Extended architecture of knowledge management system with Web 2.0 technologies

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Abstract

Knowledge management systems (KMS) become increasingly important in periods of crises and economic slowdown, as many organizations are forced to lay off people, to reduce research and ICT budgets, to restructure departments and to optimize their costs. Subsequently, organizational knowledge assets, and mainly the existing tacit knowledge are threatened. This raises the importance of technologies that could assist organizational efforts to capture the existing knowledge and to mobilize it in order to overcome the crisis.

Knowledge management systems should respond to these expectations and enable organizations dynamically to acquire and profit from all sources of knowledge.

The present paper discusses the opportunities provided by extended KMS architecture combining elements of Web 2.0 technologies. It considers how Web 2.0 technologies can increase organizational effectiveness, efficiency and usability for company KM. The main services provided by KMS are identified and ranked. Finally, the paper makes an overview of the issue how KMS can enable companies to transform risks of the crises to new opportunities for further development.

Key words: Knowledge management system, KMS architecture, Web 2.0, Cloud computing;

1. Introduction

Nowadays, knowledge management (KM) faces difficult times. In periods of financial crises and economic slowdown, organizations are forced to restrict activities and to lay off people, eroding knowledge resources, but as well threatening company climate and knowledge sharing motivation. Subsequently, although admitted as important for organizations, knowledge management is still considered as a cost-based activity that could be easily limited or suspended. Several organizations treat KM, KM team and KM systems mainly as an additional organizational cost. In addition, it is difficult to measure KM and its effectiveness for organizational growth, and to justify its impact as the expected outcomes are seen in medium to long-term, and KM concerns in many cases "soft" organizational practices. Organizational knowledge management systems (KMS) still remain underutilized and hardly recognizable by knowledge workers [Davenport, 2005; Maier, 2007, McAfee, 2006]. In the same time, knowledge workers lack and increasingly need appropriate Information Technology (IT) solutions facilitating their daily work [McAfee, 2006]. Definitively KMS need to change and to respond to the new requirements.

Some challenges to KM raises the fast emerging Web 2.0, Enterprise 2.0 and cloud computing technologies which have transformed the Internet and have created new dimensions for cooperation and social networking. Many researchers and practitioners are posing the question if knowledge management is going to become obsolete and will disappear silently as other managerial approaches [Erdos, 2007, Firestone, 2007]. Web 2.0 is firstly defined in 2004 [O'Reilly] and it nowadays is widely accepted and implemented in business environment [McKinsey, 2008; De Saulles, 2008]. Web 2.0 could be discussed mainly as “a way of thinking, a new perspective on the entire business of software - from concept through delivery, from marketing through support” [O'Reilly]. Web 2.0 transformed the role of Internet, and represents an evolving complex eco-system consisting of various technologies, culture and relationships, exploring social capacity of the networks [O'Reilly, 2004]. Tim Berners-Lee, 2001 defines Semantic Web as an extension of the current web, in which the information has well defined meaning, better enabling computers and people to work in cooperation. Both Semantic web and web 2.0 are interconnected eco-systems, focusing on interaction between systems and interaction between people. Thus, individual and computer intelligence can be integrated in collective (networked) intelligence. So web 2.0 approach relies on distributed systems and networked crowd intelligence.

The emergence of Web 2.0 technologies and cloud computing influenced dramatically the way people cooperate and collaborate via electronic media. Despite the substantial number of existing KMS architectures, different studies discover that they remain underutilized in practice and do not really support knowledge work [McAfee, 2006]. The present paper aims to consider characteristics of KMS architectures in order to respond to socially-oriented Web 2.0 and cloud computing. An emphasis is put on characteristics and motivation of knowledge workers – the main KMS users and how they could explore and use web 2.0 instruments.

The paper makes an overview of basic KMS architecture and the web 2.0 advantages and limitations. The main knowledge services provided by KMS are further exploited. Finally, a new model of distributed architecture of KMS is proposed, trying to overcome the existing limitations and to apply Web 2.0 and cloud computing principles.

2. Changes in knowledge work and services

The concept of knowledge management refers to the process of managing intangible assets from the combination of knowledge and experience provided by individuals or knowledge workers within organizations or society. With evolution of technology, approaches to KM are shifting [Lee, 2007]. A “traditional” or “conventional” approach to knowledge management focuses on collection of knowledge in a centralized repository and its accessibility. On opposite “conversational” approach puts an emphasis on knowledge creation, the integration and collaboration of knowledge workers [Lee, 2007].

Knowledge management systems could add value only in the context of its daily application in knowledge work. The concept of knowledge work was introduced in order to stress the changes in work processes, practices and places in the knowledge economy and thus, the differences to traditional (manual) work [Maier, 2007]. Some of the main problems of knowledge work are that it is invisible (the processes of producing it are unclear), knowledge work is often interrelated and cannot be separated into sub-tasks, as knowledge work processes are complex [Röll, 2004]. All these characteristics impede KM to be easily integrated in IT systems.

Knowledge workers need to process information and to transform it to meaningful and action-oriented knowledge, that has to be incorporated in service or product required by organization or customer. Thus, knowledge workers need to search for relevant information and knowledge, to fast process it and apply it within specific context and after that to produce a desirable output. The knowledge work often is individualized and the produced outcomes differ and cannot be easily reproduced or re-used as the context and the environment are changing fast.

There are a number of challenges and factors influencing the knowledge work today, including the fast changing and interconnected global environment, increasing innovations and shorter product-life, wider adoption of technologies in business, as well as the global demand for talents and increased mobility of knowledge workers. In fact, the class of independent workers is evolving, including freelancers, part-time employees, consultants and contractors with own choice of tools, connections and content.

In the same time, people need to cope with daily increasing information overload, often resulting from the inefficient use of IT. In a number of surveys it is stressed that most used technologies by knowledge workers still remain Internet, Intranet and e-mail [Davenport, 2005, Roll, 2004]. The need for new efficient IT solutions is clear as the majority of knowledge workers recognize e-mail technologies as overused, overwhelming and diminishing their productivity, while information in the Intranet can be hardly retrieved [McAfee, 2006].

In order to build on Software as a Service approach, a short overview of the basic KM services delivered by KMS and IS in general is presented. As described by [Maier, 2007], KM services can be classified as subset of complex services. They can be both basic and composed and their functionality supports high-level KM instruments as part of on-demand KM initiatives.

Services are offered by service providers that procure the service implementation, supply their service descriptions, and provide the necessary support. Often, KM services cater to the special needs of one or a small number of organizational units, e.g., a process, a work group, a department, a subsidiary, a factory or an outlet in order to provide a solution to a defined business problem. KM services describe

individual aspects of KM instruments implemented in heterogeneous application systems that can be combined into an enterprise knowledge infrastructure [Maier, 2007].

KM services	Functions	Web 2.0, Enterprise 2.0 and Cloud computing,
Access services	- Translate and transform the content and communication to and from the KMS to heterogeneous applications and appliances. -Protect against eavesdropping and unauthorized KMS use.	Enterprise 2.0 integrates and gives remote access to company systems and applications. Cloud computing allows better security and open access management.
Personalization services	Personalization services have to provide a more effective access to the large amounts of knowledge elements and thus to avoid information overload .	Web 2.0 provides instruments and tools allowing better customization and personalization of content from both internal and external knowledge sources. (RSS, Mashups, etc)
Knowledge services.	The core knowledge processes search, retrieval and presentation of knowledge elements and experts with the help of search, mining, visualization, mapping and navigation tools, publication collaboration and learning	Enterprise 2.0 SLATES model [McAffee, 2006] support and extend all knowledge services - Web 2.0 provides tools and instruments enhancing knowledge services and conceptualizes better service integration.
Integration services.	knowledge repository handles the organization's meta-knowledge describing knowledge elements that come from a variety of sources	Cloud computing, Semantic web, Crowd intelligence and various web 2.0 technologies
Infrastructure services.	Intranet infrastructure which provides basic functionality for synchronous and asynchronous communication, the sharing of data and documents as well as the management of electronic assets and of Web content	Internet 2.0 and Cloud computing infrastructure identify new business models combining SaaS, IaaS and PaaS approaches
Data and knowledge sources.	Internal sources and external sources	Web 2.0 and cloud computing overcome the organization boundary limitations and allow automatic up-date and access to newest and most relevant knowledge

3. Knowledge management systems

KMS should provide the basic KM infrastructure, enabling knowledge workers and organizations to better access and exploit existing knowledge resources. As defined by Alavi & Leidner (2001) KMS are IT-based systems developed to support/enhance the process of knowledge creation, transfer, and application. KMS are admitted to be complex socio-technology solutions, providing opportunities for users to create knowledge assets and to share them interacting with other agents. The main purpose of KMS is existing knowledge to be better utilized within organizations, serving as basis for further decision making and learning.

The majority of existing knowledge management systems (KMS) aim to centralize the knowledge assets [Maier, 2007] applying the same basic architectural principles as other integrated organizational business systems (as for example ERP and CRM). Within this context, KMS often represent centralized, standalone information solution (Maier, 2002), aiming to "extract" some "neutral" knowledge from employees, to verify it and to transfer it and store it properly in one organizational knowledge/data base. For example, Maier (2002) finds out in a survey that almost all large organizations have an Intranet and/or

groupware platform that offers basic KM functionality. A short review of the results shows that although the variety of implemented KMS functions, they are not used intensively; most organizations build their own KMS solutions and integrative KMS functions predominate (focusing on explicit knowledge). KM-related IT systems usually lack integration with other systems. Finally, KMS are considered highly complex systems, being cross point of technology, organizational and human complexity [Maier 2002].

There are a number of constraints affecting KM processes and issues: knowledge access and knowledge protection (who can access KMS), knowledge use (what is the right knowledge and who are the right people), knowledge sharing (what knowledge to share), knowledge validation (who is the expert) and knowledge verification (who maintain and up-date knowledge resources). There is further a need for complex social relationships and subordination of users, well defined roles of users and contributors, clear responsibility of domain experts, strict processes and pre-defined taxonomies, structures and boundaries. Existing knowledge management systems in fact cost additional efforts for knowledge workers and are time-consuming, and in result often the knowledge resources there are obsolete or old. Even, the majority of their sophisticated functions are rarely used (Maier, 2002). That is why people are not intrinsically motivated and empowered for using these systems. In practice, KMS have been designated as “Knowledge museums” in personal blogs and this metaphor illustrates clearly the knowledge workers attitude.

On the opposite, Web 2.0 applications provide new opportunities for companies and their employees, customers and suppliers to interact and to create new content in specific context while cooperating and collaborating. Web 2.0 concepts put a challenge on traditional knowledge management with centralized knowledge repository to shift into a more interactive conversational approach [Lee, 2007]. Networks are among the most valuable organizational assets. Knowing somebody who knows or who will know is much more appreciated in real-time business, than past facts and data without context.

3.1 KMS Architectural models

A number of KMS architectures are discussed in the literature. Two common characteristics of a KMS are knowledge repositories and knowledge maps [Wu, 2006]. The first ones are databases of useful documents with the system that provides functions for capturing, organizing, storing, searching, and retrieving the knowledge and information (or content management facilities). Thus, a KMS serves as a repository of explicit knowledge for the organization, overcoming the limitations of time and geographic barriers and improving the capability for the combination and exchange of intellectual capital. The second component includes searchable indexes or catalogues of expertise held by individual employees. However, because it is impossible to capture and store tacit knowledge itself, the best way to use it is to map it in an organized way.

Among the main KM architectural models, both main KMS models could be seen, as described by Zack (1999). This classification corresponds to two main directions of KM research, human orientation and technology orientation. It points out as well the idea of differentiation of tacit and explicit knowledge.

- Interactive KMS architecture – focusing primarily on the exchange of tacit knowledge, or aiming to integrate persons and thus to facilitate knowledge sharing.
- Integrative KMS architecture – aiming to facilitate the explicit knowledge management within organization, or focusing on effective content management, indexing, tagging etc.

According to Maier (2007) the KMS architectures can be basically divided into 3 main groups:

- Theory-driven architectures that are result of theoretic investigations and which represent a theory-driven decomposition of an organizational knowledge base and derive ideal groups of functions or components of a corresponding IT system respectively.
- Vendor-specific architectures aiming to integrate the existing IT within specific organization, placing the KM tools according to the already available IT infrastructure. KMS is just moved in between a standard Web browser and relevant data and document sources that exist in an organization. Comprehensive KM suites comprise often large number of modules offering functions such as text mining, tools for semantic integration of meta-data on data and documents, a search engine, visualization, administration of users and privileges, publishing and reporting.

- Market-driven architectures – The market-driven architectures are based on empirically proven important components of an organizational knowledge management environment which is integrated with more traditional data and document management systems as well as communication systems and other integrated company IT. These architectures are presented on the base of layer models (varying from 4 to 7 according different authors) and are mostly exploited in practice.

Benbya et al., [2008] build the concept of KMS architecture as a knowledge market, connecting and facilitating knowledge sharing between knowledge producers and knowledge seekers. The concept of Knowledge market can be extended further, discovering various possible KMS application as innovation platform, collaboration platform, talent/solution search platform and others. In [Antonova and Nikolov, 2008] there are discussed 4 main types of infrastructures and strategic approaches that could be organized around knowledge market and innovation platform.

Another classification makes the distinction between Centralized KMS architecture and Distributed KMS architecture. Centralized KMS architectures are mainly technology-oriented, with predefined structure, and trying to capture objective and stable knowledge [Lehner, 2008]. Organizations are used to adopt mainly centralized KMS framework, figuring out that they can collect and thus manage their knowledge assets and resources around one unified platform.

On the opposite, distributed KMS are human-oriented and based on peer-2-peer collaboration. The goal of distributed KM system is to engage users in a knowledge acquisition and dissemination procedure that enables both the utilization of tacit and explicit personal knowledge, and often merging knowledge from different organizations in a transparent to the user process [Belsis, 2005].

3.2. Distributed systems

Metcalfe's law states that the value of a network is proportional to the square of the number of connected users of the system (n2). Metcalfe's law characterizes many of the network effects of communication technologies and networks such as Internet, social networking, and the World Wide Web. Networked effects arise when the act of participation makes the entire network more useful to everyone. Increasing the variety of links and things being linked can create more valuable networks [Davis, 2009].

Often people tend to search for knowledge (best practices, documents, and knowledge resources) outside rather than inside the organization. Internet provides unique combination of tools and services, of explicit documents and personal references, and represents unique information infrastructure, knowledge-intensive and ever evolving platform giving access to new appearing, contextualized explicit and tacit knowledge, whenever it is about personal or expert point of view. But Internet is evolving and changing. New websites and knowledge resources constantly appear and other disappears. The results from Internet search engines can be hardly repeated. One of the reasons can be the indexing services of search machines, or the lists of the searches, the web-page indexing and the journey of search for information. This is why once found, the valuable piece of knowledge is often downloaded or stored on a personal area, whether on Web or offline, whether as a document or as a reference link. The fact of this is that almost all references from Internet are bearing the date when the last were accessed.

The advantages of Peer-to-peer and distributed KMS as defined by Benger 2003 are as follows:

- autonomy: semi-autonomous organizational units can easily create and share knowledge with the help of those tools
- direct communication: knowledge is exchanged directly without central units that often act as an unwanted filter to knowledge,
- flexibility: peer-to-peer KMS allow for the configuration of temporary, dynamic networks of knowledge workers,
- acceptance: local storage together with an efficient management of access privileges reduces the barriers to provide knowledge that some central KMS solutions experience.

Additionally, distributed KMS reduce substantially the costs of the design, implementation and maintenance of centralized KM suites, in terms of hardware, standard software as well as the often underestimated costs of designing, structuring and organizing a centralized knowledge server and the management of users and privileges.

Distributed KMS as well have been recognized in their position to (Maier, 2007):

- reduce the barriers that prevent individual knowledge workers from actively participating and sharing the benefits of a KMS, e.g. by reducing the psychological barrier to publish knowledge elements to an unknown target group by giving the user full control over the access privileges to its knowledge elements,
- overcome the limitations of a KMS that (almost) exclusively focuses on organization-internal knowledge whereas many knowledge processes cross organizational boundaries, because workspaces can easily and flexibly be extended to knowledge workers from partner organizations,
- include individual messaging objects, e.g. emails, instant messaging objects, into the knowledge workspace that are rarely supported by centralized KMS,
- seamlessly integrate the shared knowledge workspace with an individual knowledge worker's personal knowledge workspace.

Several innovative models for distributed KMS architectures were reviewed, combining some of the Web 2.0 tools and concepts (Organik- Bibikas (2008), Infotop- Maier (2007), Webblog KMS- Roll (2004), E-KMS -Woitsh (2003), Abdullah (2005, 2008), Ikos -Papailio (2007) and others). However, still lacks integration of overall KMS functions and Internet, combining application of Enterprise 2.0 and cloud computing and emphasizing on the Knowledge worker. The new proposed framework for distributed KMS aims to deliver better instrument for knowledge workers to create their virtual working place, integrating better internal and external organizational resources.

3.3. KMS distributed architecture and Cloud computing model

Cloud computing is one of the major consequences of Web 2.0 in the software development, discovering new business models and extending the philosophy of IS use. The benefits of cloud computing are widely discussed recently, focusing on increased agility, adaptability, flexibility, cost savings and interoperability Kim (2009). However, cloud computing today faces some security, privacy, and other barriers that prevent their widespread enterprise adoption Li (2009).

Development of KMS architecture model using the cloud computing approach can be the next step toward more effective and user-oriented distributed KMS solution. The 3 perspectives of Cloud computing (Fig.1) – Software as a Service (SaaS), Infrastructure as a Service (IaaS) and Platform as a Service (PaaS) will allow organizations to develop new models of KMS integrating additional systems, collaborating with other organizations and facilitating the knowledge exchange. The adoption of the cloud computing approach will facilitate knowledge sharing and integration of various platforms and IT services around two main clouds - internal and external. According to Li (2009) there is a clear trend for expansion of external clouds in the near future as the cloud computing model improves over time and security technologies improve. Another benefit is that cloud computing will allow knowledge workers to integrate freely content from external and internal clouds, using Web 2.0 tools (as Mashups, Wiki, Blogs etc), and creating their own virtual working place. This virtual working place could combine as well several clouds of various organizations, facilitating knowledge transfer.

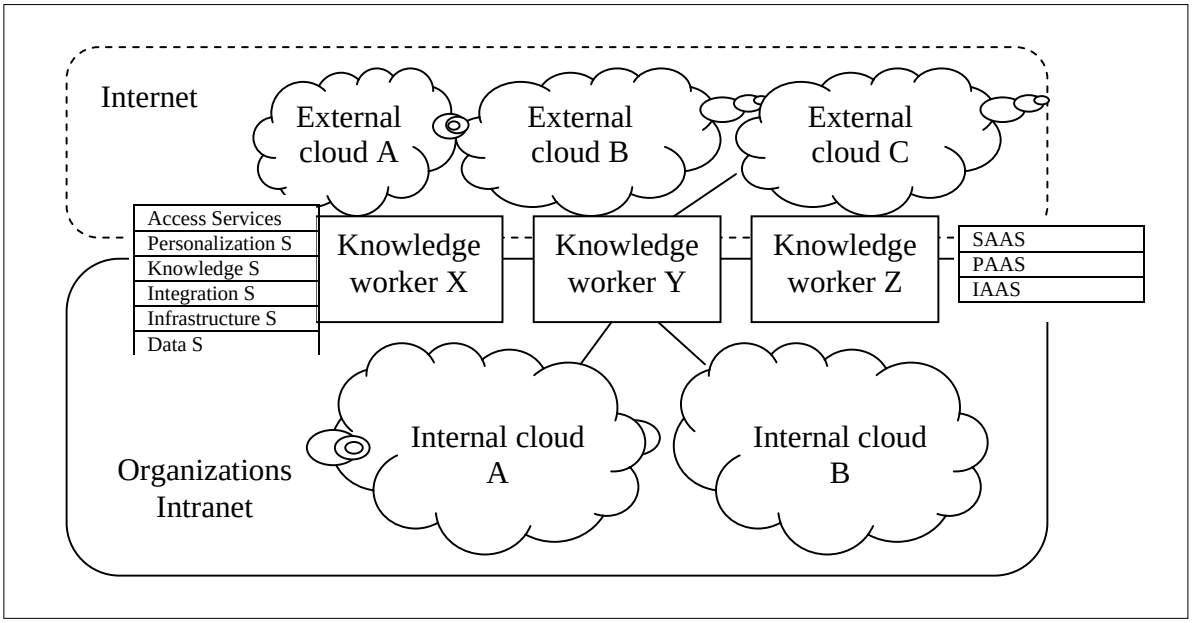

Figure 1. Cloud computing and distributed KMS

4. Conclusions

In economic slowdown, usually businesses need to cut costs, to adopt new practices, to explore new business models and to identify new market niches. Web 2.0, Enterprise 2.0 and cloud computing represent not only new technological solutions, but new strategic vision for business development, proposing new alternative business models, adding value services and business opportunities. All Web 2.0, Enterprise 2.0 and cloud computing concepts revolutionized the way people and organizations use Internet and deal with knowledge. Web 2.0 technologies change the culture, technologies and state-of-mind in order to transform the users as source of dynamic and ever-changing knowledge.

Finally, several major implications of Web 2.0 could be identified:

- Web 2.0 is here to stay – people like it and use it in their personal life
- Web 2.0 is about personal interactions – organizations try to catch up and to compete on this basis.
- Web 2.0 is about cooperation, collaboration, continuous management – it facilitate communities emergence
- Web 2.0 is voluntary, decentralized network of interactions.

This is the reason to develop an approach of KMS architecture combining with Web 2.0 and cloud computing. The future work will extend the model of distributed KMS to new critical mass of "nodes" and social cooperation.

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