

## Implementation of a Knowledge Management Tool within a VDO Network: Preliminary Results.

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*Abstract:* - This paper presents a Knowledge Management (KM) software tool which has been designed to support managing implementation of best practices and improvement initiatives within a VDO (Virtual Development Office) Network. A VDO Network is an organization integrated by SMEs, with a particular form of governance. Furthermore, the KM tool enables building a knowledge base of key capabilities available to a VDO to support decision-making and responding effectively to new business opportunities. KM tool acts not only as a repository for knowledge pertaining to improvement initiatives, but it also drives SMEs to apply and share that knowledge within the wider VDO Enterprise Network. The availability of KM tools for SMEs is rare. This is more evident for Enterprise Networks. The KM tool can be easily modified to address better the requirements of the user (VDO) due to its flexible architecture.

*Key-Words:* - Knowledge Management, Knowledge Sharing, Virtual Development Office, SMEs

### 1 Introduction

In the current scenario, enterprises competitiveness is not based on company or industry, but on the value creating systems themselves, within which different agents work together to co-create value and build a network [1]. Researches in interconnected systems have contributed to characterize the benefits correlated to cooperation between companies [2,3,4,5]. These advantages could be particularly important for Small Medium Enterprises (SMEs) given the resource constraints and limitations they work within [6]. On the other hand, networking of enterprises entails new organizational problems, such as the decentralization of decision-making process and the horizontal coordination between different business functions [7] as well as the problem of knowledge management. The evidence in extensive literature and case studies [8,9,10,11] supports the belief that Knowledge Management (KM) can play a key role in managing businesses successfully and improving their performance. In addition, the way in which an organization learns can influence its effectiveness and potential to innovate and grow [12]. Nowadays, it is possible to affirm that the ability to learn, acquire, foster and integrate relevant

knowledge within an organization and its value chain is one of the most important competences to achieve strategic success [8,13,14,15,16,17]. In the present competitive environment, manufacturing organizations have achieved poor relative performance in world markets in terms of competitiveness, world trade, R&D expenditure and patenting, management practices, etc. This is partly due to poor understanding of organizational learning processes, which is critical for the facilitation of improvement and innovation in business processes [18]. Behavioural change of individuals that may lead to performance improvement can be achieved by understanding and optimizing learning processes, which reinforce the existence of a strong relationship between learning and performance improvement [19,20,21]. ICT-based Knowledge Management Systems (KMSs) can be seen as enabling technologies to effectively support knowledge management aspects and related learning processes [22].

The failure of early IT-based KMSs has encouraged the application of KM soft approaches. These are focused on learning through direct social communication and interaction [21]. However, soft KM approaches provide a vague proposal for a

systematic implementation of learning organizations [23]. On the other hand, there is concern that IT-based KMSs will objectify knowledge into static repositories without acknowledging the critical role of individuals in knowledge creation, application and dissemination [24,25,26]. IT-based KM applications should be combined with soft KM approaches [27] to encourage individuals to think beyond their current boundaries. This will facilitate organizational activities, promote continuous knowledge creation and continuous improvement, and support growth through innovation [28,24].

In addition, strategies for capturing, creating, using, integrating and transferring organizational knowledge should aim to improve efficiency of business processes and provide sustainable competitive advantage. SMEs are disadvantaged in this area due to resource constraints [29]. Learning networks have proved successful to help SMEs in transferring new concepts such as Continuous Improvement and Total Quality Management [30], in the diffusion of wide variety of technologies, and increasing the knowledge base and other capabilities [31,32,33]. Intranet and Internet technologies facilitate knowledge transfer and collaboration within a distributed learning network, which include the implementation of KMSs.

Extensive surveys show that large organizations are investing resources to develop at some degree their own ICT-based KMS [34]. However, it is difficult to implement KM in SMEs because resources are reduced and more research focused on SMEs is needed [35]. Therefore, there is a real need to develop affordable KM tools dedicated to SMEs to help them improving their competitive position. Such need is even higher if referred to the domain of SMEs organized in virtual enterprises [36].

In recent years, research has addressed the utilization of the intranet and internet not only as a repository of unstructured information but also as a powerful enabler of effective information and knowledge accessibility and communication [37], supporting collaborative projects and offering the opportunity to create new knowledge.

Consequently, the need exists to develop a low-cost ICT-based KM solution to support manufacturing SMEs in order to help them to obtain the KM benefits available to large organizations. This can be done within the environment of a virtual Knowledge Sharing Network (KSN).

This paper presents the implementation of an ICT-based KM tool to support the activities of a virtual network of SMEs in industries such as communications, packaging and logistics. The purpose of the ICT-based KM tool is to facilitate

establishing a systematic approach to convert part of the tacit knowledge embedded in improvement projects and management best practices into explicit form.

The article has four sections. In the first section, the VDO Network model is presented. In the second section, the environment of the case study, the GPT VDO Network, is briefly introduced so as to characterize the context for which the KM tool has been implemented. In the third section, the KM tool is presented by highlighting the desired characteristics and its structure. The final section focuses on presenting preliminary results after the tool implementation. Conclusions are drawn consequently.

## 2 The VDO Concept

The Virtual Development Office (VDO) is a new conceptual organizational model for enterprise networks [5]. The Virtual Development Office (VDO) model has been developed within the Italian research project MIGEN, during which the University of Perugia supported the development of an enterprise network from its first steps. In particular, it focuses on SMEs. SMEs represent an important aspect of the European economy and they require effective cooperative models to encourage the development of collective innovative capabilities to respond to emerging business opportunities. The aim of the project was to define a conceptual organizational model for enterprise networks, in order to increase the competitiveness of SMEs. These organizations require cooperative models encouraging the development of collective innovative capabilities in terms of providing new innovative solutions for emerging business opportunities and pressing research to develop process technologies and improve the quality of the products through process improvements.

The approach proposed is based on the creation of an independent subject, the Virtual Development Office (VDO), GPT in the case study, which acts as a leading actor, and it has the role of creating, coordinating and managing a community of enterprises. Particularly, it should be the market intelligence of the network, continuously catching business opportunities in the market and positioning the network on it. Moreover, the VDO is the permanent interface to public institutions [34], financial institutions and research centres. A proactive collaboration with such subjects is a leverage factor in today business. The VDO activities presented above are "external" to the network. However, the VDO also has a crucial role

inside the network life. First of all, it has the role of maintaining and consolidating the trust of companies involved in the network by generating and promoting a long-term alliance. By acting as a central player on respect of the “business ecosystem”, it promotes both the willing of cooperation, both the readiness to collaborate each time a business opportunity, which for a network can be defined as a “collaboration opportunity” (CO) arises (see Figure 1).

The activities performed by the VDO are summarized by the following phases:

- Analytic Phase; it involves a continuous monitoring of the environment and the competitive position of enterprises belonging to the community in terms of resources and competencies. One of the core activities of the VDO is the definition of the strategic positioning of the community and the creation/promotion of business opportunities. Moreover it is important to remark that based on this approach it is possible to define developmental lines for innovation projects and it is possible to identify criteria for opening the community to different actors.
- Planning Phase; after the target definition (business opportunity, new product development projects, etc.), the VDO should manage the following activities: (1) plan activities, identifying the necessary resources/capabilities to reach the targets; (2) select the enterprises in the community that will create the Virtual Enterprise (VE) to fulfil the CO derived from the identified Business Opportunity (BO); (3) establish the contribution of every actor in the VE and the cooperation rules based on Service Level Agreements (SLAs). The last is a very critical activity in the management of the VE, given that it requires the definition of organizational models, revenue sharing contracts, transaction costs, etc. i.e. the “rules of the game” that will guide the activities of the single enterprise.
- Operating phase; it implies the control of the quality of the products/services provided (safety, availability, reliability, etc.) and the solution effectiveness; these data represent fundamental feedbacks for the analytical phase.

From a value chain point of view, particularly interesting is the creation of the VE or VO for specific BOs, since the processes that constitute the value chain, i.e. those activities that represent the value proposition of the network and lead to customer satisfaction, will be split amongst the members of the network that are participating in the CO. This is illustrated in Figure 2.

In this conceptualization the VDO is represented as an independent entity with the authority to involve companies external to the network, if to do so it would improve the competitiveness of the network with regards to a particular BO. This approach means that an optimal provider can be selected for each stage in the value chain. As a consequence, with this approach a company may cover only part of a stage in the value chain, as in the traditional structure, or several disparate stages as demanded by the CO. Thus, the stages in the VDO value chain can be seen to be vertically as well as horizontally integrated.

### 3 The “GPT” VDO Network: the Environment of Implementation

The case company called Gruppo Poligrafico Tiberino (GPT) was founded in 2003 by three companies in the packaging district of Città di Castello in the north of the Umbria region in Italy. This new capital company was originally established to integrate and develop the commercial and marketing functions of the participating companies. GPT sought the assistance of the University of Perugia to expand its business borders, undertaking a number of projects to further develop the GPT business model. GPT has already been recognized as an innovative business model for business networks, developing a strong permanent cooperation relationship with the Academic community. Between 2005 and 2007, GPT grew from the original 3 partner firms to 18 current members in communications, packaging and logistics industries. Thus, GPT is a fast growing company offering an innovative business model, seeking to consolidate its position in its national market and entering the new markets of South America and Northern Africa. Moreover, GPT is the first enterprise business case based on the VDO model. The authors, supported by GPT management, have worked to design the KM tool so as to support the VDO Network needs.

### 4 The KM Tool for the “GPT” VDO Network

#### Identification of Needs

The Authors, together with GPT management, have worked to identify the characteristics that the desired tool should have had. This teamwork has permitted therefore to design the tool following both an academic and practical approach. The mentioned activity has permitted to highlights the following needs:

*NEED 1* - Within VDO Networks, the hub, namely the VDO, has knowledge management issues related to fact that it has to respond quickly and successfully to new BOs and therefore it needs to know network members competences and capabilities. Therefore, a KM tool, in this case, has also the role of supporting decision making activities.

*NEED 2* - SMEs can acquire new knowledge by participating in partnerships or networks with other companies, sharing similar or complementary problems in order to become more competitive. This raises the issue of how to facilitate the operation of such networks. Therefore, sharing knowledge about the implementation and outcomes of such projects among the VDO Network members should promote implementation of similar and new initiatives to improve their competitive position.

*NEED 3* - SMEs have poor managerial competences and scarce know-how of technological innovations. As a consequence of that, the KM tool should be a support in these issues, by helping promoting managerial best practices and sharing of technological know-how within the network.

*NEED 4* - SMEs desire to use simple tools, with easy user interfaces and the possibility of managing documents, drawings, procedures, spreadsheets, etc..

*NEED 5* - SMEs do not have the resources for investing in informatics infrastructures for implementing new tools. As a consequence of that, tools based on Internet knowledge portals are desired.

The above-mentioned characteristics have been considered for designing the KM tool.

### **Structure of the Knowledge Management Tool**

The KM tool (KMT) is based on a multi-user database management system (DMS) built under a Microsoft Office Access application. A DMS was chosen as best for its ability to separate data storage and analytic elements.

The system integrates five main functions:

1. creation and searching of electronic library of cases/projects by main attributes: company, manufacturing sector, manufacturing group, country and subject;
2. directory of network companies;

3. resources on the VDO and Network as overall;
4. resources of common interest such as journals, conferences, forum etc; and
5. library of management resources (technologies and management best practices).

By collecting network cases/projects and management best practices, the KMT helps knowledge sharing in the network, best practices for improvement projects and therefore fixes the bases for characterizing the VDO network as a learning network. The KMT allows recording, monitoring and controlling the development of improvement projects as they are being carried out by members of the Network. This aspect is very important, since the VDO network overcomes the geographical dimension (typical of industrial districts) and therefore knowledge management is associated to communication issues and requires effectiveness.

The user-friendly front end of the KMT provides two main sections (Figure 3). The first section, identified as the *GPT Network Cases/Projects*, contains links to a knowledge database related to the practical application and implementation of improvement tools and best practices. The second section of the application provides links to an electronic library of *Management Resources*, which offers resources regarding technologies available in the network together with management best practices.

The *GPT Network Cases/Projects* section allows access to four areas:

- directory of GPT network members;
- library of cases/projects;
- GPT network;
- support: external resources.

The tool allows creating a file with the information relevant to a single independent company, or the VDO, or the Network as overall.

This characterization remarks the company characteristics, the company field of business, the technologies available and other relevant information. For each company, previous and current cases of improvement projects and best practices can be added and classified.

The external resources area is designed to communicate information about issues of common interest to the members of the KMT such as literature, web sites, conferences, training issues, newsletters and discussion forums.

Each practical case of an improvement project added to the KMT generates a unique identification

number within the database. The cases area is divided in two main sections. In the upper section, the general details of the project and the particular details of the company are included. The details of the specific processes and machineries affected in the project are also included. The lower section of this area facilitates defining the problem to be overcome with more details, including: objectives, participants, schedules, results, information about key contacts involved in the project and an area to discuss project issues.

In addition, it is possible to add videos and links to documentation related to the project. Therefore, this section allows recording and assigning tasks and responsibilities within the project and also includes other elements like Gantt charts for monitoring and controlling the project. Minutes of meetings and other key communications between the team members, carrying out the projects, can be recorded in this area of the KMT.

The library of *Management Resources* includes two main areas, namely: technologies, and management best practices.

In the technologies section, a mapping activity of all technologies available in the network has been carried out. Such information is therefore organized through description, presentations, references, and external links. A discussion area is available to share opinions about each technology between different users. The section dedicated to management best practices is structured similarly to the previous one.

The different sections of the KMT are carefully interconnected, so as to guarantee the fluently of content navigation and the correlation of data.

The scheme of the DMS entity relationships is presented in Figure 4.

The overall structure presented permits therefore the users to easily get information about network activities, other network companies projects, information regarding technologies and at the same time resources about managerial best practices. When improvement projects are completed, records are kept within the KMT database including descriptions of procedures and documentation related to those projects. This database is very important for future consultations that may help carrying out similar projects not only within the same company but also to support similar initiatives by individuals in other network firms.

The KMT can trigger both the application and creation of knowledge, which can help to improve the competitiveness of other network members.

This approach represents an adequate environment to promote and develop a learning environment by driving users to apply and share their knowledge.

## 5 Preliminary results

The KMT tool has been implemented and tailored over GPT characteristics in a period of about 4 months. Within this period, the implementation of the tool has required few time, since the adaptability of the DMS methodology. On the other hand, a big amount of time has been employed for populating the tool with network and companies data.

A first populated version of the tool has been released on July 2008 and given to GPT Network companies under the form of a readable (not modifiable) Microsoft Access database.

Nowadays, a web version of the KMT is under construction in the form of a restricted area (accessible only by network members) of the GPT network website.

A first important achievement is the structure of the KM tool itself; indeed all the identified NEEDS (from 1 to 5) have been met:

*NEED 1* → through the directory of network members and their related characterization;

*NEED 2* → through the electronic library of cases/projects and their related characterization;

*NEED 3* → through the library of management best practices and technological resources;

*NEED 4* → through the possibility of uploading and reading all common files like documents, presentations, spreadsheets, etc.;

*NEED 5* → thanks the adaptability of the DMS methodology allowing a quick conversion to a web version of the KM tool.

Preliminary results in terms of effectiveness and likeness of the tool between the network members have been collected through semi-structured interviews with network companies entrepreneurs, carried out by the Authors together with GPT VDO employees. As a consequence of that, it is possible to remark a general appraisal of the users (network companies), which particularly valued the characterization of the network companies (this is

probably due to a scarce level of information and knowledge of the network companies regarding their network partners), and the library of cases/projects (SMEs have low managerial skills, and therefore is easy for them to identify interesting improvement activities by learning from others).

At the same time, an approval has been received by the VDO-GPT (the hub of the network), which remarked the pragmatism of formalizing the network knowledge following a learning process while populating the KMT.

Preliminary results are mainly qualitative; for this reason, a questionnaire is under development in order to quantify, quantitatively, the effectiveness of the KMT after the adoption.

## **6 Conclusions**

In this paper we pointed out the increasing importance of knowledge management, especially to foster SMEs competitiveness, capability of growth and innovation. After an introduction to the issue, authors presented an innovative typology of network, namely the VDO Network. An ICT-based KM software tool has been designed to support implementation of best practices and improvement projects within the GPT network, which is the first VDO-based network in Italy. The developed KMT allows the user to increase its knowledge of the network (both of partners and the hub), to share relevant experiences with other participants, and it also allows recording, monitoring and controlling the implementation of improvement projects. The KMT offers also the possibility of getting informed regarding the technologies available in the network and managing the best practices. Preliminary results, coming from the prototype developed for the GPT VDO Network, highlighted a positive impact of the tool and a general appraisal of users. Future research will focus on quantifying the effectiveness of the KMT adoption.

Figure 1 - The VDO network model

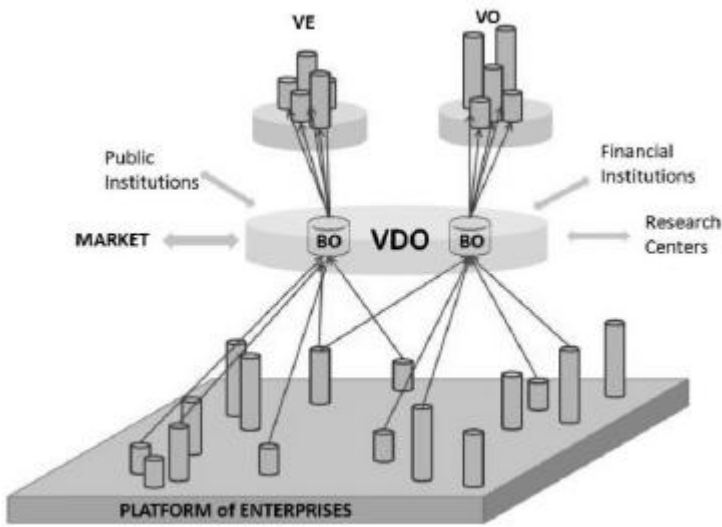


Figure 2 - Example of a VC created through a VE in a VDO-Network context

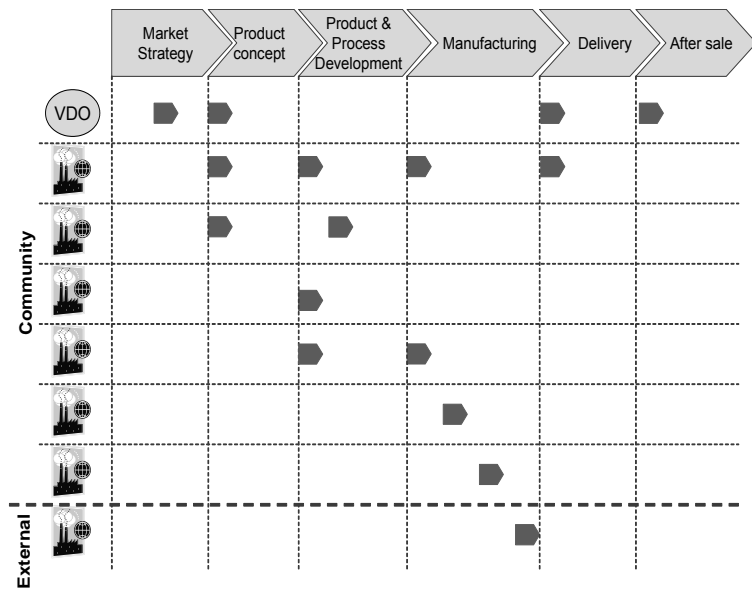


Figure 3 – Front end of the KMT, main sections

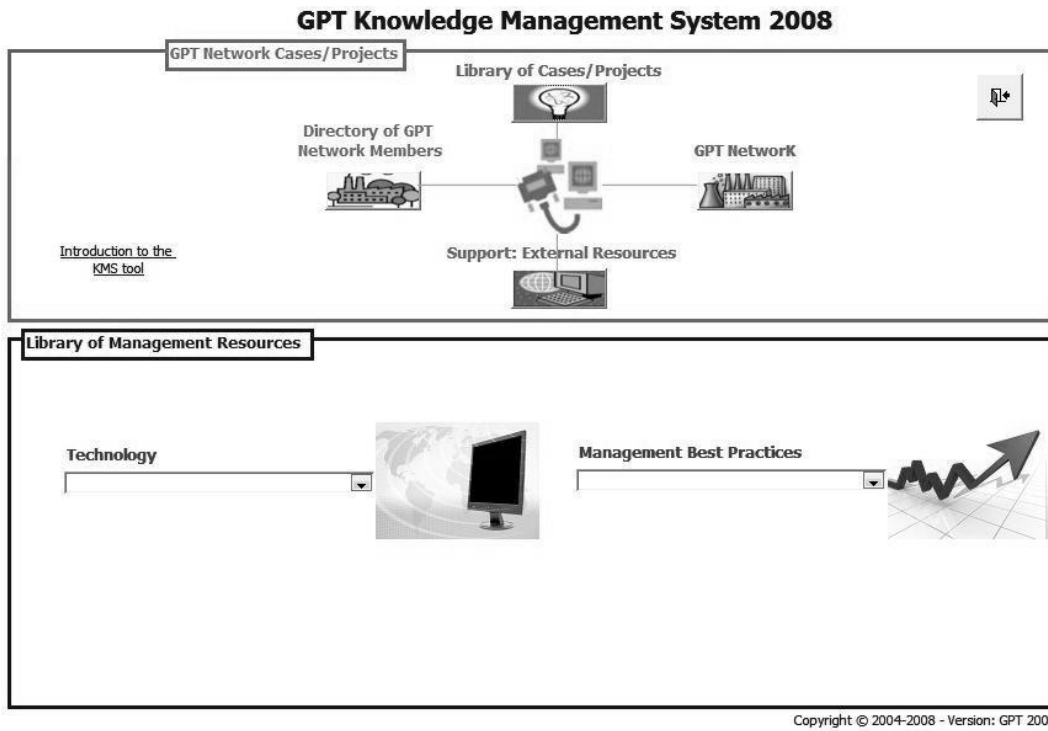
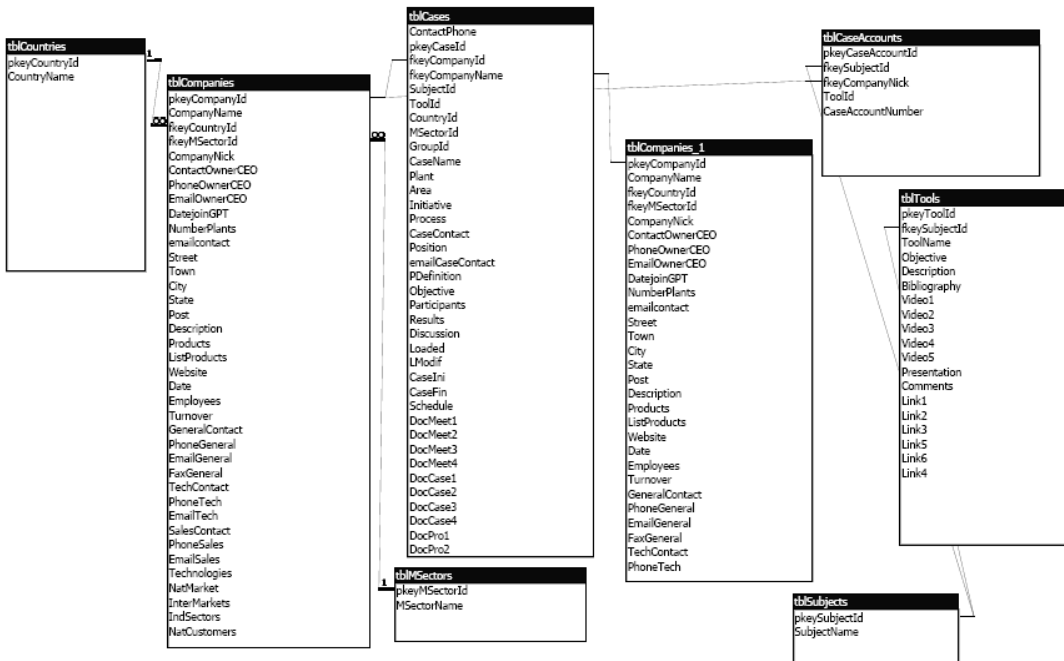


Figure 4 – DMS, Entity Relationships Diagram





## References:

- [1] L. Gadde, L. Huemer, H. Hakansson, Strategizing in industrial networks, *Industrial Marketing Management*, Vol. 32, 2003, Pages 357-364
- [2] T. MacCarthy, S. Golicic, Implementing collaborative forecasting to improve supply chain performances, *International Journal of Physical Distribution & Logistic Management*, Vo. 32 N. 6, 2002, Pages 431-454
- [3] T. McLaren, M. Head, Y. Yuan, Supply Chain collaboration alternatives: understanding the expected costs and benefits, *Internet Research: Electronic Networking Applications and Policy*, Vol. 2 N. 4, 2000, Pages 348-364
- [4] L. Horvath, (2001). Collaboration: the key to value creation in supply chain management, *Supply Chain Management: An International Journal*, Vol. 6 N. 5, 2001, Pages 205-217
- [5] Botarelli M., Revetria R., Taticchi P., Tonelli F (2008), An Agent Based Tool to Support Tactical Dialogues in Industrial Enterprise Networks, *WSEAS, Transaction on Business and Economics*, Issue 10, Vol. 5, ISSN 1109-9526
- [6] A. Gilmore, D. Carson, K. Grant, SME marketing in practice, *Marketing Intelligence and Planning*, Vol. 19 N. 1, 2001, Pages 31-38
- [7] S. Ghoshal, C. Bartlett, The multinational corporation as an interorganizational network, *Academy of Management Review*, Vol. 15, 1990, Pages 603-625
- [8] Collison, C. and Parcell, G. (2001), *Learning to Fly: Practical Lessons from One of the World's Leading Knowledge Companies*, Capstone
- [9] Kluge, J., Stein, W. and Licht, T. (2001), *Knowledge Unplugged - The McKinsey & Company Global Survey on Knowledge Management*, Palgrave.
- [10] Maier, R. (2007), *Knowledge Management Systems: Information and Communication Technologies for Knowledge Management*, Springer
- [11] Patriotta, G. (2004), *Organizational Knowledge in the Making: How Firms Create, Use and Institutionalize Knowledge*, Oxford University Press.
- [12] Garavan, T. (1997), "The Learning Organization: A Review and Evaluation", *The Learning Organization*, Vol. 4, No. 1, pp. 18-29.
- [13] Becker, M. and Zirpoli, F. (2003), "Organizing New Product Development: Knowledge Hollowing-out and Knowledge Integration – the FIAT Auto Case", *International Journal of Operations & Production Management*, Vol. 23, No. 9, pp. 1033-1061
- [14] Beckett, A.; Wainwright, C. and Bance, D. (2000), "Knowledge Management: Strategy or Software?", *Management Decision*, Vol. 38, No. 9, pp. 601-606.
- [15] Beeby, M. and Booth, C. (2000), "Networks and Inter-Organizational Learning: a Critical Review", *The Learning Organization*, Vol. 7, No. 2, pp. 75-88.
- [16] Clarke, T. (2001), "The Knowledge Economy", *Education + Training*, Vol. 43; No. 4/5; pp. 189-196.
- [17] OECD (2003), *Measuring Knowledge Management in the Business Sector*, Organisation for Economic Cooperation and Development/Minister of Industry, Canada.
- [18] Buckler, B. (1998), "Practical Steps towards a Learning Organisation: Applying Academic Knowledge to Improvement and Innovation in Business Process", *The Learning Organization*, Vol. 5, No. 1, pp. 15-23.
- [19] Garvin, D. A. (1993), "Building a Learning Organization", *Harvard Business Review*, Vol. 71, No. 4, pp. 78-91.
- [20] Pedler, M., Burgoyne, J. and Boydell, T. (1991), *The Learning Company: A Strategy for Sustainable Development*, McGraw-Hill.
- [21] Senge, P. M. (1990), *The Fifth Discipline - the Art and Practice of the Learning Organization*, Random House Business Books.
- [22] Maier, R. (2002), "State-of-Practice of Knowledge Management Systems: Results of an Empirical Study", *Informatik/Informatique, Zeitschrift der schweizerischen Informatikorganisationen (Journal of the Swiss Computer Society)*, Vol. 3, No. 1, pp. 15-23.
- [23] Garavan, T. (1997), "The Learning Organization: A Review and Evaluation", *The Learning Organization*, Vol. 4, No. 1, pp. 18-29.
- [24] Magnusson, M. (2004), "Managing the Knowledge Landscape of an MNC: Knowledge Networking at Ericsson", *Knowledge and Process Management*, Vol. 11, No. 4, pp. 261-272.
- [25] McDermott, R. (1999), "Why Information Technology Inspired but Cannot Deliver Knowledge Management", *California Management Review*, Vol. 41, No. 4.
- [26] Sveiby, K. E. (1997), *The New Organizational Wealth: Managing and Measuring Knowledge Based Assets*, Berret-Koeler.
- [27] Sanchez, R. (2004), "Tacit Knowledge versus Explicit Knowledge: Approaches to Knowledge Management Practice", *Working Paper Series, Department of Industrial Economics and Strategy, Copenhagen Business School*; No. 04-1.
- [28] Moffett, S., McAdam, R. and Parkinson, S. (2004), "Technological Utilization for Knowledge Management", *Knowledge and Process Management*, Vol. 11, No. 3, pp. 175-184.
- [29] Jetter, A., Kraaijenbrink, J., Schröder, H.-H., Wijnhoven, F. (2006), *Knowledge Integration: The Practice of Knowledge Management in Small and Medium Enterprises*, Springer.
- [30] Bessant, J. (1995), "Networking as a Mechanism for

- Technology Transfer: The Case of Continuous Improvement", in Kaplinsky, R., den Hertog, F. and Coriat, F. (Eds.), *Europe's Next Step*, Frank Cass.
- [31] Harding, S. (2002), "A Networking Model supporting Small and Medium Enterprise to Develop New Processes and Products", PhD Thesis, The University of Nottingham, Nottingham, UK.
- [32] Fuller-Love, N. and Thomas, E. (2004), "Networks in Small Manufacturing Firms", *Journal of Small Business and Enterprise Development*, Vol. 11, No. 2, pp. 244-253.
- [33] Chaston, I. and Mangles, T. (2000), "Business Networks: Assisting Knowledge Management and Competence Acquisition within UK Manufacturing Firms", *Journal of Small Business and Enterprise Development*, Vol. 7, No. 2, pp. 160-170.
- [34] McCampbell, A. T., Clare, L. M., and Glitters, S. H. (1999), "Knowledge Management: The New Challenge for the 21st Century", *Journal of Knowledge Management*, Vol. 3, No. 3, pp. 172-179.
- [35] Taticchi, P., Tonelli, F., Sameh, M., Cagnazzo, L. (2008), "Performance Measurement and Management: What is Next?", WSEAS TRANSACTIONS on BUSINESS and ECONOMICS, Issue 11, Volume 5, November 2008
- [36] Fernandez, V.P., Chalmeta, R., (2006), "Formal Methodology and Reference Architecture for the integrated development of a tacit knowledge management system for virtual enterprises", Proceedings of the 5th WSEAS Int. Conf. on Instrumentation, Measurement, Circuits and Systems, Hangzhou, China, April 16-18, 2006
- [37] Payakpate, J., Fung, C.C., Nathakaranakule, S., Marinova, D., (2007), "An Integrated Web-GIS Knowledge Management System to Enhance and Promote Knowledge on Sustainable Energy Technologies", *Proceedings of the WSEAS Int. Conference on Energy Planning, Energy Saving, Environmental Education*, Arcachon, France, October 14-16, 2007