is to make the decision scope more intelligent, making available the knowledge about the development and the management of Value Chain projects.Also, the importance of the Neurofuzzy Technology is acknowledged as an additional managing instrument at the hands of administrators, especially so for the matter at hand, which enabled to identify the market variable more effectively in decisions of the value chain performance. This requires a more attentive outlook to questions involving the external ambient. 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 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. Trough this method a more pragmatic and efficient guidance is sought, assisting the guidelines for long-term value chain managing, hence assuring this segment's competitiveness. Extensive and systematic procedures should be pursued that are capable of uniting the most diverse dimensions of VCM, surpassing the non-scientific practice often pervading some of the works.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. This proposal focuses on highlighting unexplored questions in this complex design. However, it evidently does not intend to be a "forced" methodology, but intends to render some contribution, even through independent course of actions. Furthermore, this methodological support has no illusion of being complete, but it can indeed generate elements of knowledge that are strategic for managing the Value Chain. The efficient value chain management provides an opportunity for organizations to identify their core competencies and position themselves competitively in the marketplace [43]. In short, performing value chain activities in ways that would allow a firm the capabilities to outmatch rivals is a potential source of competitive advantage. The introduction of new products or processes – represent the end of a process of knowledge sourcing and transformation. They also represent the beginning of a process of exploitation which may result in an improvement in the performance of the innovating business. This recursive process of knowledge sourcing, transformation and exploitation comprises the innovation value chain. The results obtained have been satisfying, validating the proceeding proposed for assembling and prioritizing critical knowledge for in research and development (R&D), as well as for the constitution of other elements of performance of innovation value chain. This paper is aimed at an important area for 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 projects of innovation in R&D. The methodological proposal developed here differs from other methods of decision support because it extracts the tacit knowledge and converts it into the managers' explicit knowledge about R&D. The approach of this work is to make the decision scope more intelligent, making available the knowledge on the development and the management of projects. With base on the Knowledge, we have developed the proposal of a methodology that is focused on contributing to patterns of resource allocation to build-up innovation in R&D. In this scenario, our methodological contribution is highlighted, because it provides support for the critical priorities in implementing this project and is directed to building up of the knowledge as a key element for the development of products. We are looking forward to a more practical and efficient orientation supporting its long-term goals and assuring national competitiveness concerning the category of priorities. This methodological support does not intend to be complete, but it is our intent to make it a generator of strategically elements for the development of projects of innovation. This is where the information Management becomes important, since it is a key instrument for projects development in such a complex issue, as it is the case of R&D.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.. 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

1. Griliches Z, (1990) Patent statistics as economic indicators: A survey. J. Economic Literature 28:1661-707.
2. Teece DJ (1986) Profiting from technological innovation. Research Policy 15(6)285-305.
3. Chesbrough H, Rosenbloom RS (2002) The role of the business model in capturing value from innovation: Evidence from xerox corporation's technology spin-off companies. Industrial and Corporate Change11 (3):529-555
4. Christensen CM (2003) The Innovator's Dilemma, Harper Business Essentials, New York, NJ.
5. Damanpour F (1996) Organizational complexity and innovation: Developing and testing multiple contingency models. Management Science, 42(5):693-716
6. Teece DJ, Pisano G, Shuan A (1997) Dynamic capabilities and strategic management. Strategic Management Journal 18(7):509-33.
7. Wheelwright S, Clark K (1992) Revolutionizing Product Development. Free Press, New York.
8. Prahalad CK, Hamel G (1990) The core competence of the corporation. Harvard Business Review 79-91, May/June.
9. Amit RE, Schoemaker PJH (1993) Strategic assets and organizational rent. Strategic Management Journal 14(1):33-46.
10. Nonaka I, Takeuchi H (1995) The Knowledge-Creating Company, Oxford University Press, New York, NY.
11. Nelson R, Winter S, (1982) An evolutionary theory of economic change. Cambridge, Mass.: Harvard University Press.
12. Johannessen J, Olsen B, Olaisen J (1999) Aspects of innovation theory based on knowledge-management. Int. J. Informaiton Management 19:121-39.
13. Ropera, S., Dub, J., James H. and Love, J.H., (2008). Modelling the innovation value chain. Research Policy Vol. 37. pp 961–977.
14. Hoffman K, Parejo M, Bessant J, Perren L, (1998) Small firms, R&D technology and innovation in the UK: A literature review. Technovation 18(1):39-55.
15. Cheng J, Yeh C, Tu C (2008) Trust and knowledge sharing in green supply chains. Supply Chain Management: An Int. Journal 13(4):283-95.
16. Power D (2005) Supply chain management integration and implementation: a literature review. Supply Chain Management: An International Journal 10:252-63

17. Blos MF, Quaddus M, Wee HM, Watanabe K (2009) Supply chain risk management (SCRM): A case study on the automotive and electronic industries in Brazil. Supply Chain Management: An Int. Journal 14: (4)247-52

18. Fawcett SE, Allred C, Magnan GM, Ogden J (2009) Benchmarking the viability of SCM for entrepreneurial business model design. Benchmarking: An International Journal 16(1):5-29

19. Fletcher L, Yiannis E, Polychronakis YE (2007) Capturing knowledge management in the supply chain. EuroMed J. Business. 2(2):191-207.

20. Hanisch B, Lindner F, Mueller A, Wald A (2009) Knowledge management in project environments 13:148-60.

21. Kannabiran G (2009) Process and content dimensions of Knowledge Management Strategy planning: An exploratory study. Int. J. Knowledge Management Studies 3:(1/2):79-96.

22. Kayakutlu G, Buyukozkan G (2010) Effective supply value chain based on competence success. Int. Journal: Supply Chain Management: 15:2.

23. Godsell J, Birtwistle A, Hoek RV (2010) Building the supply chain to enable business alignment: Lessons from British American Tobacco (BAT). Supply Chain Management: An Int. Journal.15(1):10-5.

24. Utterback JJ, Abernathy WJ (1975) A dynamic model of product and process innovation. Omega Vol. 3(6) 639-56.

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

26. 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. Int. J. Information Management 30:502-11.

27. Svensson G (2007) Aspects of sustainable supply chain management (SSCM): conceptual framework and empirical example. Supply Chain Management: An Int. Journal. 12(4):262-6

28. Miguel LAP, Franklin MA, Popadiuk S (2008) The Knowledge creation with view to innovation as a dynamic capability in competitive firms. J. Academy of Business and Economics 8(4):45-56.

29. Shelanski HA, Klein PG (1995) Empirical research in transaction cost economics: A review and assessment. J. Law, Economics and Organization 11:335-61.

30. Joshi AW, Sharma S, (2004) Customer knowledge development: Antecedents and impact on new product performance. J. Marketing 68:47–59.

31. Horn PM, (2005) The changing nature of innovation. Research Technology Management 48:28-33.

32. Hemphill TA, (2003) Cooperative strategy, technology innovation and product development in industrial companies. Int. J. Production Economics 69:169-176.

33. Roper S, Hewitt-Dundas N, Love JH, (2004) An ex ante evaluation framework for the regional benefits of publicly supported R&D projects. Research Policy 33:487-509.

34. Cooper RGE, Kleinschmidt E (1987) Success factors in product innovation. Industrial Marketing Management 16(3):215-33.

35. Buchanan EA (1999) An overview of information ethics issues in a world-wide context. Ethics and Information Technology 1(3):193-201.

36. Herschel R, Nemati H, Steiger D (2001) Managing the tacit to explicit knowledge conversion problem: Knowledge exchange protocols managing the tacit knowledge problem. J. Knowledge Management 5(1)107-16.

37. Thurstone LL (1927) A law of comparative judgment. Psychological Review. England.

38. Cury MVQ (1999) Modelo Heurístico Neurofuzzy para Avaliação Humanística de Projetos de Transporte Urbano. Tese submitted for the degree of. Doctoral of Science in Production Engineering of University Federal of Rio de Janeiro, COPPE/UFRJ.

39. Oliveira, RLM (2004) Modelo Neurofuzzy para Escolha Modal no Transporte de Cargas. Dissertation submitted for the degree of. Master of Science in Transport Engineering of the Institute Militar of Engineering, Brazil, Rio de Janeiro.

40. Von Altrock C (1997) Fuzzy Logic and Neurofuzzy Applications in Business and Finance. Prentice Hall, USA.

41. Cooper RG (1983) A process model for industrial new product development. IEEE Transactions on Engineering Management, 30(1):2-11.

42. Cozijnsen AJ, Vrakking WJ, IJzerloo MV (2000) Success and failure of 50 innovation projects in Dutch companies". European J. Innovation Management 3(3):150-9.

43. Al-Mudmigh, Abdullah S, Zairi Mohamed, Ahmed Abdel M (2004) Extending the concept of Supply Chain: The effective management of value chains. Int. J. Production Economics 87(3):309-21.