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Knowledge management in virtual enterprises: A systemic multi-methodology towards the strategic use of information

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Abstract

This paper examines the development of a systemic multi-methodology for knowledge management in virtual enterprises. The main objective is the strategic management of information for the acquisition of competitive advantage and the advance of networked corporate agreements (i.e., Virtual Enterprise Projects) in order to maintain business flexibility and innovation. Making use of systemic methodologies, emphasis is given on the creation and the sustenance of knowledge coming from both the internal and the external business environment, instead of directly intervening to the operational characteristics of the modern enterprise. We present an approach to knowledge management supported by four systemic methodologies namely the total systems intervention (TSI), the strategic assumption surfacing and testing (SAST), the viable systems model (VSM) and the problem structuring methodology (PSM). The composition of systemic methodologies can result in powerful multi-methodologies that effectively compensate complexity, combine different mental pictures and perspectives and handle diversity in a creative and innovative manner. Information systems, especially those involving multiple stakeholders, profoundly limit the capability of traditional generic methods of analysis to develop and utilize interventions. In this paper, we demonstrate the effectiveness of a multi-methodology designed to facilitate the creation of a knowledge exchange business network in the field of consulting companies that provide an ideal practice field for the verification and testing of the results of our study.

Keywords: Virtual enterprises; Information management; Knowledge management; Strategic information systems; Systemic methodologies

1. Introduction

A thorough examination of both strategic management and information management at the beginning of the 21st century both from the theoretical and the practical point of views has resulted to two fundamental challenges in organizations within the context of international competition: firstly, the management of corporate knowledge for the acquisition of competitive advantage based on its own resources, and secondly, the development of network—centred, co-operative alliances aiming at the sustenance of flexibility and innovation. In this paper, we propose to combine these two challenges by examining the aspects of *knowledge management in virtual enterprises*, being motivated by an obvious research gap in this area until now (Riggens & Rhee, 1998).

Information and its inter-organizational management constitute critical factors for the acquisition and the sustenance of a competitive advantage in modern companies (Preiss, Goldman, & Nagel, 1996). Therefore, interactions among enterprises for the exchange and the creation of knowledge have become a key concern for managers. Business alliances often turn out to be more powerful and successful than traditionally large enterprises. Empiric figures on the increasingly high importance of co-operations can be drawn from the field of the automobile industry, e.g. the International Motor Vehicle Program-IMVP of MIT (Womack, Jones, & Roos, 1990).

However, research on the field of the strategic management of information is characterized by the absence of a unified and common terminology; a variety of definitions is used to describe the same or similar aspects of modern

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enterprises and co-operations (Blecker, 1999). In addition, we can only identify gradual differences among these definitions, since almost all underline the collaboration among financially and/or legally independent enterprises aiming to achieve a competitive advantage by having a primary focus on their core competencies. In the present study, we investigate the notion of virtual enterprises (VE) from the perspective of knowledge management using in our approach the systemic methodologies for the development of a generic strategic model. In this context, the idea of strategy can be regarded as the long-term direction and field of activities of the enterprise, which ensure a competitive advantage through the fast response to market needs and the service of the interests of the companies involved in the alliance (Johnson & Scholes, 2002).

Our main objective is to investigate the notion of inter-organizational information and knowledge exchange presenting in detail the challenges that this has brought about in the concurrent business environment (Pollalis Yannis & Grant, 1994). During our research, we have examined the approaches through which enterprises can obtain a competitive advantage based on the knowledge that they contain, taking part in new organizational structures such as the *virtual enterprise*. Systemic methodologies have a catalytic role in this direction that is to say in the formulation of a strategic model for the inter-organizational management of knowledge, through their combination by offering solutions to complex problems such as the lack of confidence among partners, the absence of compatibility in business models and processes, and the constant market changes.

2. VEs in the context of strategic information management

2.1. Enablers for knowledge exchange in VEs

Byrne, Brandt, and Port (1993) define VEs as a "temporary network of enterprises, which cooperate in order to exploit the fast evolving business opportunities. In a VE, companies can share the expenses, the skills, and access to global markets, with each partner contributing to what they specialize better." This definition was later extended by the authors to: "a temporary network of independent companies—suppliers, customers, and even competitors—who collaborate with the assistance of information technology in order to share expenses, skills, and markets." The substance of this definition lies in that it refers to VEs as a temporary network of companies (New & Mitropoulos, 1995). The companies involved make common use of their resources, share profits and try to obtain a common competitive advantage.

Traditional hierarchical organization structures tend to be replaced by network forms of organizations, such as the VE, which are becoming more and more popular nowadays. Globalization extends the need for communication and coordination across different time zones and locations. Strategic information management systems can enable organizations to create more flexible and efficient structures so that the organizational memories and knowledge of the cooperating parts are available wherever they are needed, thus leading to the age of the VE as a new organizational form.

There are many ways in which knowledge can be created and disseminated across VEs. Any network of organizations that aims to create a knowledge management and exchange system should have to follow these general knowledge management initiatives

- creation of knowledge teams,
- sharing of best practices,
- development of knowledge databases,
- creation of knowledge centres,
- selection and use of collaborative technologies,
- creation of Intellectual capital teams.

The action that must precede all of the above initiatives in order to achieve the strategic management and use of information resources in VEs, is the creation of a *knowledge exchange protocol*, which with the use of new technologies (e.g. a knowledge-portal) is going to provide broad access to corporate knowledge and information resources, and encourage interorganizational collaboration. In this context, the proposed protocol will be based on the systemic notion of *self-organizing knowledge ecosystems*, in which information, ideas and insights are diffused in an open and democratic manner, free from biases and utilitarian constraints. The knowledge exchange protocol comprises a set of pre-agreed rules providing the partners with easy ways to interact and share what they know, thus forming a 'knowledge ecosystem'.

According to Por and Molloy (2000), a *knowledge ecosystem* comprises (a) a people network of productive conversations designed to create (b) a knowledge network of ideas, information, and inspiration, supported by (c) a technology network of knowledge bases, communication links, and so on. This concept fully applies to the knowledge-exchanging network formed by VEs, which is presented in the following figure accordingly adapted to comply with the present study.

The knowledge exchange protocol represents the systemic tool for the enhancement of dialectical and dynamic collaborations among cooperating organizations, which is based on the free exchange of expertise and knowledge and the application of *best practices* in day-to-day management, as well as on the common will to promote the essential interactions to enable the knowledge ecosystem (Fig. 1).

A prerequisite for information diffusion and sharing via the use of strategic information systems is the development of suitable infrastructure, in which diverse information coming from partners will be stored, classified and managed. Within the context of the present work, the proposed infrastructure can be a web application for the interaction and communication among the members of a VE, which is based on a fundamental agreement, i.e. the

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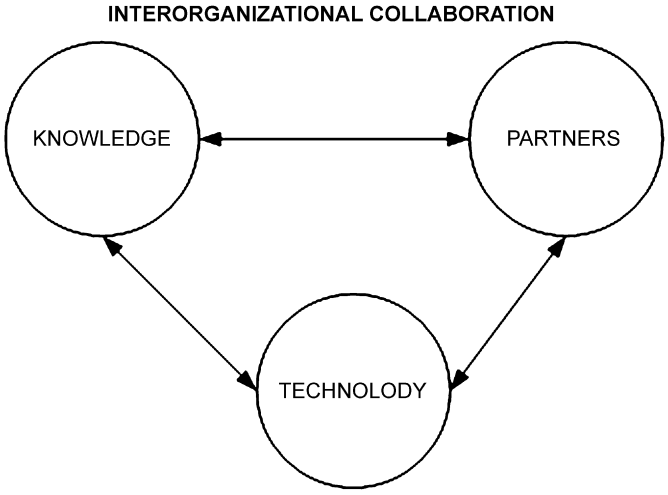

Fig. 1. The knowledge ecosystem.

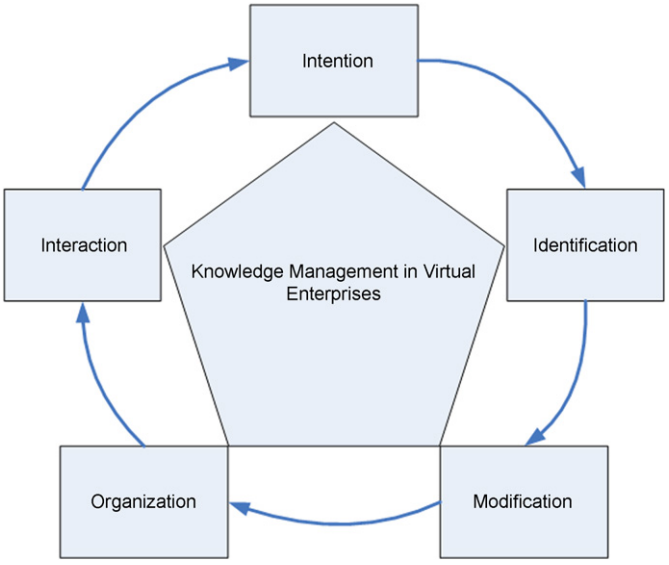

Fig. 2. Knowledge management life-cycle in virtual enterprises (adapted from Blecker & Neumann, 2000).

knowledge exchange protocol, based upon the following principles:

(1) the use of a common infrastructure for the creation of an interorganizational and collaborative business network,
(2) the mutual share and exchange of knowledge assets among the cooperating partners,
(3) the achievement of better and more efficient use of knowledge aiming at the preparation of executives, ready to undertake action and initiatives.

2.2. The knowledge management life-cycle in VEs

Knowledge management in VEs includes the control and the emergence of a goal-oriented organization of knowledge among partners. According to the systemic approach to management (Gomez & Zimmermann, 1992), there can be a distinction among strategic, legal, operational, and business process reengineering (Bleicher, 1991). Provided that knowledge management in VEs includes regular and on-the-spot managerial decisions, an iterative process that can be referred to as the *knowledge management life-cycle in a VE* can be formed. According to Blecker and Neumann (2000), this process consists of the following five stages: Intention, Identification, Modification, Organization, and Interaction (see Fig. 2).

2.2.1. Intention

The Intention stage includes the specification of knowledge objectives and their corresponding measurable criteria. Therefore, in the first stage, the companies involved in the alliance should specify common visions, objectives and strategies in regard to their shared knowledge. For the completion of this common set of goals, two important issues should be examined thoroughly:

- to what extent knowledge affects the financial success of the enterprise?
- which strategic objectives are primarily supported by a more efficient use of knowledge?

2.2.2. Identification

The Identification stage aims at the tracing of the existing inter-organizational knowledge as well as the available core competencies within the VE boundaries. In addition, partners should assess those core competencies that will be essential in the future as well. Hence, this stage focuses on the systematic search for unique elements of knowledge of each cooperating company (North, 1998). Different knowledge bases often cause variations in performance among the VE members. Consequently, it is essential to specify what kind of knowledge and to what degree each company holds.

2.2.3. Modification

During the third stage, an intelligent organization of knowledge is developed. This stage includes creation, organization, and modification of the already implemented information systems. Particular emphasis should be given to the so-called "ecology of knowledge" (Nonaka, Takeuchi, & Takeuchi, 1995). This is mainly a duty assigned to the higher levels of management, where inter- and intra-organizational processes are 'surrounded' by a technologically supporting environment, such as strategic information systems.

2.2.4. Organization

The fourth stage can be attributed to the regulatory part of knowledge management in VEs. Therefore, it mainly focuses on the processes of the inter-organizational creation of knowledge and the processes related to the intensity of learning. The creation of knowledge is influenced by processes of learning improvement and renewal

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(Nonaka et al., 1995). The inter-organizational application and formalization of these processes can be achieved with the help of common clusters of skills and knowledge (Sydow, & van Well, 1996). These emanate from autonomous practices of the participants and lead to an established enlargement and a combination of knowledge that is based on relationships of exchange.

2.2.5. Interaction

The creation, distribution, and integration of knowledge can be considered to offer a competitive advantage, only if it is actively used for the development of innovative products and services. Consequently, the fifth stage of the KM life-cycle in VEs aims at a systematic inter- and intra-organizational utilization of knowledge. In the past, competitive advantages mainly stemmed from a more efficient combination of traditional business characteristics. Today, knowledge as a basic resource constitutes an important and critical factor of success in this direction. Thus, until recently industrialized economies will be transformed to knowledge-intensive economies (Drucker, 1994).

3. Systemic multi-methodology for knowledge management in VEs

3.1. Introduction to systemic methodologies

3.1.1. Systemic ''metaphors'' and ''philosophies''

Systemic methodologies are based upon profound ideas—philosophies. A methodology follows the systemic and/or systematic and repetitive directives that are related to a holistic idea about the world (Flood & Carson, 1993). The consideration of a methodology as a philosophy, i.e. a whole new way of thinking, is an important fact which includes the whole set of its principles (Avison & Fitzgerald, 1996). When two or more methodologies are combined, the same happens with the sets of their corresponding philosophical principles (Brocklesby, 1997). Flood and Jackson (1991) have presented a number of methodologies and their philosophies in their work. A summary of the ''systemic philosophies'', which we have used in our research, is presented in the following paragraphs along with their application to the case study of a virtual consulting company in an attempt to design a generic multi-methodology for knowledge management in virtual enterprises.

In order to obtain a more profound insight on the philosophical background of systemic methodologies, we are going to present the various principles on which they are based—known as ''metaphors''—which form different perceptions of the real world, thus determining the way each one attempts to intervene and make changes within enterprises and organizations. People use systemic metaphors to apply systems thinking to problem contexts of enterprises or other organizations. Flood and Jackson (1991) pointed out that there are five popularly used systemic metaphors; these are machine metaphor, organic metaphor, neurocybernetic metaphor, culture metaphor and political metaphor. Later, in his book ''Solving Problem Solving'', Flood (1995) abandoned the set of metaphors in favour of an exploratory process that draws out the metaphors already existing in people's dialogue—not just those confined to machine, neurocybernetic, etc. The five metaphors capture, in essence, the basic principles of almost all management and organization theory, in a way that is described below.

3.1.1.1. Machine metaphor or ''closed system'' view. The machine metaphor or ''closed system'' view is used in cases where the system under study is conceived as a ''black box'' with certain inputs, sets of processing activities and outputs. The machine metaphor appeals to minds that like orderliness—such as engineers. Any business requiring a high level of efficiency is essentially a machine. However, machines can only be repaired or replaced, they cannot evolve or develop. Certainly, all businesses need to deliver today's products efficiently as well as adapt to the future. So, all businesses will have a relatively machine-like part. Those that compete solely on cost, service and quality, not on innovation, need to be machine-like in their efficiency. MacDonald's and similar service businesses are examples—they offer the same product everywhere all the time at minimum cost and maximum quality—this is machine-like.

3.1.1.2. Organic metaphor or ''open system'' view. The idea of using organic, or biological metaphors, was introduced by Bertalanffy (1968), who was one of the first to suggest that living systems might be viewed as *open to their environments*, rather than as the closed isolated systems preferred by the Classical Analytical approach (''closed system'' view). The organic metaphor is associated with a very different view of systems than the mechanical metaphor. By contrast with the machine metaphor, where all events are expected to be under the control of someone or something, in an organic metaphor, systems are considered to be autonomous or self-regulating. Under a machine metaphor, systems are based on linear hierarchies; organic metaphors, however, treat organizations as integrated systems of interrelated processes and relationships.

3.1.1.3. Neurocybernetic metaphor or ''viable system'' view. The neurocybernetic perspective, in contrast to the above, emphasizes active learning and control rather than passive adaptability and focuses on information processing and viability. As the name suggests, this metaphor *captures the idea that organizations have brains—senior management constitutes the brain of the organization*. It builds upon the standard cybernetic model that has a transformation process, an information system, a control unit, and an activating unit, by adding the important attribute of learning. Thus the model can accept dynamic aims and objectives and is capable of self-questioning rather than

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merely self-regulating. The neurocybernetic view is useful in practice for systems that exhibit self-enquiry, self-criticism, and dynamic goal seeking based on learning. It is useful in environments that exhibit a high degree of uncertainty where creativity is encouraged. It could well provide a useful model for adaptive information systems. The neurocybernetic view does, however, neglect to recognize that organizations are socially constructed phenomena and that the purposes of the parts of a system can be different from that of the whole.

3.1.1.4. Cultural metaphor. In a broad sense, culture refers to various abstract shared characteristics at all levels of organization: societal, corporate group, etc. Typical features include shared language, religion, history, values and beliefs, and a shared sense of belonging. The cultural metaphor is useful when it shows that rational aspects of organizational life are only rational in terms of the commonly accepted culture. This highlights that the cohesion generated by shared social and organizational practices can both inhibit and encourage organizational development and as such is something to be managed and something that will take time to change. The cultural metaphor, like all the others is only appropriate for certain circumstances. It fails to address the structure of complex organizations and its adoption can lead to feelings of manipulation and resentment stemming from attempting explicit ideological control of the people within an organization.

3.1.1.5. Political metaphor. The political metaphor applied to organizational structures focuses on relationships between individuals and groups as competitive and involving the pursuit of power. The political metaphor looks at issues of interests, conflict and power. It is through these issues that the political character of a situation may be assessed (as unitary, pluralist or coercive). The use of the political metaphor sensitizes us particularly to the possibility of conflict in organizations.

3.1.2. Systemic methodologies and diagrammatic designs

Systemic methodologies rely heavily on schematic representation. Having to deal with difficult non-linear and not well-defined situations, 'systemics' pioneers developed diagrams and schematic representations in order to capture and encapsulate complexity and effectively manage and combine diverse viewpoints. Schematic and diagrammatic representations have the virtue of being accessible to anyone. Anyone can contribute to a diagram or a schematic representation according to his internal mental models. Systemic diagrams and schematic representations are flexible and can be redesigned many times, as a situation is being processed and stakeholders contribute their internal representations. Systemic methodologies have developed powerful representation methods, as illustrated in Table 1. These methods involve sets of rules easily comprehended and applied, and can be easily and effectively used in interpersonal communication, board meetings and mass organizational communication, such as the communication of strategies, visions and change initiatives.

Table 1
Schematic representation of systemic methodologies

No.	Systemic methodology	Semantics
1	Total systems intervention (TSI)	System of systems methodologies—systemic metaphors
2	Strategic assumption, surface and testing (SAST)	Concept maps
3	Problem structuring methodology (PSM)	PSM block diagrams
4	Viable systems model (VSM)	VSM whole system diagrams

Systemic methodologies make use of sophisticated yet flexible visual representation mechanisms based on pictorial and graphical elements and concise constructing rules. These diagrammatic representations can become a rigid base for the introduction of *systemic diagrammatic reasoning* as a managerial tool capable of encapsulating *complexity* and enhancing *systemic thinking and problem solving*. Systemic diagrams can also be used as effective communication tools since they have the ability to visually expose and combine different internal mental representations and create collective pictures of reality.

3.2. The systemic approach

The systemic approach to knowledge management in VEs requires major adjustments to be done on organizational structures, production designs, managerial approaches and business strategies. To the degree that a company operates within a system of competition and dynamic developments, gaining and sustaining competitive advantage depends on understanding not only a firm's value chain, but also how the firm fits in the overall system (Porter, 2001). As business environment becomes more and more complex, managers have to learn to expect the unexpected, the unpredictable and unknown. Therefore, the main stages involved in the transition toward the competitive advantage through the application of the systemic approach, are the following:

The first level in this effort, i.e. *the conceptual stage*, involves the conception of knowledge as the strategic resource for competitive advantage. In order for managers to be able to cope with the unpredictable changes in the market there is the need for the emphasis to be given for the qualitative and not easily assessed characteristics of corporate knowledge, both in the internal and the external business environment with the use of the systemic tools and techniques that help on understanding problems, opportunities, challenges just in time and act upon. The outcome of the first stage is a *conceptual schema* of the VE. This schema, which can also be considered as a knowledge map, is the corollary of the Systemic Approach and can be

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utilized as the basis for the discourse on the development of interorganizational collaboration.

In these terms, knowledge resources are considered as the most critical strategic resource as well as the ability to acquire, integrate, store, share and apply them become the most important resource for building and sustaining competitive advantage (Grant, 2001; Penrose, 1995; Teece, 2000). Companies having superior knowledge are able to coordinate and combine their traditional resources and capabilities in new and distinctive ways, providing more value for their customers than can their competitors (Penrose, 1995, Teece, Pisano, & Shuen, 1997). Hence, competitive advantage can arise from effectively creating and transferring knowledge (Alavi, 2000), especially collective tacit knowledge that is not stored in any given individual, and it is also difficult to convey to others (Brown & Eisenhardt, 1997; Orlikowski, 2002). Knowledge will become the fundamental factor underpinning successful organizational networks.

The second level, i.e. *the creation of knowledge-intensive human capital*, considers individuals as the basic repository of knowledge. Consequently, the knowledge worker turns out to be the most important asset for organizations.

Business networks therefore play a central role because they provide a shared context, where individuals can interact with each-other and engage in the constant conversation on which effective reflection depends (Nonaka et al., 1995). An organization cannot create knowledge on its own without individuals. Organizational knowledge creation should be understood as a process that organizationally amplifies the knowledge created by individuals and crystallizes it at the group level through dialogue, discussion, experience sharing, or observation. The recognition of human capital as a strategic asset is especially relevant for knowledge management, owing to its labour-intensive nature. Changing the skills base, creating multi-disciplinary competencies and capabilities are the drivers for innovative solutions and services. In this framework, learning is seen as a response to an increasingly unpredictable and dynamic business environment and as the only sustainable competitive advantage.

Our primary concern, at this point, was to study the relationships and interdependencies among the factors and their influence on the formulation of scientific collaboration. The basic systemic methodology applied in this stage is Churchman's strategic assumption and surface testing (SAST). This methodology is appropriate for conducting constructive dialogue among multiple and diverse personalities in an effort to approach a collective representation of a mutually accepted reality.

The output of this stage is a knowledge map, in terms of the skills and competences of the human capital, which represents the *behavioural schema* of the knowledge exchange network that is under consideration.

In the third level, the *VE formulation*, creativity and innovation patterns require action processes based on knowledge creation, sharing and dissemination, for continuous upgrading of resource basis and attainability of a sustainable competitive advantage.

From a systems thinking perspective it is more useful to think of VEs as value networks that generate tangible and intangible knowledge through complex dynamic exchanges between two or more individuals, groups, or organizations (Allee, 2000). In this view, organizational structures need to evolve toward network structures, which can facilitate the design and production of complex products through the common use of their resources, shared profits in order to obtain a common competitive advantage. They are considered superior to other structures to cope with complex systems owing to: multi-firm collaborative relationships, autonomous organizational structures, dynamic relations and knowledge exchanges, responsiveness and flexibility to environmental changes thanks to 'dynamically adaptive' IT infrastructures; creation of collective capabilities at the organizational and inter-organizational level; emphasis on customer relationships.

Therefore, the challenge for VEs as a new organizational form (i.e. the *structural schema*) is exploit networking and collaboration for using and deploying other resources to gain competitive advantage and to enhance customer value.

Finally, *in the fourth level*, the appropriate *systemic intervention* is formulated enabled by the application of strategic information systems. In all four stages, the systemic analyst is acting as a facilitator that carefully orchestrates the new reality of the knowledge-exchange organizational network.

Given that information and its management are necessary to provide a competitive advantage, business strategy revolves around knowledge management tools and methods. The creation, exchange and dissemination of information (residing in individuals, products, and services) help managers and organizations to respond and adapt to the new emerging situation and to reflect on their own actions. As Helfat and Raubitschek (2000) suggest, it is the dynamic sharing and distribution of organizational knowledge and capabilities that can result in competitive advantage. Successful strategies, especially in the longer term, do not result from fixing an organizational intention and mobilizing around it; they emerge from complex and continuing interactions between individuals.

However, the ability of firms to realize strategies that create competitive advantage depend on their capabilities to capture and absorb the resources and knowledge residing inside the network, on the relationships between firms, customers and suppliers.

In this context, it is necessary to adopt of a systemic approach to knowledge management—as a new knowledge creation process for social and business innovation, which transcends the organizational borders. Systemic methodologies and tools need to be engaged to diagnose and analyse the economic, geographic, geologic, and ecologic components of interorganizational systems. Interactions between the VE members and their environments are pervasive.

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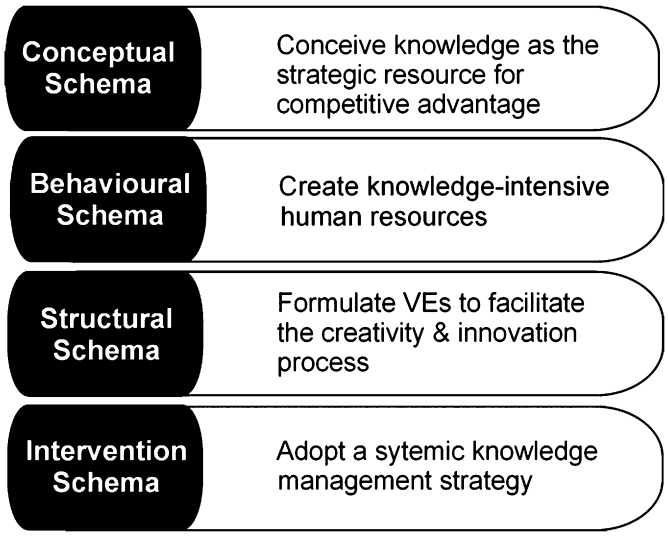

Fig. 3. The systemic schema for the knowledge management multi-methodology.

A systemic approach helps integrating diverse sets of knowledge and experiences to study and analyse the context and the business dynamics where the systems act, along with the environment in which they are embedded. Only by understanding the systemic structure, the systemic analyst can choose the actions that have the greatest leverage (Senge, 1990).

The integrated set of the systemic approach as described in the four methodological components/levels above is depicted in Fig. 3.

3.3. The proposed multi-methodology

The book "Multimethodology" published by Mingers and Gill (1997) has been the main source of inspiration for our study, which gave us the motivation for further research in areas that have not been adequately examined, such as the development of complex methodologies (i.e. new multi-methodologies) with the combination of the above fundamental systemic methodologies in the context of *systemic knowledge in VEs*. The substance of a multi-methodology is the use of more than one methodology or even part of these, and probably from diverse optical angles, through one and only *intervention*.

The proposed multi-methodology is primarily based on the principles of systems thinking, systems design, knowledge mapping, diagrammatic thinking, viable systems methodology and Systemic Intervention. The multi-methodology is composed with the use of the total systems intervention (TSI) methodology (Flood & Jackson, 1991). TSI is also applied at the first stage, the creativity stage of the multi-methodology, resulting in a cyclic overall implementation. This is denoted by the term "CYCLE" added, renaming the methodology in the last step to "TSI CYCLE". In this manner, we wish to stress the dual implementation of TSI both as a composing aid for the creation of the multi-methodology and as a part of the multi-methodology itself.

The new multi-methodology consists of four basic steps, which are:

- Step 1: TSI
- Step 2: SAST
- Step 3: SAST + VSM
- Step 4: TSI + SAST + VSM + PSM

The idea of this multi-methodology is that we are working in the general context of TSI, where we are applying the other systemic methodologies; so we consider this as the first step of our multi-methodology.

The second step is to implement SAST. We are using this methodology in order to concentrate the attention of managers to the relationships among people—knowledge workers, which take part in a problem. We divide people into groups and we ask them to develop their preferable KM strategic plan. Then, during the Dialectic Discussion at the presentation of the strategies, groups should think about the adjustment of their assumption. Finally, we shall compromise based upon the already formulated assumptions.

The third step is to use the above groups—which mean pluralism of opinions—and their strategies—which mean pluralism of ideas- to implement VSM. We are using the result of the previous step to create the rich icon of the problem and their strategy and opinions in order to build the definitions of this methodology (VSM).

Finally, the fourth step in order to represent the above results in a comprehensible and simple—but not naive—way. We have chosen PSM in order to represent these results at all the levels. Apart from that, the ability of PSM to re-organize the structure very easily and to adapt to possible changes is something that enhanced our choices (Fig. 4).

In the following sections we will unfold the steps of our systemic multi-methodology, applied to the case study of a virtual consulting company.

4. Application and findings

4.1. The case of a virtual consulting company

The enterprise under study is a quite successful small to medium-sized consulting company located in Munich, Germany. Consulting companies belong to the so-called knowledge-intensive category of companies (Starbuck, 1992) and form ideal examples for case studies in regard to knowledge management, mainly for the following reasons:

- one of the products/services provided by consulting companies is knowledge; their customers might act with a better way than that they did before the services received from the consulting company (Senge, 1990);

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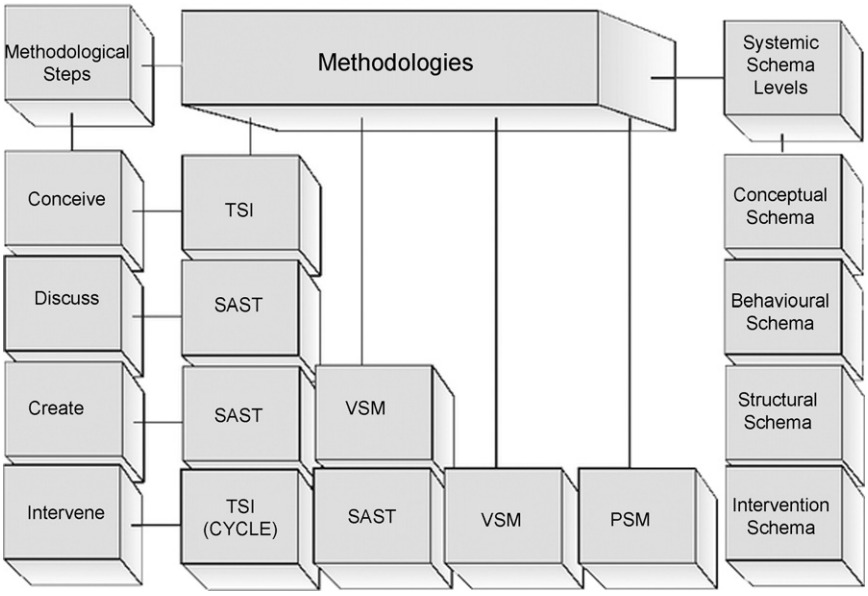

Fig. 4. Systemic multi-methodology for KM in virtual enterprises.

- moreover, most consulting companies offer knowledge management as one of their services, and finally;
- they very often apply knowledge management for their interest.

The company specializes in the fields of law, financial and corporate management mainly addressing small family-owned firms with regard. Though there is an obvious need for consultation of family-owned firms, they usually do not have the resources (in terms of money, time, people, for example) in order to finance consulting services.

The consulting company under study was founded in 1982 as an association. The legal structure as an association was mainly prescribed from the existing regulatory framework in order to consult not only in business but also in law and tax-related problem situations. Without the legal structure as an association, to consult in all three mentioned fields would be forbidden according to German law. Besides, an association as a business entity comprises an organization that enhances trust among its members due to the mutuality and shared responsibility aspects of associations.

In terms of organizational structure, the consulting company forms a *virtual network* of partners, consisting of a *central unit*, several geographically dispersed *subunits* and a set of approximately 80 *external partners*, which can be divided into two categories:

- special consultants, and
- technical consultants, depending upon the level of knowledge and services they offer to the network.

The network itself can be described as an open grouping of partners which have agreed to share the knowledge of one another's and decided to establish an organizational network (Goldman, Nagel, & Preiss, 1995). The central unit of the network is responsible not only for a specific region but also for the entirety of services: research and development of products, control, marketing, intranet administration, public relations, training and education, knowledge management, Database storage, and strategic planning. The geographically dispersed subunits are responsible for consultants in the corresponding region, which are either companies of limited responsibility or S.A.s.

4.2. Step 1: TSI application

The TSI (Flood & Jackson, 1991) represents an approach to planning, designing, problem solving and evaluation. The process entails a range of systemic metaphors (machine, organic, neurocybernetic, cultural and political) to encourage creative thinking within the organizations and the difficult issues that managers have to deal with. These metaphors are linked through a framework known as the "system of systems methodologies", to various systems approaches, so that once an agreement is reached about which metaphors most adequately match the current organizational state, an appropriate systemic methodology will guide the "problem-solving" process in a way that it is ensured that it addresses the main concerns of the problem under study.

The seven principles of TSI are as follows:

- Organizations are too complicated to understand using one model.
- Organizations, their strategies, and the difficulties they face should be investigated using a range of system metaphors.
- Systemic metaphors can be linked with systems methodology to guide intervention.

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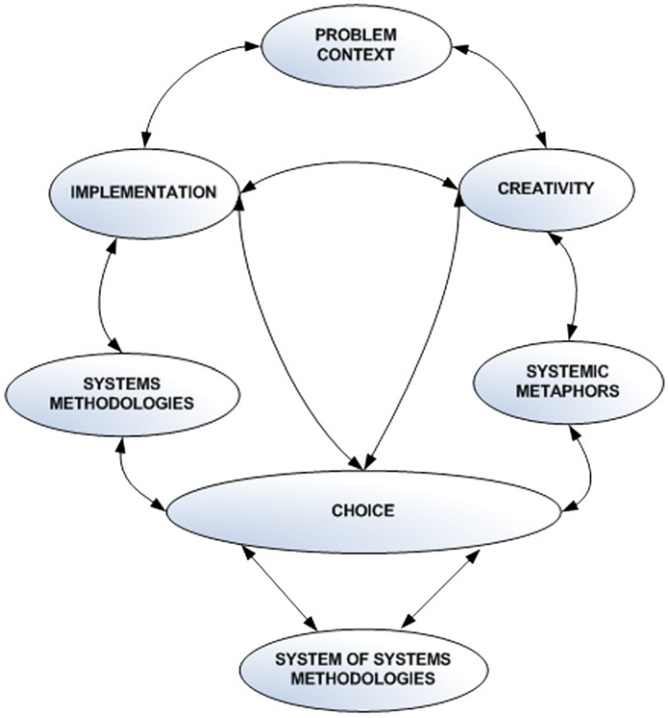

Fig. 5. The TSI process.

- Different systemic metaphors and methodologies can be used in a complementary way to address different aspects of organizations and the difficulties they confront.
- It is possible to appreciate the strengths and weaknesses of different systems methodologies and to relate each to organizational concerns.
- TSI sets out a systemic cycle of enquiry.
- Facilitators, clients, and others need to be engaged at all stages of the TSI process.

The three phases of TSI are called "Creativity", "Selection" and "Implementation". We shall consider these in turn, examining the various tasks being carried out:

- In the creativity phase, systemic metaphors are used as organizational structures to help managers think creatively about their enterprises.
- In the selection phase, an appropriate systems-based intervention methodology (here a set of methodologies) is (are) chosen to match particular characteristics of the organization's status as revealed by the investigation conducted during the creativity phase.
- In the implementation phase, specific systemic methodologies are applied to translate the dominant vision of the organization, its structure, and the general orientation adapted to concerns and problems, into specific proposals for change (Fig. 5).

During the process of diagrammatic designs that represent the organizational and managerial structure of the company under study, we work under the philosophy and principles of TSI mainly from its "Creativity" point of view. We continuously analyse and design diagrams that reflect the organization, which is under examination, but among them we select those that best match the organization's status. This is the role of the "Selection" phase. In the final phase of "Implementation" we check these diagrams in order to verify that they truly represent the organization's current state. Then we follow all these steps from the beginning in a repetitive manner, until we are satisfied with the result.

According to Flood and Jackson (1991),

> …different metaphors focus attention on different aspects of an organisation's functioning. Some concentrate on organisational structure, others highlight human and political aspects of an organisation.

The outcomes from each one of the three phases involved in the TSI process are presented in Table 2 along with the tasks carried out and the tools used to achieve these.

Therefore, in the first step, we use the TSI, aiming at the guidance *for selecting the appropriate systemic methodologies* in the context of our problem, having as basic tools the fundamental systemic principles of *recursion* and *variety*.

4.3. Step 2: SAST application

This step aims at the formation of specific groups so that the corresponding preferable KM strategies/solutions are developed, as integrated products (knowledge management as a product).

Table 2
The three-phase TSI methodology (Flood & Jackson, 1991)

Creativity	Task	To highlight aims, concerns and problems
	Tools	Systemic metaphors
	Outcome	*Dominant* and *dependent metaphors* highlighting the major issues
Choice	Task	To choose appropriate systems-based intervention methodologies
	Tools	The system of systems methodologies; the relationship between metaphors and methodologies
	Outcome	*Dominant* and *dependent methodologies* chosen for use
Implementation	Task	To arrive at and implement specific change proposals
	Tools	Systemic methodologies employed according to the logic of TSI
	Outcome	Highly relevant and co-ordinated intervention

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The SAST (Churchman, 1971) is a systemic methodology, which concentrates the attention of managers to the relationships among people—members, who participate in a problematic situation. SAST is the answer to insufficiently structured problems where several diverse opinions make the decision-making process extremely difficult.

The SAST methodology includes four main stages:

(1) group definition,
(2) assumption formation,
(3) dialectical discussion, and
(4) composition.

During the first stage if more people who may have an opinion about the structure of the problem cooperate, then the results we get will be better. The members are divided into groups, which are defined according to specific criteria such as:

- type of personality,
- time definition (long/short term),
- personal profit,
- supporters of specific strategies.

During the Assumption Formation stage, each group develops its preferable strategy/solution. There are three techniques, which can be followed:

- In the first, all members in key positions must be identified.
- In the second, assumptions are specified.
- The third technique is the classification of each group. The classification takes place according to two criteria:
  (1) The importance of the hypothesis influencing the success of the strategy.
  (2) How certain we are that the assumption is justified.

During the Dialectic Discussion stage, all groups present their strategies and they take questions from the other groups, which they have to answer. After this conversation, each group should think about the adjustment of their assumption provided that this adds value to the already proposed strategy/solution.

Composition constitutes the last stage during which we aim at a compromise between the presented assumptions. A new strategy should be formed consisting of the old ones and be even better than them.

Our main criterion for the final "composition" of the optimal solution depends upon the effect that this will have to the company's relationships with its customers, thereby indicating the success or failure of the selected product, as it is illustrated in Table 3. At this point, we evaluate the final product based on the "Assumption formation" both from the partners' point of view and from the customers' point of view.

Table 3
"Assumption formation" based upon customer relationships

Readiness/capability of customer for change	Ready and/or capable for change	Unready and/or incapable for change
System success		
Successful	Successful solution	Less successful solution
Unsuccessful	Less successful solution	Problematic situation

4.4. Step 3: VSM application

The philosophy that guides Stafford Beer's Viable Systems Model (1979, 1981), entails the organizational changes that we experienced during the twentieth century.

- Organizational and social "problems" arise due to high degrees of complexity.
- A scientific model, which is based upon cybernetic principles and covers a large part of the theory of management, is essential to deal with modern complexity.
- Since control is the main target, then the best approach is the imitation of a thoroughly tested and verified "control system", such as the human brain or the nervous system that have been studied for thousands of years.
- Organizations, in the ideal case, are organized so that they achieve efficient and effective achievement of the pre-determined objectives, however these objectives should be re-examined continuously in conjunction with the rapidly changing environment.

The scope of this step is the *identification* and *analysis* of the *communications* among the VE members, i.e. the information and knowledge flows linked to business processes. An essential aim of communication identification and analysis through the VSM-based framework is to increase the capacity within the organization to receive signals from the scattered 'sensors' (or 'algedonics') throughout the organizational structure and transform them into information and action. By using appropriate sensors and indicators, we evaluate corporate performance and its potential to *respond* to the environmental changes.

In VSM terms a 'responsive' organization is one that is capable of 'sensing' changes early and adopts the necessary behaviour to match environmental variety. To achieve this, focus should be on detecting changes from the external environment and plan strategies to respond accordingly in order to achieve adaptation to the new conditions. In a hierarchical organization people responsible for this task are mainly marketers and others working at the corporate level. From the 'viable' viewpoint, everyone in the organization should be concerned, connected and interacting with the external environment, and hence everyone should be involved in the formulation of the appropriate

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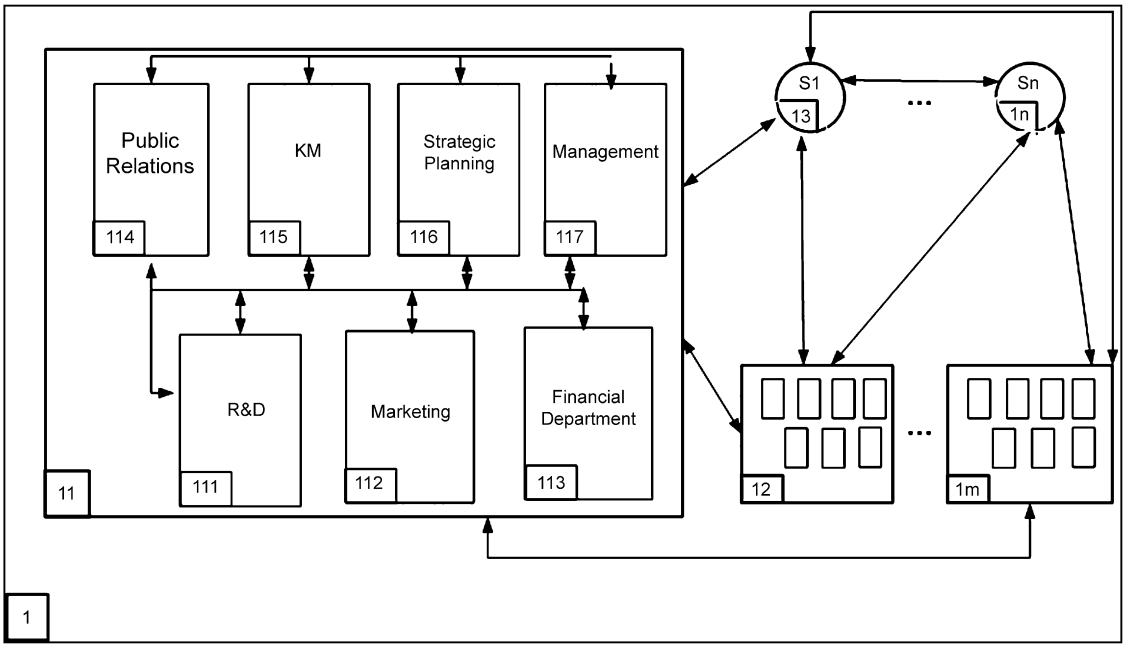

Fig. 6. A simplified diagram based on the PSM schema for the virtual consulting company (VSM & SAST implementation).

response strategies. Therefore, knowledge of the environment is necessary, and people at all levels need to develop a deeper grasp of the connectivity between them and the global environment.

To achieve this, the appropriate information is measured and feedback is used to modify the way work is conducted. This is carried out through the operation of strategic information management systems based on performance indicators, which serve as 'corporate sensors' and trigger the generation of the appropriate alerting signals called 'algedonics', so that the organization is aware of any problem as soon as it happens.

In Fig. 6, a simplified diagram of the virtual consulting company under study is illustrated based on the PSM schema (see Section 4.5 for more details).

4.5. Step 4: PSM application

The problem structuring methodology (PSM) by Panayotopoulos and Assimakopoulos (1987) is used for modelling real-world systems, based upon the following terminology:

(1) *Subsystem*: A person or a small system can be regarded as a unique element of a system.
(2) *Member of a system*: One or more elements can compose a subsystem of a larger system.
(3) *Communication*: The information flow between two subsystems, which can be one-way or both ways.

We have distinguished communications and control according to their type or kind. Types that have arcs are one-directed, whereas edges represent bi-directional communication. Bold types illustrate the flow of control. The design of each type is completed by its value kind, which is one of the letters as they have been defined by Bowen (1981):

- *P*,*p*: Potential conflict (unconstructive communication in a conflict situation).
- *C*,*c*: Communication (good communication).
- *U*,*u*: Purposeful action (good necessary communication).
- *G*,*g*: General interaction or influence (interaction with no particular stress on communication).
- *D*,*d*: Distorted communication (incomplete communication with inevitable distortion of information).
- *Δ*,*δ*: Distorted purposeful communication (incomplete necessary communication with inevitable distortion of information).

4.5.1. PSM schematic representation or schema

PSM is a systemic structuring methodology aiming at providing a suitable graphical environment that is powerful enough to represent the real structure of a problem, the systems and subsystems engaged as well as the agents and the flow of information. PSM is capable of creating templates of objective representation and understanding that can be shared among specialists leading to consensus and efficient decision making. PSM can be applied in any stage of decision making and problem solving. It can be easily used as a tool for reconstructing and planning different configurations. The word "configuration" denotes any phenomenon that can be distinguished. It includes everything that is called feature, property, state, pattern, structure or system.

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4.5.2. Elements of PSM schematic representation

PSM uses a small set of symbols along with a simple set of rules that provide flexibility and practically unlimited capability of representing complex systems and problems.

(a) *Positionings*: Positionings can either be subsystems or persons (stakeholders).
(b) Communication channels: A communication channel carries information to and from a stakeholder or a subsystem. The communication channel carries a Bowen symbol (as set out above) that characterizes the type of communication (Fig. 7).

PSM diagrams (see Fig. 8) are very expressive and clear diagrams. They can combine different perceptions to a mutually acceptable representation, thus helping to provide a formal representation of the structure of an organization or enterprise.

This step involves the structurization and formalization of the important communications that are of interest to higher management inside and outside the company, and their classification to categories within each department, by utilizing the strong diagrammatic potential of the PSM (Fig. 9).

4.6. Knowledge management in the virtual consulting company supported by strategic information systems

The following figure illustrates a holistic approach to knowledge management in a VE, which resulted from the composition of the four already analysed systemic methodologies, i.e. the TSI, the SAST, the Viable Systems Model (VSM) and the PSM, *each one supported by the appropriate strategic information systems and technologies*. By having a quick look at the diagram, we can distinguish the importance given by each methodology to different co-related entities of the enterprise, i.e. the VE as a Whole (TSI), the potential of Groups within enterprises (SAST), the influence of environmental changes on business processes and how these can be attenuated (VSM), and the structurization and formalization of information flows among individuals (PSM), all of which are regarded as enablers for organizational flexibility and efficiency.

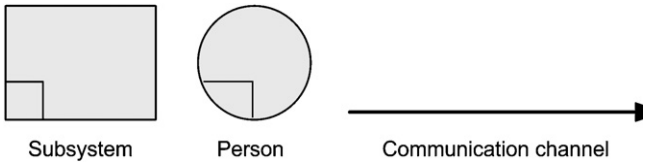

Fig. 7. Elements of the PSM schema.

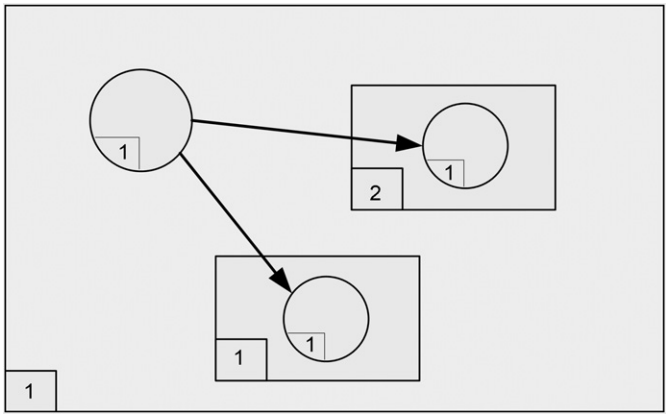

Fig. 8. An example of PSM diagrams.

During all stages of the proposed multi-methodology *strategic information systems* play a major role. In the case of the virtual consulting company under study, many of its partners can be geographically distributed, in different time zones, so systems such as *Email* might be well warranted. The advantages could be: lower costs, less time wasted when establishing the contact with partner(s), and better documentation and organization of information and organizational memories. *Groupware systems* such as video conferencing might reduce the required travel cost and time. The combination of video conferencing with group text processing systems can be useful for developing common documents (e.g. contracts, plans) without the need of face-to-face meetings.

For VEs, where partners are often geographically dispersed and do not work under the same formal organization, it might be more critical to use data and document management systems to assure document access to all partners as well as reliable archiving of files.

Trust among the VE partners is perhaps the most important factor for the development of interorganizational collaboration, in terms of information and knowledge sharing. If trust between two VE partners is lost, the collaboration collapses immediately. Apparently, trust cannot be facilitated only with the use of strategic information systems, but it can well help. For example, in the case of the virtual consulting company, *allowing open access* to others' mission-related information systems without case-wise permission can serve to build trust in the same way an "open-door policy" might work in a typical office setting (Faisst, 1996) (Fig. 10).

Another class of strategic information systems is that of *project management systems* providing group and project scheduling operations. Similarly, it is necessary for the company to keep an on-going evaluation of partner skills and performance. Electronic checklists for partner evaluation stored in the partner database could serve this purpose very well.

4.6.1. Step 1: conceive knowledge as a strategic resource (conceptual schema)

Given the partner entities and their specified characteristics and missions within the business network, the conceptual schema specifies the available knowledge resources as well as the means to acquire, integrate, store, share and apply them towards the VE overall mission achievement. To guarantee sufficient documentation access

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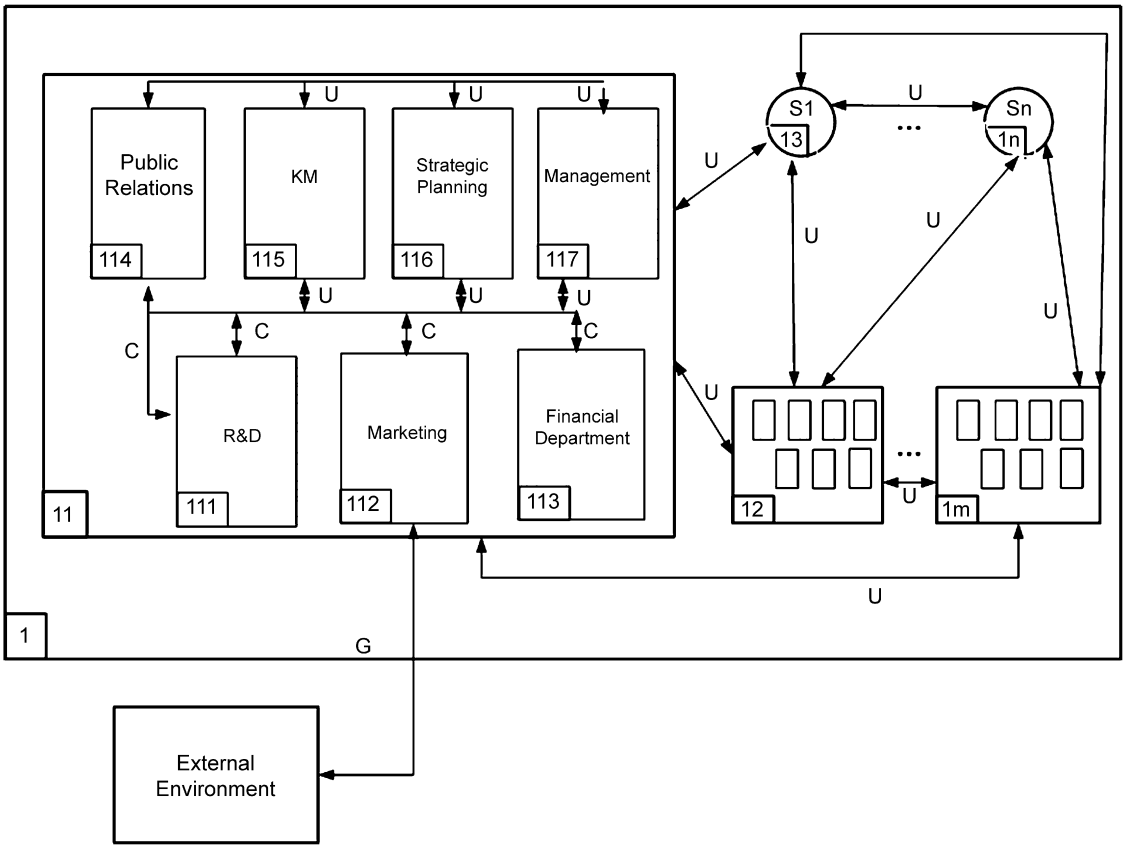

Fig. 9. Structurization and formalization of the information flows among the corporate departments.

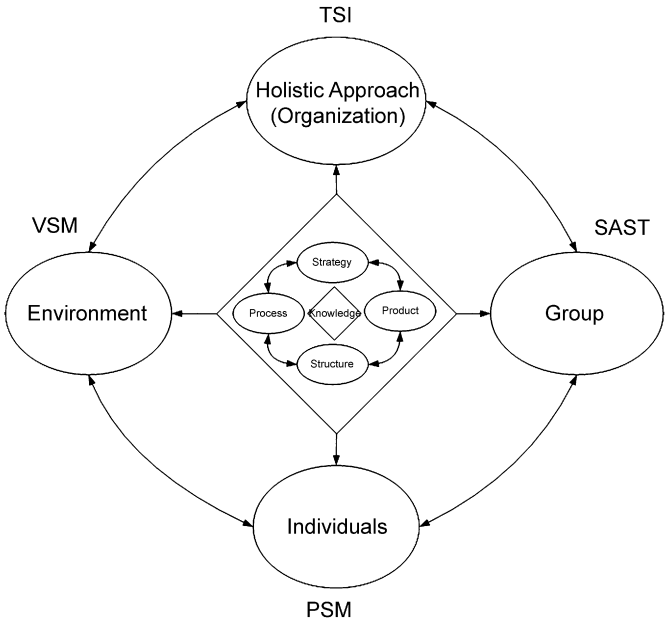

Fig. 10. Systemic multi-methodology for knowledge management in a virtual consulting company.

during the life-cycle of the VE to all partners, an integrated database needs to be developed, including all mission-related information. Information management systems that might be useful at this stage include legal software (which typically include a library of reference contracts, forms, etc.) and expert system software for resolving any inconsistencies between the different partners' information management policies.

4.6.2. Creation of knowledge-intensive human capital (behavioural schema)

The available *human resources* of a consulting company are an important factor that affects its efficiency. It is obvious that the more human resources a firm has at its disposal the more work it can carry out. Therefore, it can develop more collaborations with the other VE partners. On the other hand, the effectiveness and the human capital of a company do not depend entirely on the number of its employees but mainly on the level of the expertise and the quality of its members.

During the second step of the proposed multi-methodology, tools such as *online databases* (user interfaces needed), newsgroups, content and document management systems would be useful for brainstorming and sharing ideas for new ventures or projects. *Newsgroups* and the *WWW* are important for both identifying new ideas for projects as well as making offers for them. *Strategic planning software* supports the VEs mission definition, e.g. by electronically checking the activities needed in a VE.

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4.6.3. VE formulation (structural schema)

During the VE formation phase, a key activity is to identify suitable partners as specified by the VE mission and goals. Nowadays, partners are found using personal relations or social networks (Krulwich, 1997). However, this method does not ensure the required market transparency. Increasing competition urges companies not to take any partner, but the "best" one. This is only possible with global sourcing, and therefore IT support is necessary.

Finding potential partners can be facilitated either through an *internal partner database* or through *internet search of enterprise presentations*. An *internal partner database*, i.e. a network of entities (potential partners) including an inventory of partner capabilities and capacities, could be constructed. Upon definition of a particular mission, the network could be searched for specific recommendations for possible partners.

4.6.4. Systemic knowledge management (intervention schema)

Strategic information systems make it possible to get central information from a decentralized position and to combine dispersed expert knowledge. Therefore, the knowledge (technical know-how, knowledge about customers and markets, organizational knowledge) can be shared. In the network employees can find know-how in databases as well as in human knowledge bases (experts) by *knowledge portals*.

In the VE context a *knowledge portal* can be created in the collaborative extranet, in order to establish communities of practice and harness the knowledge gained by individuals, through years of experience, the processes of debriefing and mentoring.

The necessary technological infrastructure will be web-based, i.e. an open-source web-portal installed on a web-server. The home page will be common to all users through which they can be navigated to all the supported functions. The management of the portal will be carried out through the same interface; however the functionality will be quite different. Further, a number of other functions dealing with the parameterization of the application will be carried out through separate screens.

The most important outcomes that can result from such a web application—in terms of interorganizational cooperation among VE members—include (a) the improvement of skills and competences of employees by facilitating the appropriate and efficient use of acquired knowledge, (b) the familiarization with the real needs of the market through the engagement in collaborating projects, (c) the exchange of ideas and experiences through the involvement in "virtual" learning environments, as well as (d) the collaboration and employment in innovative interorganizational programmes (Fig. 11).

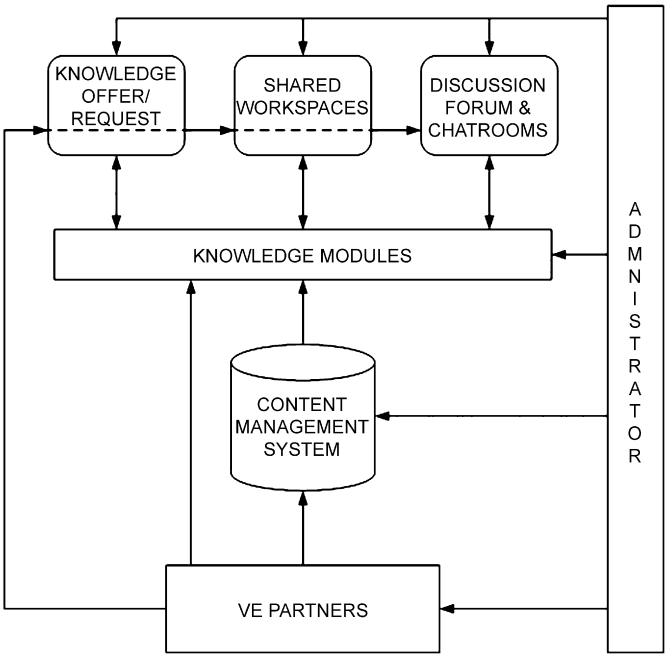

Fig. 11. Architecture of the knowledge portal.

5. Summary of outcomes from the application of the systemic knowledge management multi-methodology to the virtual consulting company

Systems thinking has been successfully applied to a wide range of problems and a significant number of methodologies have been developed to support this activity. The first step in identifying appropriate methodologies is to determine the generic type of the area of concern, i.e. the system under study. Therefore, the first area of concern is a designed physical system (that also contains human components). For this purpose in our approach, we propose a consistent multi-methodology that can facilitate and monitor knowledge management in a VE.

The initial step in our multi-methodology was the correct specification of the area of concern, i.e. the virtual consulting company. This requires the mapping of the subsystems and the positioning of the stakeholders engaged in the systemic schematic representation. For example, if we are to change the way partners in the virtual network collaborate, we must first build a detailed map of the system involved. In this map, we must position the main systems and subsystems, the stakeholders and their roles together with the communication and control patterns. This map must be agreed upon by all the stakeholders involved in the paradigm change.

We chose to implement the mapping with the PSM methodology. PSM helped us to construct the "physics" of the system and its environment in an ontological manner that holds a significant degree of accuracy and objectivity. PSM diagrams are powerful representations that can be easily communicated among stakeholders and reconstructed until a critical amount of consensus is achieved. In the case study above, we briefly demonstrated the use of PSM.

The second area of concern in a systemic process is a human activity system (engineering organization). This observation is valuable as it indicates that the two areas of concern are of fundamentally different types and hence had

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to be approached with *different methodologies*. The identification of suitable methodologies for each of the areas of concern is the work of TSI, as already mentioned.

In the next part of our methodology, SAST and VSM are used, respectively to facilitate the specification of the system's boundaries, the information flows among its subsystems and its interaction with the environment. This requires that the stakeholders involved in the new model reveal their mental models and their hidden assumptions to each other so that a higher degree of understanding can be achieved. In the case of installing a content management system, senior management might reveal that it is disrupted by leaving information management and control to an information system. Lower-level staff might reveal that this system gives them the ability for a higher degree of control and access to more and useful information resources. By combining worldviews and accepting a common perspective of reality, each stakeholder reconsiders the culture that drives the work pattern he is attached to.

VSM is a powerful descriptive and diagnostic tool to promote organizational viability. The traditional organization chart of a company can be regarded as being rather unsatisfactory as a model of a real organization nowadays. Beer's suggestion was to develop a more useful model (Beer, 1985). The VSM provides a model of the operational characteristics of a viable system. The design of communication channels is based on the PSM schema that links the various functions, as well as the system with its environment, which is also of great importance. In all cases, the VSM-based model gave us the chance to look at the organization interacting with its environment. The VE was viewed as consisting of two parts: the Operational which does all the basic work (production, distribution, earning the money) and the parts that provide a service to the Operation by ensuring the whole organization works together in an integrated way (scheduling, accounts, strategic planning).

Finally, the most important step of our multi-methodology was involved in identification of methodologies that would be appropriate to the two areas of concern as already described. Jackson (2000) has identified over 20 methodologies that could have applicability for dealing with complex systems. Our primary concern in this paper was to identify which of these, or combinations of these, might be useful to our areas of concern. We have reached the conclusion that TSI would be helpful in this respect.

The special success factor of the systemic approach described is the fast and effective solution of problems through mutually accepted representations of each problematic situation and effective knowledge sharing with the use of appropriate systemic methodologies. Therefore, the most important outcome of the proposed application was the design of a holistic approach to support the problem-solving process by a systematic exchange of knowledge. The developed multi-methodology has provided unique insights on knowledge management in virtual networks that can be classified on three levels:

5.1. Human level

Strategic information and knowledge management systems are successfully used more often if they are implemented and supported by the appropriate systemic methodologies. Structured representations of human activity systems are helpful for better and more effective description and positioning of roles and responsibilities of employees from the beginning, e.g. in a new project, and problems arising can be decreased to minimum.

5.2. Organizational level

Problematic situations can be encountered with problem-solving strategies, methods and tools combined in a systemic manner. The prevention of problematic situations in virtual networks can be achieved with formalization and structurization of information flows leading to the improvement of the internal and global corporate knowledge-intense cooperation through standardization of project tasks and communications.

5.3. Technological level

The creation of a dynamic virtual network for knowledge exchange with the use of modern information technologies and systems in a Web-based platform can be expanded through the use of a *knowledge exchange protocol*, which with the use of new technologies (e.g. a knowledge portal) provides broad access to corporate knowledge and information resources, and encourages interorganizational collaboration.

In terms of the virtual consulting company the holistic approach has led to important advantages with respect to interorganizational collaboration and problem-solving procedures, such as:

- effective collaboration of experts in a virtual environment,
- fast feedback in every stage of a project, thus leading to fast realization of ideas and innovations,
- better project coordination which results in better project scheduling,
- cost reduction through easier and more effective organization of projects,
- the standardization and schematic representation of information flows has led to an easier replacement of face-to-face meetings by the use of communication software and tools, and
- a common knowledge base concerning customers and previous experience can be used and built up by all the participants in the virtual network.

6. Conclusions

There is no doubt that organizations today need information to stay competitive. 'Knowledge is power'

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has become one of the catch-phrases of our time. Yet information does not equal knowledge, and as the quantity of information mushrooms, the gap between these two entities widens. Disorderly or poorly managed information actually impedes knowledge, rather than increasing it. As the Information Age reaches maturity, the most pressing concern for many businesses today is not how to obtain the information they need, but how to control the information they already have.

In this paper, we have studied *knowledge management in VEs* in a systemic manner, a field that is characterized by an obvious research gap at the moment. In order to conduct such a research, we have used the results of recent studies and presentations in the international bibliography. The findings of the case-study used have showed important differences between the traditional and hierarchically organized enterprises in comparison to the virtual consulting company under study.

Through the systemic approach, we have managed to formulate a new multi-methodology, which combines four systemic methodologies; the TSI, the SAST, the VSM and the PSM. We have used the methodologies mentioned in order to benefit from the pluralism and the ideas that can be expressed by groups or individuals (SAST), the stimuli and the changes of the environment and its interactions with the company (VSM), the structurization and formalization of problems (PSM), and finally by combining all these methodologies (TSI) we have reached to a strategic model for knowledge management in VEs, consisting of four iterative steps supported by appropriate strategic information systems.

The challenge was to enhance knowledge sharing in VEs through the 'lens' of systemic metaphors and methodologies supported by strategic information systems enabling the creation of self-organizing communities of practice, in the frame of a knowledge ecosystem. A problem-solving process can only be implemented successfully if the knowledge-intensive tasks to solve a problem are supported by a strategically built methodology. In conclusion, the cornerstone of our research was the design and application of a multi-methodology to support the problem-solving process by a systemic management and use of knowledge. The creative potential of a VE is used directly, e.g. at a value chain in a cooperation project, and is so directly constituted and used.

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