

TRANSACTIVE MEMORY SYSTEM PROPOSAL TO FOSTER COLLABORATIVE LEARNING AND KNOWLEDGE SHARING INTO ORGANIZATIONS

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Abstract: Knowledge management on learning organizations is a broad area that still needs more research in order to offer to organizations a set of methodologies, technologies and strategies that allow them to capitalise their knowledge. This paper proposes as a solution the development of a transactive memory system to allow organizations and their members to collectively encode, store, and retrieve knowledge in a smart manner, where every piece of knowledge could be accessible to all organization members in order to help them to perform their daily activities, and at the same time to allow organizations to assess the quality of their knowledge as well as to represent, use and reuse all their know-how towards their organizational and business goals.

1 INTRODUCTION

It is stated that people is the most important asset into organizations; every person is important due to his skills and abilities to perform his daily work, nevertheless, when a person leaves an organization, he or she leaves with all his know-how in his brain, this fact constitutes a big problem for organizations, the typical productivity cost of an employee leaving is 85% of their base salary due to the mistakes committed by his replacement (Yelden & Albers 2004).

The first step for organizations to overcome this problem is to recognize that organization members are a great source of knowledge and innovation, the synergy of all the ideas that come from all the people across the organizations is fostering the rise of a new kind of society where knowledge plays an important role; nevertheless organizations need a global strategy to improve knowledge management in order to ensure the accessibility, usability, learnability and reusability of organizational knowledge. This global strategy, supported by the information technologies, must ensure that all the knowledge generated in organizations could be accessed, reused and improved in a simple and usable manner. Moreover, this global strategy must ensure the maturity of the generated knowledge in

order to foster innovation; also knowledge usage must be tracked and measured in order to allow knowledge to become intellectual capital, which is one of the most valuable assets of organizations (Paradise 2008), (Strong, Davenport & Prusak 2008), (Argote, McEvily & Reagans 2003), (Ajmal & Koskinen 2008), (Viedma, 2004).

According to the *American association for Training & Development* (Paradise, 2008) the investment in training and institutional knowledge management and transference had shown that the business leaders are aware of the value of knowledge for their success. In spite of this recognition, organizations in general, independently of the sector, are not achieving the desired results and the advantages expected from the investment in management and transference of corporative knowledge (Strong, Davenport & Prusak 2008).

The reasons behind organizations' problems managing their learning and knowledge assets are the following (Jacobson & Prusak 2006), (Cohen 2006), (Paradise 2008), (Strong, Davenport & Prusak 2008), (Argote, McEvily & Reagans 2003), (Ajmal & Koskinen 2008), (Fontaine & Lesser 2002): (1) The value of the identification of learning and knowledge assets to the organization is lower at the senior and executive levels because people at the non-executive level spend a lot of time searching

their information sources through on-line education or knowledge portals; sometimes this time effort is not appreciated by the directive level of organizations, and for this reason they do not value the possibility of identify organizational knowledge and learning units as assets. (2) It does not exist an institutional culture that promotes the share of knowledge at an interpersonal, inter-group or inter-department level into organizations. So it is necessary the definition of procedures and mechanisms to promote and to encourage knowledge sharing across organization. (3) The return of the investment (ROI) in knowledge management is something not appreciated by organizations because the use of organizational knowledge is hard to measure; also there is no connection between the knowledge used to produce a product and the strategic goals of the organization. (4) The organization splits learning and training courses from their know-how, when both elements are the two sides of the same coin. The know-how is not identified as an organization asset and the material of training courses for the members of the institution is disconnected from the organization know-how.

As can be seen problems described above are beyond e-learning, since they entail not only learning issues, but also organizational issues related with the necessity to create a culture of knowledge management into organizations in order to allow the assessment of the impact or benefit that knowledge management has on organizations that are interested in constitute their intellectual capital.

In order to solve the mentioned problems, a combination of information technologies and ideas from different disciplines is needed; the remainder of this paper will show some of the current solutions for these problems, as well as the authors' proposal to overcome the same problems in a novel way.

2 CURRENT SOLUTIONS TO SUPPORT ORGANIZATIONAL KNOWLEDGE

Nowadays there are several research efforts and technologies that could be used to support organizational knowledge, nevertheless this section emphasises those that are most relevant or recognised. First an analysis of the existent technological solutions to satisfy the knowledge transfer and foster transactive memory systems is presented, later some scientific solutions related with knowledge management are analysed.

Currently we are immersed in an *information society* where new models and paradigms to manage knowledge are essential (Fundación Telefónica, 2009). In order to overcome this fact, leader information technology (IT) companies are working on the development of a set of software tools and platforms in order to encode, store, and retrieve knowledge. Following, some of the most relevant efforts are briefly described below.

Sun Open Learning Center (Sun Microsystems 2009): It offers training courses regarding the tools, operative systems and programming languages developed by Sun Microsystems. The training is done through videos that combine theory, practice and tests. An outstanding innovation in this learning offer is the possibility to share acquired knowledge among users, and to promote self-learning as well as collective learning through the user communities that exist in the platform

Microsoft E-Learning (Microsoft Corporation 2009): It is a self-training environment intended to acquire knowledge and expertise in Microsoft products and technologies. It offers a set of training courses that contain theoretical explications, narrations, videos, tests and games; all of them intended to empower an effective self-learning environment. It lacks from a collaborative interface to interact with other students or instructors.

Cisco Training & Events (Cisco Systems 2009): This is one of the best offers in learning and knowledge transfer; it uses a complete set of tools that foster collaboration and promotes self-training as well as group-training by combining multimedia content, collaborative environments and live events that are broadcasted on the Web. This learning framework is open to professionals, practitioners and students all over the world, and is complemented in some countries by the Cisco Networking Academy, a common effort between Universities, Governments and Cisco Systems to create a global education program.

Oracle University Live Virtual Class (Oracle 2009): This knowledge management offer consists on a set of videoconference courses where users can learn directly from the Oracle's experts. Courses are taught using a collaborative tool where users can chat among them, assess their skills in virtual labs and share applications to facilitate the communication and sharing of ideas or questions. As a complement to these courses, Oracle offers a large knowledge base where users can access additional education sources to improve their learning. This

learning framework could be accessed all over the world.

Besides the technological solutions for knowledge management described above, there are several scientific and research efforts that have been made in order to help society and its institutions to deal with information and knowledge management, following some of the most relevant that have some connection with authors' proposal are briefly described.

elearningeuropa.info (European Commission 2009): It is an initiative of the European Commission's Directorate-General for Education and Culture, aiming to promote the use of IT for lifelong learning; it is focused to promote the use of multimedia technologies and Internet at the service of education and training. It offers an open platform where its users can obtain information, share experiences, and discuss ideas.

InCaS - Intellectual Capital Statement for Europe (InCaS Consortium 2009): It is a collaborative business project between leading academic institutes, such as London School of Economics and Political Science, Fraunhofer Institute and Polytechnic University of Catalonia (UPC), and a number of SME associations in five countries working with SME companies. InCaS aims to develop a way of being able to understand, value and represent Intellectual Capital for the benefit of companies internally but also to outside groups such as the financial community for further and better exploitation.

e-Learning Research Group at UCM (E-UCM 2009): This research group is part of the Department of Software Engineering and Artificial Intelligence at the Complutense University of Madrid. Its research is focused on developing methods, techniques and tools to simplify the production and maintenance of standards-compliant educational applications and e-learning systems. In this line, the <e-UCM> group is involved in several projects in the e-learning arena, where the key aspects are web-based systems applied to education.

As can be seen, most prominent companies in the IT area have focused their efforts to transfer knowledge mainly using e-learning solutions, they are not addressing at all the necessity of manage the intellectual capital of organization in a very effective manner and promote the development of transactive memory systems. From the technological point of view, despite the evolution of information technologies, there are some issues that must be addressed in order to improve the learning experience, to encourage knowledge sharing and to

foster intellectual capital management towards the development of transactive memory systems. Following is a list of some aspects that could be improved in the existing technological solutions and that want to be covered by authors' proposal: (1) They lack of learning contents based on standards, like SCORM (Advanced Distributed Learning 2009), to make easier their incorporation in existent e-learning and training environments. (2) Most of the content is incompatible with the accessibility rules and policies defined by the World Wide Web Consortium (2009). (3) The knowledge units or training contents are static, their knowledge does not evolve as the organisation does, so that, feedback from knowledge users is not always taken into account to improve the learning experience. (4) Multiplatform or multi-device access is not ensured. (5) Knowledge presented by the existing technological solutions is not connected with the strategic objectives and business goals of the organization, so that it is not possible to measure the return of investment on training. This fact could discourage organizations to invest on knowledge management initiatives. (6) There are no connections between the knowledge that people acquire through training courses and the know-how of the organizations. This leads to squander the skills and knowledge that are learned in training or learning courses when they want to be used at work.

From the scientific point of view, some of the unsolved issues encountered in the existing solutions are the following: (1) There is a gap between the training and learning resources that are used to transfer knowledge and the know-how of organizations, despite both are an essential part of the intellectual capital of institutions. (2) Most of the organizational knowledge remains as tacit knowledge; this is another gap that must be covered in order to allow the creation of an effective strategy to represent organizational knowledge in order to transform that knowledge into intellectual capital and to create a transactive memory system. A mechanism to encapsulate, store, share and find the explicit and tacit knowledge of institutions in a formal and structured is needed. (3) Nowadays most of the know-how of organizations is inaccessible and unusable, regardless it is represented in some way. (4) The investment to provide to institutions a new culture that promotes the identification of learning and knowledge assets with the appropriate technological focus on human assets and their social relationship is a investment which return of investment is nowadays intangible.

It can be conclude that current technologies are so powerful, nevertheless they are still unable to

assess the value that knowledge has to institutions; on the other hand, there several laudable scientific and research efforts that have proposed interested solutions, but managing the intellectual capital of organizations in order to create a transactive memory system is a broad area that still needs more research in order to offer to organizations a set of methodologies, technologies and strategies that allow them to capitalise their knowledge.

3 PROMISE: TRANSACTIVE MEMORY SYSTEM PROPOSAL

In order to overcome the issues identified in Section 2, authors propose to create a *transactive memory system* (TMS) (Wegner 1987) to allow organizations and their members to collectively encode, store, and retrieve knowledge in a smart manner, where every piece of knowledge could be accessible to all organization members in order to help them to perform their daily activities, and at the same time to allow organizations to assess the quality of their knowledge as well as to represent, use and reuse all their know-how towards their organizational and business goals. Authors' proposal includes a methodological and a technological framework, for the management of knowledge and its effective practice in organizations with the following features: (1) **Accessible** so that the knowledge could be efficiently recovered. (2) **Reusable (usable)** so that the knowledge could be used and reused in project's management into the organizations. (3) **Learnable (transferable)**, it is related with the ability to learn, and it is dependent on the profile that people play into organizations and their interest in doing something. **Quantifiable (measurable)**, so that the project's activities that were developed using the business assets could be related to the strategic goals of the organization and therefore the value of those activities could be quantified. These four features have never been taken into account together and even quantification of knowledge use is a novel and very promising approach in order to improve institutions productivity and innovation.

The key components of authors' proposal, are related to:

- Information technologies, focusing on: (1) Software technology to support the architecture, procedures and methodologies to be defined along this project. (2) Software Engineering to define the processes to be deployed and to elicit tacit

knowledge to be transformed into knowledge units for the institution.

- Knowledge management and organizational behaviour, focusing on: (1) Knowledge representation, to have a common knowledge depiction. (2) Organizational learning and behaviour, to identify and to deal with the barriers that could impede that the knowledge can flow along the organization levels. (3) Management of knowledge to transform it into intellectual capital. (4) Transactive memory systems that allow the definition of collective structures to share knowledge.

Authors propose the definition of an **architectural model for knowledge sharing and collaborative learning** driven by levels and roles to ensure the learnability of knowledge. This model has four levels:

- *Level 1: Lifelong Learning Level*, which will ease the access to the explicit organizational knowledge and will provide a representation mechanism for tacit knowledge based on Product Patterns (Amescua et al, 2006).
- *Level 2: Operative Level*, which will ease the access to the formative or initial knowledge as well as the tacit knowledge of organizations. At this level, knowledge units will be developed including experiences and data of real projects.
- *Level 3: Social Level*, which will define the necessary protocol to share across the organization all the knowledge gathered and generated by members when they solve a problem together. The knowledge defined by this protocol will be registered as an institutional asset.
- *Level 4: Proactive Level*, which will define the strategy to make all the existing knowledge into the collective organizational repository, accessible to everyone in an accurate manner according to the profile and competences of each member in the organization.

Authors have also defined three novel methods to improve learning, coaching and knowledge quality assessment, in order to deploy the four levels defined in the PROMISE TMS; these methods constitute one of the most important contributions of authors' proposal. Following is a brief description of these methods that will allow organizations to share knowledge and to ease collaborative learning.

Live Learning (Mora-Soto et al, 2009) method (Figure 1), which entails three main phases: Phase 1

“Knowledge Live Transferring”, in this phase knowledge is transmitted through a master class that could be hold in-person or via videoconference. It is mandatory to include during the master class real-world examples where the knowledge that is transferred to people has been applied in real projects. In order to ensure the accessibility and usability of the examples presented in the master class, they are stored in a standardized format in a knowledge base that could be accessed through any e-learning or collaborative platform compatible with SCORM (Advanced Distributed Learning 2009). In Phase 2, “Knowledge Live Explanation”, the strength of knowledge transference is validated; this phase implies figuring out an example, which authors named “Live Example”, where the key concepts previously explained in Phase 1 could be applied. Instructors and students solve the example in parallel in order to promote a group-learning environment where, if there is a question from any student, the instructor or any student could solve it immediately. The purpose of the live example resolution is to promote knowledge assimilation; it also allows students to have a chance to apply the explained concepts in order to corroborate by themselves the validity of what they have learned. Phase 3, “Collaborative Learning Experience”, is the most collaborative phase of the proposed method; in this phase people have the opportunity to experiment a computer supported collaborative work environment while solving a problem applying the case study method. Instructors and students use a social network as collaborative work platform; everybody is a user in the social network, nevertheless they play different roles. Instructors play as coaches or mentors during the case studies resolution while students are organized into working groups to solve the case study.

It is important to note that offered learning courses and content used in the Live Learning Method will be connected with the know-how of organizations. Also this method will ease the access to the learning courses as well as the sharing of knowledge regarding recommended best practices when daily work activities are assigned and developed.

Live Coaching method, which will provide the mechanisms to ensure that the learned knowledge is properly used during its deployment in daily tasks and will also ensure that any organization member will be assisted in case some new information regarding their daily activity is needed.

Live Quality Management method, which will keep track of the activities performance through relevant quality indicators, aligned with the

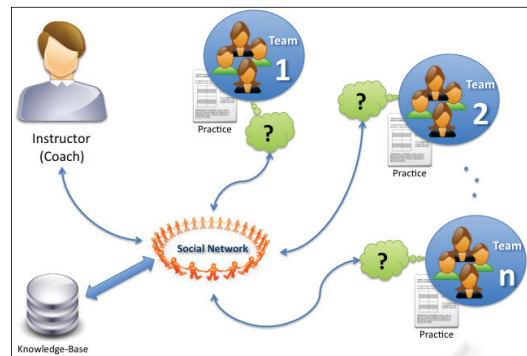


Figure 1: Live Learning Method Phase 3.

strategic objectives of the institution. This method will use Six Sigma techniques and non-intrusive information gathering mechanisms.

The most remarkable technological contributions of authors' proposal are the following: (1) Collaborative work platform, which could be used from any operating system or dispositive, besides the use of the platform by blind or deaf people. (2) Enterprise social networks incorporation using Web 2.0 tools. (3) Implementation of the methods Live Coaching, Live Learning and Live Quality Management for their validation in real environments.

4 PROPOSAL VALIDATION

Right now there are some organizations interested in this research work such as CIMAT (Center for Research in Mathematics, Mexico) and the SEI (Software Engineering Institute, USA); also some enterprises are interested in the results of this research work, such as: Tival (Spain) and Syngular (Mexico). They are interested in: (1) The PROMISE architectural model by levels to implement in one of their processes of software projects management. (2) The PROMISE strategic models of collaborative work development. (3) The PROMISE technological platform that will implement all the mentioned models and strategies.

In the long term, it could be possible to transfer the results of this project to other institutions because the models and theories developed are intended to be independent of organizational models or industrial sector.

5 CONCLUSIONS

In this paper authors have wanted to highlight the

importance that knowledge has for organizations and the necessity to create not only knowledge management tools and frameworks, but also a transactive memory system that organizations members could use to collectively encode, store, and retrieve knowledge to foster collaborative learning. Authors proposed PROMISE TMS as a transactive memory system where every piece of knowledge could be accessible to all organization members in order to help them to perform their daily activities, and at the same time to allow organizations to assess the quality of their knowledge as well as to represent, use and reuse all their know-how towards their organizational and business goals. Despite further work is needed to validate authors' proposal, they believe that this multidisciplinary approach could offer a novel mechanism to help organizations to constitute their intellectual capital.

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REFERENCES

- Advanced Distributed Learning (2009). *Home SCORM* [online]. Available from: <http://www.adlnet.gov/Technologies/scorm/> [Accessed 18/12/2009]
- Ajmal, M. & Koskinen, K. (2008). *Knowledge Transfer in Project-Based Organizations: An Organizational Culture*. Project Management Journal. 39 (1). p. 7
- Amescua, A et al (2006). A pattern-based solution to bridge the gap between theory and practice in using process models. In *PROSIM 2006, Software Process Simulation and Modelling Conference*. Shanghai, China, Saturday 20th to Sunday 21th May 2006.
- Argote, L., McEvily, E. & Reagans, R. (2003). *Managing knowledge in organizations: an integrative framework and review of emerging themes*. Management Science. 49 (4). Special Issue on Management Knowledge in Organizations, Creating, Retaining, and Transferring knowledge p 571-582.
- Cisco Systems (2009). *Cisco Training & Events* [online]. Available from: <http://www.cisco.com/web/learning> [Accessed 12/12/2009]
- Cohen, D. (2006). *What's Your Return on Knowledge*. Harvard Business Review. (December).
- E-UCM (2009). *e-Learning Research Group at UCM* [online]. Available from: <http://www.e-ucm.es/> [Accessed 12/12/2009]
- European Commission (2009). *Elearningeuropa.info* [online]. Available from: <http://www.elearningeuropa.info> [Accessed 12/12/2009]
- Fontaine, M & Lesser, E. (2002). *Managing organizational knowledge* [online]. IBM Institute for Knowledge-Based Organizations. Available from: <http://www-935.ibm.com/services/ph/igs/pdf/g510-3234-00-esr-managing-organizational-knowledge.pdf> [Accessed 12/12/2009]
- Fundación Telefónica (2009). *La Sociedad de la Información en España 2009* [online] Available from: <http://e-libros.fundacion.telefonica.com/sie09/> [Accessed 28/11/2009]
- InCaS Consortium (2009). *InCaS - Intellectual Capital Statement for Europe* [online]. Available from: <http://www.psych.lse.ac.uk/incas/> [Accessed 12/12/2009]
- Jacobson, A. & Prusak, L. (2006). *The Cost of Knowledge*. Harvard Business Review. (November).
- Microsoft Coporation (2009). *Microsoft E-Learning* [online]. Available from: <https://www.microsoftlearning.com> [Accessed 12/12/2009]
- Mora-Soto, A et al (2008). Collaborative learning experiences using social networks. In *International Conference on Education and New Learning Technologies (EDULEARN 2009)*. Barcelona, Spain, Monday 6th to Wednesday 8th July 2009.
- Oracle (2009). *Oracle University Live Virtual Classroom* [online]. Available from: <http://ww.oracle.com/education> [Accessed 12/12/2009]
- Paradise, A. (2008). *State of the Industry Report*. USA: ASTD (American Association for Training & Development).
- Strong, B., Davenport, T. & Prusak, L. (2008). *Organizational Governance of Knowledge and Learning*. Knowledge and Process Management. 15 (2) p. 150-157.
- Sun Microsystems (2009). *Sun Open Learning Center* [online]. Available from: <http://www.sun.com/training/solc/> [Accessed 12/12/2009]
- Viedma, J. (2004). *CICBS: a methodology and a framework for measuring and managing intellectual capital of cities. A practical application in the city of Mataro*. Knowledge Management Research & Practice. (2) p. 13 – 23.
- Wegner, D. (1987) *Transactive memory: A contemporary analysis of the group mind*. Theories of Group Behavior. Springer-Verlag, New York. p. 185-205.
- World Wide Web Consortium (2009). *Web Accessibility Initiative (WAI)* [online]. Available from: <http://www.w3.org/WAI/> [Accessed 12/12/2009]
- Yelden, E. & Albers, J. (2004). The Business Case For Knowledge Management. *Journal of Knowledge Management Practice* [online] (August). Available from: <http://www.tlinc.com/articl69.htm> [Accessed 15/12/2009]