

Towards a holistic knowledge management model

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Abstract Knowledge management (KM) has been gradually established as a strong methodology to support business viability, competitiveness and growth; however, the lack of maturity is obvious, as evidenced by divergent points of view in critical sub-domains of the related theory and practice, such as the spectrum of processes and the clusters of tactics scheduled to underpin them. The systems thinking logic, the discipline for seeing structures underlying complex phenomena, is perceived as a promising direction for consolidating the various approaches and developing a holistic KM paradigm. Through the integration of the fragmented landscape of knowledge management on a transparent and concrete framework based on cause-effect relationships, not only the underlying theoretical assumptions are clarified and subjected to further analysis at a strategic level, but also practical issues concerning planning and decision making become less complicated, increasing effectiveness.

Keywords Knowledge management, Intellectual capital, Strategic planning

Introduction

Knowledge management constitutes an emerging discipline aiming to support enterprises in the new business environment where the notion of economics of ideas seems to be an important prerequisite for success and viability (Wiig, 1997a). Despite the significant progress in both theory formulation and practice, various contradictory critiques have been observed, which mainly stem from the fact that KM is still in its early stages and many issues related to the basic processes, the pursued objectives and the appropriate measures to ground the KM activities are still a matter of debate for both the scientific and business community. This study emphasizes many aspects of knowledge management, reviewing widespread approaches on it and trying to formulate broadly accepted theoretical schemes, with ultimate goal the construction of a holistic model able to eliminate the existing ambiguities and facilitate the operations of strategic planning and decision making, so as to achieve more knowledge creation and better knowledge exploitation.

The major guide to build the desired KM model has been the systems thinking logic, which according to Rubenstein *et al.* (2001): "... is a conceptual framework for problem-solving that considers problems in their entirety ...". One important task of this mental scheme is the recognition of the boundaries that distinguish the parts belonging to a given system from those lying outside it, thus defining the environment still interacting with the constituent elements of the system. Following this rationale, an integrated KM model is designed step-by-step; basic KM processes and their relations are discerned, significant types of metrics able to activate and

support the processes are classified into discrete clusters and two major sets of enterprise objectives are recognized. The KM model is completed with the incorporation of the "environmental" factors that systems thinking theory suggests; these factors concern both intra- and extra-organizational elements. The background of the developed model is a platform of cause-effect relationships assumed to connect the core elements (measures, processes, objectives and "environmental" factors).

Knowledge definition and conversion types

The term knowledge signifies an area of conflict for many years due to the existence of resemblant concepts, such as data and information, which can easily approximate some forms of knowledge. For a deeper understanding of the knowledge management processes, an attempt to express the hidden meaning of data, information and knowledge is necessary. Joia (2000) cites the following:

... Data means a set of discrete and objective facts concerning events. Therefore, they can be construed as a structured record of transactions within an organization ...

... Information is data with attributes of relevance and purpose...usually having the format of a document or visual and/or audible message. ...

... Knowledge is linked to the capacity for action. It is intuitive, therefore hard to define. It is linked to the users' values and experience, being strongly connected to pattern recognition, analogies and implicit rules. ...

Webb (1998) associates the triple set data/information/knowledge with the capacity for action and, eventually, decision making: "... by selecting and analyzing data, information can be produced; by selecting and combining information, knowledge can be generated; from this decisions can be made and actions taken ...". In addition, Wiig (1998) distinguishes information from knowledge saying that information consists of facts and other data organized to characterize specific situations and conditions, while knowledge is used for the analysis, interpretation and evaluation of these situations and conditions. Knowledge consists of truths and beliefs, perspectives and concepts, judgments and expectations, methodologies and know-how and, furthermore, knowledge is possessed by humans, agents or other active entities. People who are knowledgeable not only have information, but also have the ability to integrate and frame the information within the context of their experience, expertise and judgment (Grover and Davenport, 2001).

Except from the debate about the meaning of knowledge comparatively to those of data and information, special interest has drawn the dichotomy of explicit and tacit knowledge (Webb, 1998): "... Explicit knowledge can be articulated in formal language and transmitted through manuals, written specifications etc. Tacit knowledge is seen as personal knowledge based on individual experience and values and therefore not as easily transmitted ...". Civi (2000), in addition, cites that: "... Explicit knowledge can be expressed in words and numbers and shared in the form of data, scientific formula, specifications and manuals ... It is codified and stored in databases where it can be accessed and used easily by anyone in the company ...", while "... Tacit knowledge is highly personal and hard to formalize, making it difficult to communicate or share with others ...". Tacit knowledge can be further split in two sectors; on the one hand embracing informal personal skills and crafts referred as know-how, while on the other hand considering an implicit cognitive dimension including beliefs, values and mental models (Civi, 2000). The opponents of the dichotomy explicit/tacit knowledge (autopoietic epistemology school) maintains the private/personal nature of knowledge; knowledge cannot be explicit, only tacit. From this point of view, explicit knowledge is actually data and/or

☞ **Knowledge consists of truths and beliefs, perspectives and concepts, judgments and expectations, methodologies and know-how.** ☞

information which enable other people to create their own knowledge. However, trying to capture modern aspects, the distinction between explicit and tacit knowledge seems to be accepted by the majority of academics and practitioners.

Beyond the ascertainment of the proper terminology about knowledge, a thorough analysis of all possible types of conversion between tacit and explicit knowledge is useful as this fact plays a critical role in the efficient and effective management of knowledge at an organizational level. Nonaka and Takeuchi (1995) are the researchers who introduced the notion of conversion schemes between tacit and explicit knowledge. These schemes are captured through the terms socialization (tacit to tacit), externalization (tacit to explicit), combination (explicit to explicit) and internalization (explicit to tacit) (Nonaka and Takeuchi, 1995; Becerra and Sabherwal, 2001; Civi, 2000):

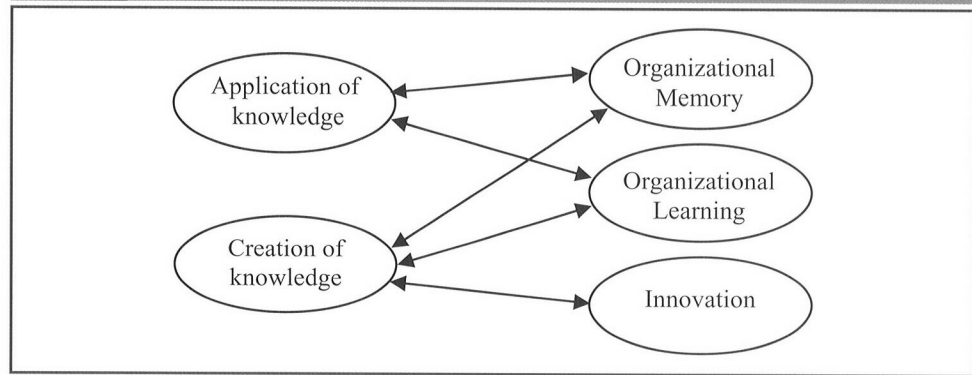
- **Socialization** describes the modification of tacit knowledge to other types of tacit knowledge. This process includes the sharing of experiences, ideas, images, mental models and technical skills. It takes place through joint activities, observation, imitation and practice rather than written or verbal instructions. Obviously, the investigation of the social gatherings and the appropriate working conditions play an important role in this form of knowledge transition.
- **Externalization** refers to the conversion of tacit knowledge to explicit knowledge; hidden tacit knowledge, as ideas, concepts, visuals, metaphors, analogies, narratives etc., is articulated and takes an understandable format. Computer-based techniques (visual modeling, inductive/deductive inference mechanisms, machine learning methodologies, case-based reasoning, decision support systems etc.) able to support individuals to describe, express and explain their inherent conceptualization are prominent in the externalization phase.
- **Combination** declares the explicit-to-explicit conversion. It involves the mixture of different bodies of explicit knowledge producing more complex sets of explicit knowledge. The systemization and codification of knowledge and, second, its communication, diffusion and integration, are integral parameters for the efficient and valid function of knowledge combination. Knowledge combination is strongly supported not only by computer-based technologies, as in externalization, but also by networks. Databases, classification methodologies, Web-based tools, intranets and the Internet are on focus.
- **Internalization** refers to the extension of explicit knowledge to tacit knowledge. Learning by doing, on-the-job training, learning by observation, face-to-face meetings listening to others' stories, simulations and experiments are some of the usual practices establishing the internalization procedure. Internalization produces experience knowledge through the explicate source; the individual acquiring the explicit knowledge embodied in action and practice can re-experience what others go through.

Finally, it must be clarified that there is a dual perception about knowledge; the individual and the organizational dimension. Based on Carayannis (1999), organizational knowledge is: "... the collective sum of individual knowledge assets ... processed information embedded in routines and processes which enable action ... knowledge captured by organizational systems, processes, products, rules and culture ...". Although the previous analysis in this section has mainly a human-centered approach, this does not mean that individuals' knowledge is of higher importance comparatively to the organizational type. Additionally, it is important to notice that organizational knowledge comprise both explicit and tacit elements.

KM processes: basic principles and an innovative causal model

The focus of knowledge management is on the integration and coordination of individuals' knowledge, that is, the appropriate "application/management" of current organizational knowledge, and the "creation" of knowledge (see Figure 1). These two dimensions, which under the "knowledge-based theory of the firm" are considered crucial when pursuing a sustainable competitive advantage, are closely related to the static and dynamic nature of knowledge (Grant, 1996; Hendriks and Vriens, 1999):

Figure 1 The dimensions of knowledge management



- The term “application/management” of knowledge stands for the effort to achieve an efficient and, ultimately, effective use of the knowledge lying in the organization. Core elements of this managerial initiative is the retrieval and systemization of the existent knowledge pool, the maintenance of (technological, social etc.) conditions reinforcing the availability and transfer of knowledge and, last, the setting up of the appropriate procedures and climate amplifying the learning behavior in organizations.
- On the other hand, the “creation” of knowledge exploits primarily the innovative nature exhibited by individuals and organizations. The acquisition of external knowledge bases, the elaboration of the current knowledge pool, the benefits of organizational learning, and an empowering and motivating working environment constitute substantial parameters for accomplishing the objective of knowledge creation.

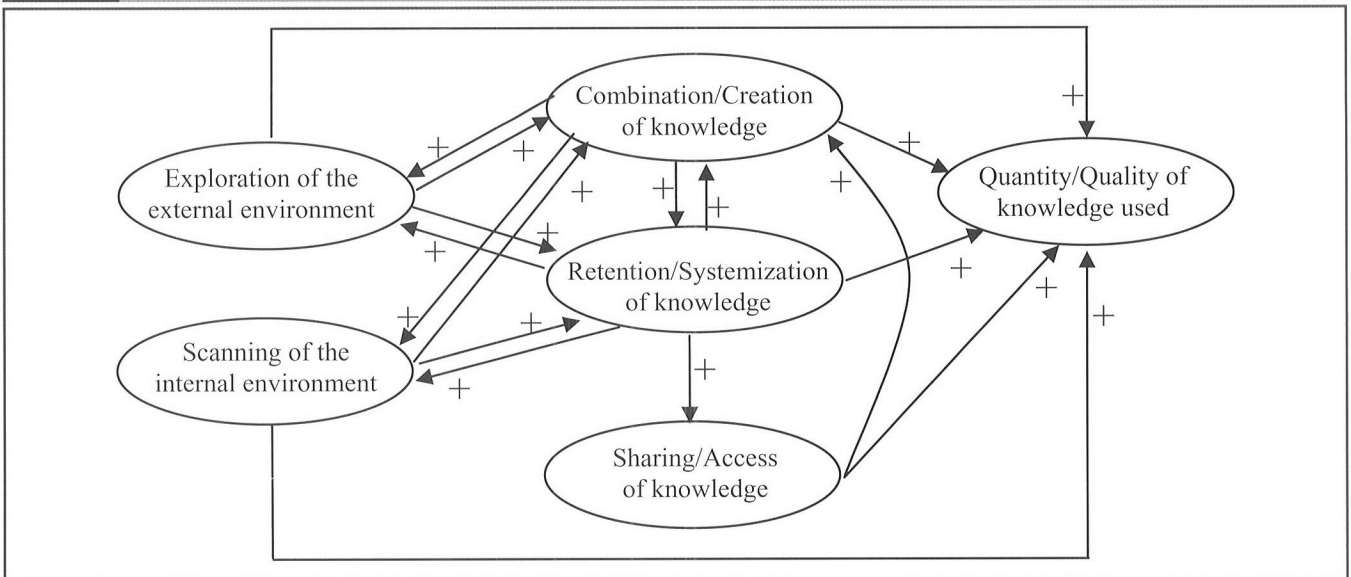
The aforementioned description leads to the framework depicted in Figure 1, where the discrete dimensions of knowledge “application/management” and “creation” are associated with three modern aspects of business thinking; organizational memory, organizational learning and innovation. The term organizational memory expresses (Stein, 1995): “. . . the means by which knowledge from the past is brought to bear on present activities, thus resulting in higher or lower levels of organizational effectiveness . . .”, organizational learning implies (Teare and Dealtry, 1998): “. . . the processes for continually generating, retaining and leveraging individual and collective learning to improve the performance of the organizational system . . .”, while innovation encompasses (Swan *et al.*, 1999): “. . . the dynamic, cognitive, social and political processes through which new ideas are developed, communicated, transferred and implemented over time within particular organizational contexts . . .”.

In order to give a more clear-cut description of the KM environment, diverse approaches, as expected, have been presented. For instance, according to Holsapple and Joshi (2000) knowledge management includes the acquirement, retrieval, generation, storage, distribution and externalization of knowledge, Soliman and Spooner (2000) suggest the creation, capture, organization, access and use of knowledge, Wiig (1997a) assumes that KM is regarded to build, transform, organize, deploy and use of knowledge, while Rowley (2000) proposes the operations of creation of knowledge repositories, improvement of knowledge access, enhancement of knowledge environments, and management of knowledge as an asset. Notice that most of the modern descriptions address the processes of knowledge management with a rather linear manner, that is the existence of relationships between them is disregarded. Such relationships were roughly and partially recognized only in Lim and Klobas (2000), which constituted a source of inspiration for this study.

Developing an integrated framework linking together the KM processes, the scheme depicted in Figure 2 is introduced. Accordingly, knowledge management is considered to encompass the processes of “retention-systemization of knowledge”, “sharing-access of knowledge”, “combination-creation of knowledge”, “exploration of the external environment”, “scanning of the internal context” and the “use of knowledge”. The constituent elements are assumed to



Figure 2 The causal nature of the KM processes



possess various cause-effect relationships between them, which are all positive but their strength differs significantly. Moreover, the strength of these relationships vary when examining organizations with divergent characteristics. To elaborate:

- The exploration of the external environment if improved through the development of inter-organizational collaborations (alliances, joint agreements, R&D contracts, customer/supplier partnerships etc.) or with the acquisition of strategic resources of knowledge/information, instantly improves the quantity of knowledge used, while, in parallel, augments the potential for knowledge generation. There is, additionally, high probability for improvement of the current knowledge systemization and codification as more knowledge spurs a better understanding of the meaning and the structure of the available knowledge assets.
- The internal scanning refers to the externalization process (tacit to explicit knowledge conversion). Similarly to the exploration of the external environment, the scanning of the internal part, in case of improvement, will augment the quantity of knowledge used, the potential for knowledge creation and the codification of the available knowledge pool. As such, the systematic search for hidden individual and social knowledge patterns using mainly computer-based technologies (e.g. expert systems) and the predominance of a behavior prompting the disclosure of intrinsic ways of thinking and acting, are expected to firmly sustain this process.
- The sharing and access of knowledge, as easily recognized, includes the process of socialization (tacit to tacit knowledge conversion) and, to a large extent, that of combination (explicit to explicit knowledge conversion). Concerning the surrounding relationships, if the sharing/access status is improved, through e.g. the use of better IT systems or with the adoption of more collaborative forms between organizational departments, then the quantity of knowledge used and the potential for knowledge creation will augment.
- The systemization and codification of the maintained knowledge and the capabilities to avoid erosion constitute one more core process in the KM environment, which in case of improvement will increase the capability for knowledge creation and use, while, additionally, it will improve the effectiveness of the existing sharing/access mechanism (better organized knowledge is more easily accessible). Moreover, a better structured knowledge base often motivates the systematic exploration of the external and internal environment. This part concerns mainly the combination process (explicit to explicit knowledge conversion).
- The increase of the potential for knowledge creation, obviously, improves the level of quality and quantity of knowledge used but also affects the systemization of knowledge assets

because, as previously mentioned, more knowledge leads to a better understanding of the available knowledge pool. Last, as the better structured knowledge base reinforces the exploration and exploitation of the external and internal environment, the same is valid for the generation of knowledge. This premise implies that the increase of the potential for knowledge creation will, presumably, increase the attempt for scanning the internal and external context. As far as the analogy to the knowledge conversion schemes are concerned, the creation phase encloses primarily the knowledge combination (explicit to explicit) and internalization (explicit to tacit).

The causal nature supposed to exist among the KM processes, as presented in Figure 2, has an operational and basically strategic impact. The conventional theoretical background of knowledge management focuses on the discrete processes in isolation to discuss the competitive advantage produced by the effective knowledge use and creation. Now, with the recognition of the causal behavior exhibited in the KM context, strategic thinking is extended, sheds light on the significance of the cause-effect relationships and shifts the interest on the strength of causality, the ensuing direct/indirect effects, the multiple feedback loops and many other related issues.

Different perspectives on KM tactics and objectives

Except from the processes around the knowledge management initiative, issues related to the formulation of strategies and operational activities, paired with the study of potential business objectives, arise. In this section, an attempt to capture the most widespread options is undertaken.

Beginning with the KM tactics, what has to be clarified is that (Davenport, 2000): "... the effective management of knowledge requires hybrid solutions of people and technology ...". This premise determines the fields that need to be analyzed in order to formulate effective knowledge management practices. In general, four domains of actions to explore exist (see Figure 3); the strategic measures (alliances, joint ventures, licensing agreements etc.), the organizational measures (job rotation, task integration etc.), the human resources management measures (motivation, training etc.) and the technical measures (knowledge-based systems, communication networks etc.) (Hendriks and Vriens, 1999). All these parts implicitly express different managerial perspectives as far as where the focus of knowledge management should fall. Although the level of detail may be broadly extended, such as in Wiig *et al.* (1997a) where decision streamlining, organizational flattening, knowledge building, R&D planning and project management programs are proposed, the categorization "strategic/organizational/HRM/technical" seems to satisfy the majority of researchers and practitioners.

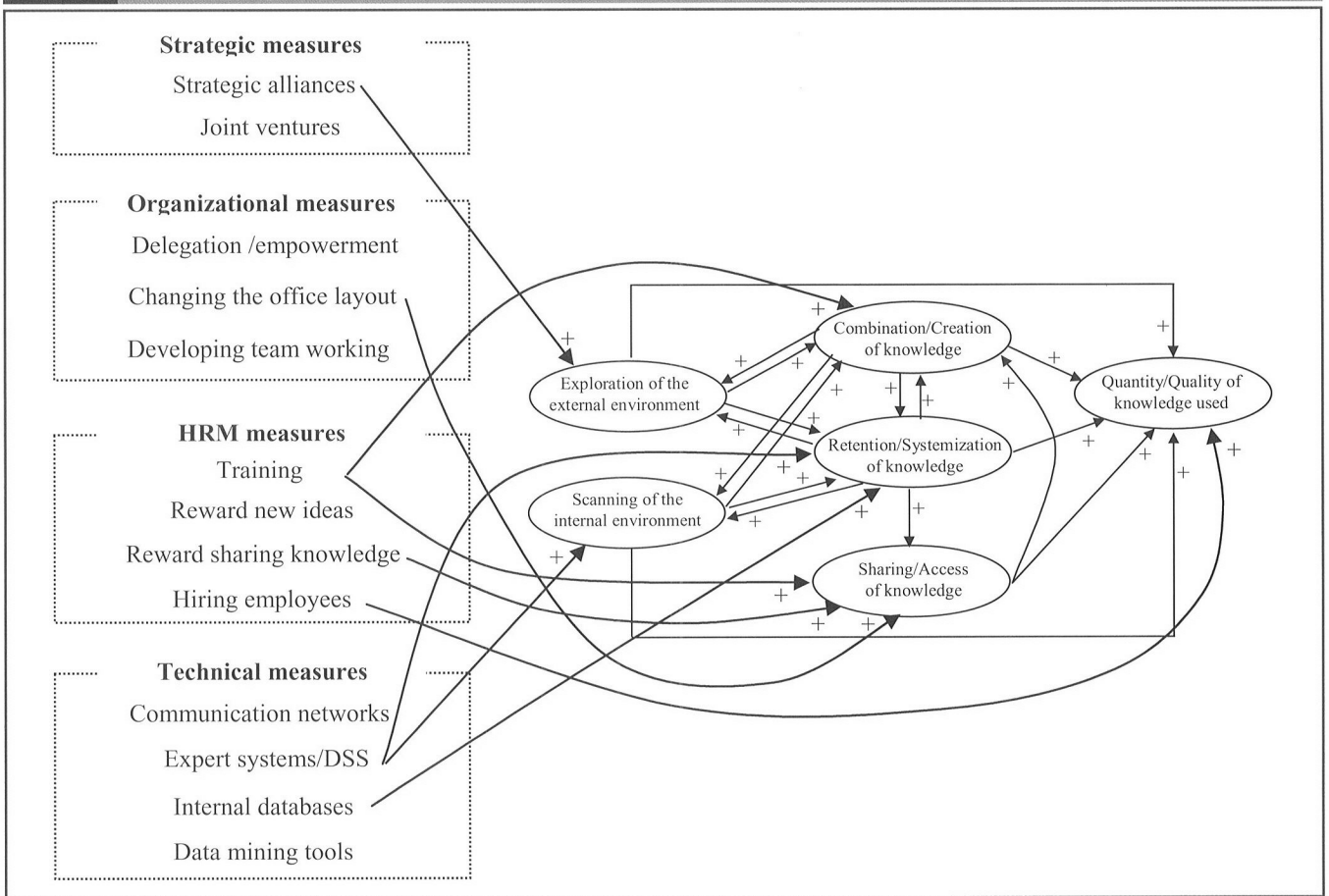
Except from the fourth-dimensional categorization, it is important to observe the multi-purpose scope of the KM activities, which means that specific initiatives causally affect a large number of knowledge management processes. This opinion has been already expressed by Levett and Guenov (2000) who investigated, through a simple linear technique, the effect of diverse knowledge management factors on specific processes, following the logic that each agent may change the state of more than one KM processes. Examples of potential cause-effect relationships beginning from KM measures and ending at KM processes are given in Figure 3 (all relationships shown are considered positive with presumably different strengths).

The objectives that organizations set to satisfy when implementing knowledge management are variable, or better multi-dimensional. In order to keep a broad perspective of the potential list of objectives, the need to look around the KM theory and investigate resembling concepts becomes imperative.

Viewing the framework of knowledge management as a generic management tool, typical (operational/strategic, short/mid/long-term etc.) measures for enterprise evaluation can be set (Martensson, 2000); productivity, competitiveness, innovation, quality of decision making, R&D effectiveness and many others. The integration of the KM model presented in Figure 3 with the set of typical managerial objectives is relatively easy as there is a clear view and understanding about how the change in quantity/quality of knowledge used in a specific domain (organizational department), or at an enterprise level as a whole, can affect each goal separately.



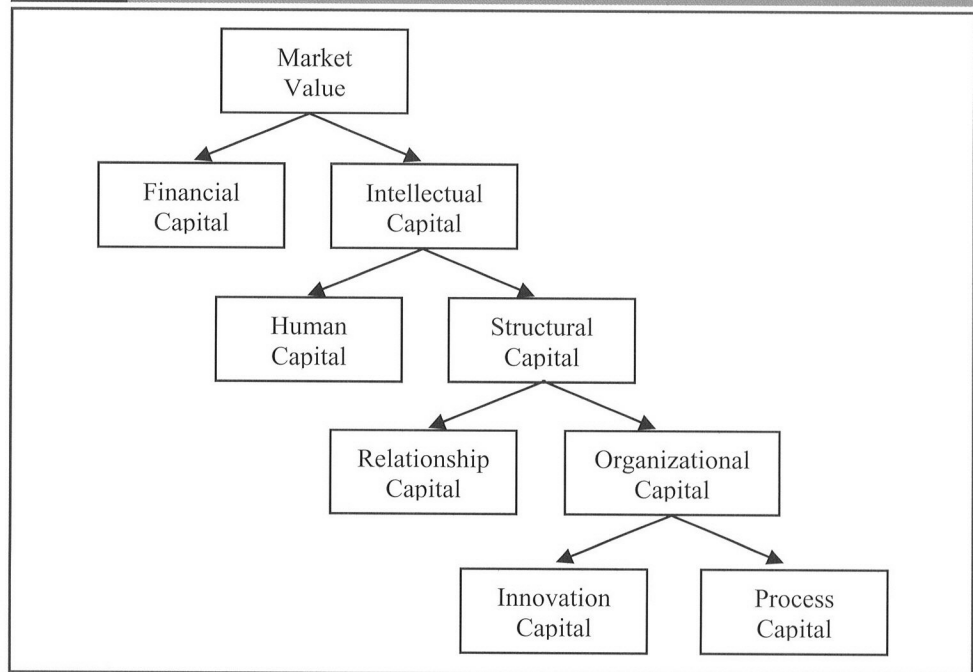
Figure 3 Linking KM measures and processes



Another interesting approach when looking for organizational objectives concerns the notion of intellectual capital and its management. Although this research field is to a large extent autonomous, the possibility for integrating it with knowledge management has already been underlined by Wiig (1997b). Conducting a brief review of the underlying conceptual framework, the significant divergence exhibited, from the beginning of 1980s, in the firms' stock market and the corresponding book values, paired with the observation that a major portion of business investments was going to upgrade the human resources and develop IT systems and networks, made necessary the formulation of new evaluation procedures and the adoption of a radically different logic about business thinking. It has been gradually accepted that the balance sheet, with its conventional form, cannot anymore capture the real potential of the modern information-based enterprises and, therefore, the gap between the market and the book value necessitates the introduction of the term intellectual capital.

According to this new way of business thinking, the market value of an enterprise consists of its financial capital and "everything else" (see Figure 4). Financial capital represents the enterprise's book value and consists of the value of its financial and physical assets, while the remaining part is the intellectual capital. Edvinsson and Sullivan (1996) accumulated a list of interesting but abstract definitions of intellectual capital expressed by various researchers and practitioners: "it is something you can't touch but makes you rich", "it is knowledge used to increase economic order in the business process", "it is knowledge with potential for value" or "it is the sum of the company's islands of knowledge". In formal wording, intellectual capital is considered knowledge that can be converted into value, such as inventions, ideas, general knowledge, designs, computer programs, patents, data processes and publications. To capture the majority of theoretical approaches analyzing the notion of intellectual capital, the

Figure 4 Intellectual capital taxonomy



classification presented in Figure 4 has dominated the scientific community. The depicted intellectual capital taxonomy is a generic scheme, which has its origin in the Skandia model (Skandia is a Swedish insurance company, which first presented and evaluated a practical and detailed intellectual capital model) but it is not identical to that because some further branches of it have not been accepted by a portion of researchers (compare the studies of Joia, 2000; Wiig, 1997b; Edvinsson, 1997; Brennan and Connell, 2000).

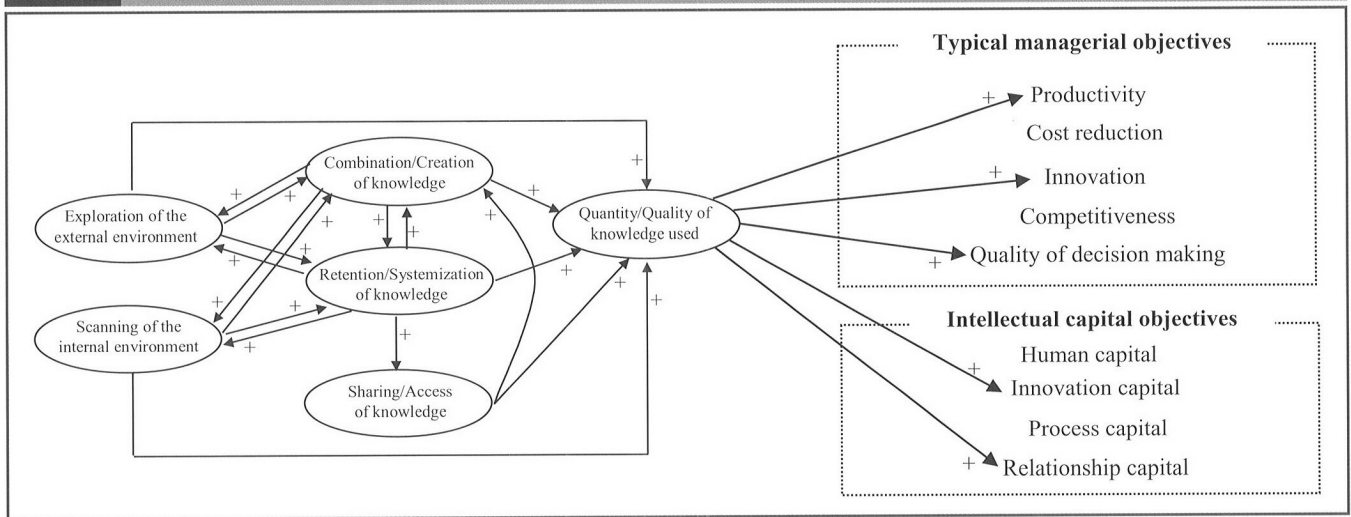
In brief:

- the “human capital” consists of the competencies and capabilities of employees;
- the “relationship capital” consists of the value of the enterprise’s relationships with its customers, suppliers, subcontractors and other major market players;
- the “process capital” consists of the enterprise’s value creating processes such as its organizational structure, management practices, systems, procedures, computerized infrastructure etc.; and
- the “innovation capital” refers to (1) the firm’s capacity of creating new knowledge from the existing supply and (2) many highly intangible assets like the culture, the community image etc.

To end with the reference to intellectual capital, the interest is on building and governing intellectual assets from a strategic perspective. Knowledge management may be seen as a satisfactory basis of strategies to achieve the goals of intellectual capital management. As Wiig (1997b) plainly cites: “... it is important to determine which characteristics and knowledge management activities are needed to obtain the desired intellectual capital results and to determine how – and at what speed – the effects can be expected to propagate ...”.

Summing up, two discrete dimensions exist to articulate objectives when designing and, eventually, implementing knowledge management activities: the first one concerns typical enterprise and, mostly, operational measures applied for evaluating all traditional management practices (such as productivity, cost reduction etc.), while the second is about the strategic management of intellectual capital assets (including customer relationships, employees competencies etc.). Figure 5 depicts the derived connection of the knowledge management

Figure 5 Linking KM processes and business objectives



causal model with the spectrum of objectives (all depicted relationships exhibit positive causality but with presumably different strength).

Cost issues and negative effects

Theory of knowledge management as presented until this point seems to propose an easily applied methodology, including a plethora of positive cause-effect relationships everywhere, without cost and trouble for the organizations. However, this is not the case; each designed KM strategy, to be effectively and gainfully implemented, arises costs (investment in information and communications technology, acquirement of knowledge from external resources, hiring employees etc.) while, in parallel, the unavoidable incurred changes of the proposed tactics (in the domain of organizational structure, working environment, applied technology etc.) may negatively affect other areas of concern, such as the existing cultural, psychological, ethical and ideological status, the quality of collaboration between enterprise departments and within team works, the organizational behavior and others.

Despite the importance of the cost issues and the potential negative effects regarding the application of knowledge management practices, relatively limited research has been reported. Indicative are the studies of Davenport (2000) and Lim and Klobas (2000) who underlined the balance between the need and the cost for knowledge acquisition, exploitation and generation. Cost is generated as investment in money and labor is needed for:

- knowledge capture, i.e. creation and moving of documents onto computer systems;
- adding value to knowledge through editing, packaging and pruning;
- developing knowledge categorization approaches and categorizing new contributions to knowledge;
- developing IT infrastructures and applications for the distribution of knowledge; and
- educating employees on the creation, sharing and use of knowledge.

Long and Seemann (2000) analyzed the negative effects of knowledge management from an organizational perspective. Emphasis was given on the political debate around knowledge management and the conflicts derived from the struggle for control over specific resources, the ideological conflicts, the necessity for business unit's integration and the control of the reallocated political power. This area of concern was also included to the study of Davenport (2000) who cited that: "... It is no secret that knowledge is power and thus it should not surprise anyone that knowledge management is a highly political undertaking. If knowledge is associated with power, money and success, then it is also associated with lobbying, intrigue

and back-room deals. If no politics appear around the knowledge management initiative, it is a good indication that the organization perceives that nothing valuable is taking place. . .”.

The theme of this section becomes exploitable after the incorporation of the “environmental” factors where the necessity to accept contingent negative cause-effect relationships is imperative.

“Environmental” knowledge management factors

The previous sections set the bases for the construction of a knowledge management model encompassing the basic processes, the related tactics able to affect them, and the set of objectives influenced by the change in knowledge use. Despite the relative completeness of the KM model as it is, recall that the systems thinking logic, eventually followed for the development of the proposed knowledge management model, suggests the determination of factors called “environmental”, reacting with (influencing and being affected by) the given system but not belonging to it. Such factors indeed exist in the knowledge management paradigm and have been indicated by many researchers who attempted an holistic approach to the specific research topic. Getting into details, the term “environmental” instantly indicates a set of agents taking place out of the organization, such as the competition, the fashion, the markets, the technological edge and the GEPSE, that is the governmental, economic, political, social and educational climate (Holsapple and Joshi, 2000). However, these are not the only “environmental” factors; various intra-organizational parameters and situations, which underlie, influence and are affected by the enterprise operations, formulate the second category factors; e.g. the knowledge culture, the trustful employees’ behavior, the freedom to apply knowledge, the understanding of organizational roles, the story-telling behavior, the political debate and the potential for ideological conflicts (Lim and Klobas, 2000; Long and Seemann, 2000; Soliman and Spooner, 2000).

Integrating actions, factors, processes and objectives

Until this point of the current study, the discrete parts of a whole system encompassing the notion of KM have been discerned. Therefore, the next step is the integration of the constituent elements to a common framework and, based on it, the conduction of further analyses, modifications and extensions. The holistic approach of the KM related system is depicted in Figure 6. Based on the designed system, various points need further explanation. At first, notice that the basic KM processes, such as sharing, creation etc. of knowledge, can be manipulated not only at an enterprise level but also relatively to specific domains of interest. This means that managers may want (according to occasional situations and problems) to study KM processes separately, e.g. the production and the marketing/selling operations as shown in Figure 6. Such a distinction, despite the increased complexity and computational effort, is sometimes necessary as:

- the strategic/organizational/HRM/technical measures may not be scheduled with an enterprise perspective but only over specific organizational units;
- the cause-effect relationships between activities and processes may differ when examining different organizational domains, e.g. hiring new production workers may have insignificant impact on sharing knowledge in the production department, while hiring new marketing staff may hardly affect the knowledge sharing routine in the marketing department; and
- the improved knowledge use in some organizational departments/operations may affect the managerial and intellectual capital objectives in completely different ways comparatively to the knowledge use in other organizational departments/operations.

Further comments on the integrated scheme presented in Figure 6 refer to the role of “environmental” factors. They belong to both the external and internal organizational context and simultaneously influence and are affected by strategic/organizational/HRM/technical measures and specific KM processes. The role of the “environmental” factors fluctuates in significance and causality strength when stressing on different enterprise domains such as the production and the marketing operations. The intra-organizational factors could be separated in autonomous clusters corresponding to the occasional departments of concern, but for the sake of convenience they are presented as a single entity with the extra-organizational factors.

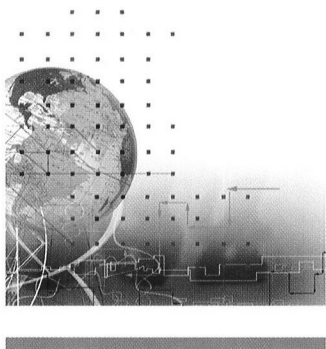
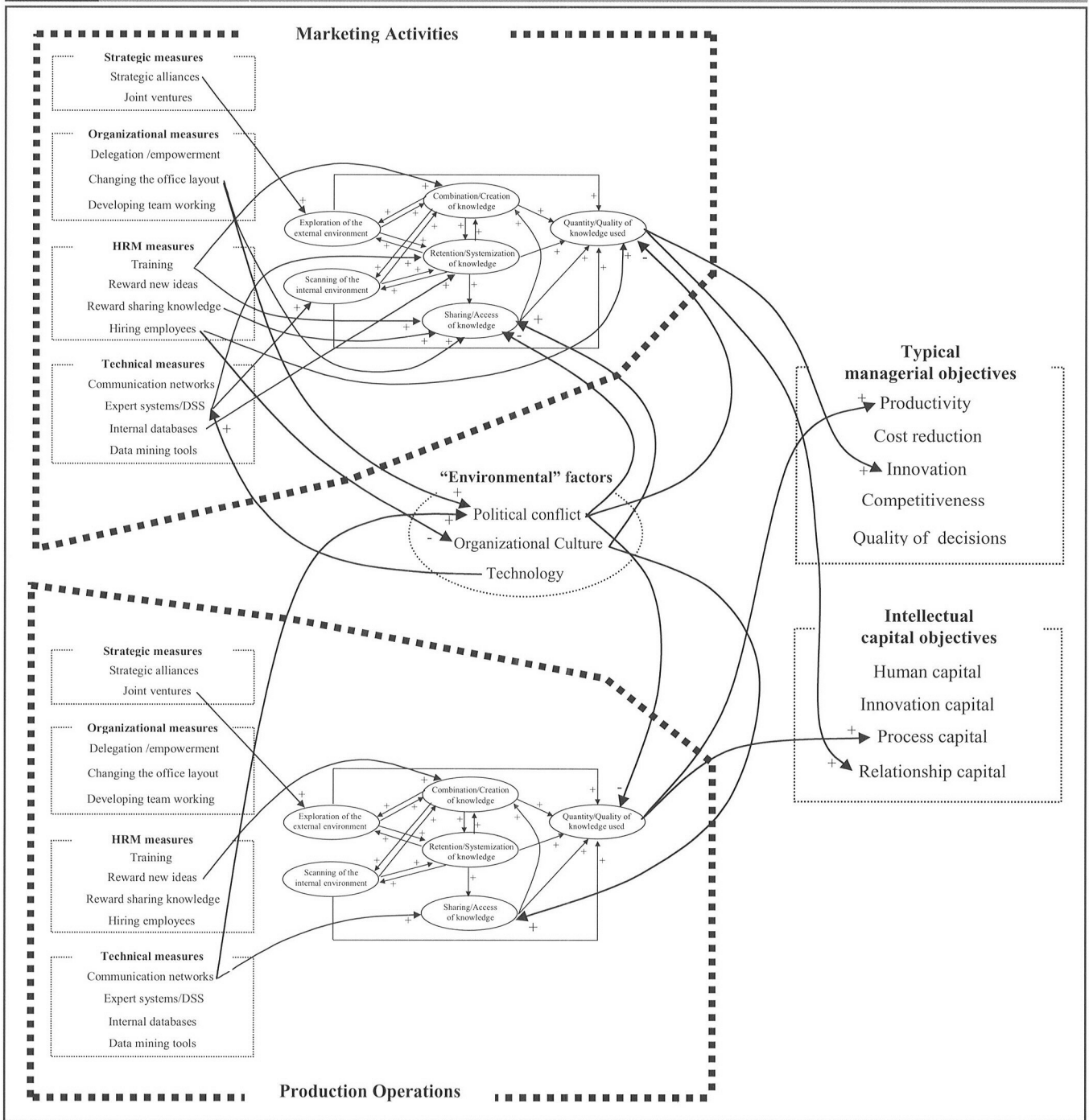


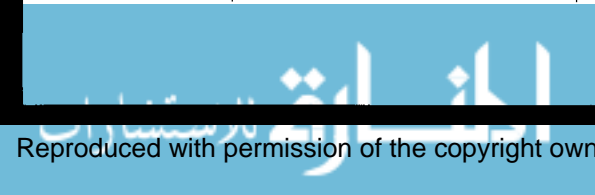
Figure 6 Holistic KM approach



Continuing the criticism, the proposed KM model correctly presumes negative causal paths as derived previously from the discussion about negative effects while, in parallel, the business objectives, managerial and IC-based, are considered common regardless of the level of detail selected for examining the KM measures and processes.

Discussion

The knowledge management model developed in this study constitutes a quite attractive framework for conducting diverse analyses at a tactical and strategic level of concern. Such a



practice becomes feasible because of a plethora of advantageous features attached to the KM model, with most important:

- the realistic nature of the cause-effect behavior implied by the whole model;
- the concrete context linking together all major knowledge management processes;
- the coexistence of different types of tactics (strategic, organizational, HRM and technical);
- the ability to directly and indirectly causally connect or associate measures and KM processes;
- the recognition of sets of objectives and their causal connection with the rest part of the system; and
- the incorporation of "environmental" factors, after the adoption of the systems thinking logic, and their integration with the measures, the processes and the objectives.

Theoretically, the proposed KM model raises an innovative approach in strategic thinking, shifting the interest from the processes, the measures and the objectives in isolation to an integrated network of cause-effect relationships, so as to investigate core competencies and develop competitive advantages. From a practical perspective, the attributes of the KM model, paired with the underlying theoretical assumptions, enables a variety of managerial applications, such as the:

- systematic design of strategies with multiple combinations of practices and not single actions;
- multi-criteria analysis;
- sensitivity analysis; and
- strategic planning and evaluation per organizational unit.

On the other hand, as drawbacks and future research directions, we outline the following:

- The inference process on the proposed model is not such a straightforward task because of the existent multiple direct and indirect cause-effect relationships, combined with positive and negative feedback loops. This fact implies the search for mathematical and computational methodologies able to adequately support this procedure.
- The related costs of the applied actions/strategies cannot be easily estimated.
- The cause-effect relationships have to be quantified because all positive or negative relationships do not have equal strength and degree of belief. It is important to mention the potential of subjective reasoning imposed by academics and practitioners when evaluating such cause-effect relationships.
- Although the designed methodological framework is considered somehow complete, some "environmental" factors may be unavoidably excluded (it depends on the level of detail selected for the construction of the KM model). This fact entails uncertainty for the whole system, e.g. the strength and the ensuing effects of specific relations may fluctuate even under identical conditions.

To conclude, the oncoming research efforts should emphasize on the completeness of the proposed knowledge management scheme through the recognition of additional "environmental" factors and even hidden cause-effect relationships, the study of potential combinations of the proposed model with decision support tools and mathematical techniques in order to conduct strategic planning and multi-criteria decision making in an effective way and, last, the conduction and analysis of real-world case studies to verify the degree of accuracy and applicability of the developed system.

Implications for managers

The adoption and realistic consideration of the holistic KM model depicted in Figure 6 entails new roles and activities in organizations. At first, managers must ensure the systematic



information gathering and content analysis in order to develop and update the constructive elements of the KM model, that is, factors and relationships. To satisfy this requirement, proper combination of procedures, systems and humans is needed:

- Scheduling of new procedures and team-building explicitly oriented towards the support of the given knowledge management initiative are necessary due to its inherent complexity and demanding effort. Unavoidably, this initiative raises antagonism with other programs running already in the company.
- The assignment of roles to adequately trained employees must be in the agenda of managers. These roles will concentrate on the specification of critical (for the given enterprise) factors and the recognition and quantification of potential relationships taking place in the KM model. The employees finally selected to get involved with this task must be occupied to different units of the organization so as to extract their domain-specific knowledge and adapt properly the sub-systems of the KM model. It seems more correct to assign roles to employees having a long experience of the enterprise and its organizational structure, business and social processes, culture and politics etc. Of equal importance is the cooperation with experts being members of the academic community.
- Except from the human resources, the investment on technological-oriented resources remains at the forefront because of the nature of the problem at hand, which demands adequacy and validity; otherwise, the existing structural complexity will generate misleading outcomes. Graphical tools to facilitate cognitive/causal mapping, databases to store/categorize information, statistical packages to analyze correlated events, computational methodologies for causal patterns recognition etc., are all useful to support employees to accurately design the KM model. Also, as the KM model is a structure of cause-effect relations, keep in mind that there are many efficient techniques to fuse knowledge denoted as causal map by many different participants, that is, employees, experts etc. (Silva, 1995; Taber, 1991).

Having deployed the structure of the KM model, managers must work on its proper exploitation. Three issues must be taken into account: strategic planning, coordination, and computer-based decision support. The holistic KM paradigm must be purposefully incorporated in the strategic planning process because it offers a platform to evaluate with multiple objectives previous and new decisions, to identify hidden behaviors of the organizational system and to explore scenarios. The pluralism of perspectives underlying the KM model paired with its coherent theoretical background increases the criticality of the produced outcomes in strategic decision-making. In parallel, due to the multidisciplinary character of the model, managers ought to spend time and effort to coordinate opinions, preferences, constraints and objectives of different operations and units. This presupposes consensus and commitment to the importance of the KM model in strategy formulation. Last, managers must invest in decision support systems for causal inference in complicated networks with feedbacks. The KM model will be adequately exploited if proper methodologies are applied which can easily identify and quantify causal paths and, ultimately, develop cause-effect scenarios that humans can discern with difficulty. The domain of computational intelligence is very fruitful on such methodologies, which many of them combine the easiness with advanced technical analysis (Kosko, 1986; Koulouriotis *et al.*, 2001; Zhang *et al.*, 1989).

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