Journal of Universal Computer Science, vol. 11, no. 4 (2005), 526-545
submitted: 29/11/04, accepted: 28/2/05, appeared: 28/4/05 © J.UCS

The Role of Knowledge Management Solutions in Enterprise Business Processes

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Abstract: Knowledge technologies, the software products that support all aspects of knowledge processing and exchange, are the subject of permanent interest for software engineers at research organizations, as well as, for market analysts in commercial organizations. In order to clarify the role of knowledge management solutions in an enterprise business process, in this paper we survey the market of knowledge management solutions and analyze their functionalities from operational and strategic business perspective. Although knowledge flows are identified on an operational level, discussion will show that knowledge management solutions here serve to utilize the enterprise knowledge in an efficient performance of daily work. We argue that data and information collected on the operational level are processed by knowledge management solutions on a strategic level thus creating new knowledge that is used for strategic management of customers, suppliers and partners. This paper gives an insight into knowledge management market that can help the strategic planners to easily begin a knowledge management initiative.

Keywords: knowledge management, business process, enterprises, software tools, market research
Categories: A.1, H.0, H.2.8, H.3.0, H.4.2

1 Introduction

Knowledge management (KM) initiatives in enterprises are most often driven by strategic planners with the objectives to enhance knowledge processing and organizational learning capacity, protect and develop the intellectual capital, be innovative and competitive on the market, serve customers, etc. As enterprises differ in size, type of services, established organizational structure and culture, there is no universal recipe for introducing knowledge management in enterprises. Among others, knowledge leaders are faced with the problem of choosing technologies to support their initiatives.

Knowledge technologies are software products that support all aspects of knowledge acquisition, organization/storing, representation, visualization and exchange. Knowledge technologies are the subject of permanent interest for software engineers at research organizations, as well as, for market analysts in commercial organizations. Both types of researchers are interested in current functionalities of available knowledge management solutions and their future development directions.

On the market there is no clear distinction between knowledge management solutions and information management solutions [Firestone 2003b]. Using the rising interest in knowledge management solutions, many software companies took this opportunity to sell their products describing them as knowledge management tools. As a result, nowadays, the spectrum of KM tools ranges from collaboration solutions, via document management, (WEB) content management tools and portals to e-learning solutions, analytical solutions and intelligent agents.

From today's viewpoint, surveys on knowledge management solutions that have been conducted earlier [Böhmann, Krcmar 2002; Föcker 2001; University of Washington 2000] are based on a limited to comprehensive selection of software products. The aims of this paper are twofold. First, we would like to give an updated picture of the market of knowledge management commercial solutions and as second, we would like to clarify the differences between information technologies and knowledge technologies from a business viewpoint. We discuss first the enterprise business processes and relate the knowledge processes to operational business processes and strategic business processes separately. Further on we present the results of the survey of commercial knowledge management solutions, examine the functionalities of knowledge management solutions and link them to the knowledge processes. Finally, we discuss the role of knowledge management solutions in modern enterprises, especially, their place in the customer management process.

2 Literature Review

Firestone and McElroy [Firestone, McElroy 2002] distinguish three generations of knowledge management solutions. According to them, the first generation of knowledge management solutions (1993-1997) has been focused on information integration, establishing information repositories, information retrieval and information and knowledge sharing, while the emphasis of the second generation of knowledge management solutions is on knowledge production and its use. The third generation of knowledge management solutions that is developing nowadays is based on: use of taxonomies and ontologies for knowledge discovery in databases and on the Web; use of new data and text mining algorithms, natural language processing and other statistical tools for knowledge acquisition from different sources; distributed agent systems for searching, claim evaluation and knowledge production; knowledge portals instead of information portals, etc.

Föcker [Föcker 2001] identified knowledge management with management of text, messages and other mainly unstructured data and he paid little attention to knowledge production. Böhmann and Krcmar [Böhmann, Krcmar 2002], without naming the main players, presented a more complete picture of KM market. They divided the software tools into solutions for optimization of knowledge work (collaboration, groupware systems, workflow solutions and videoconferencing equipment), solutions for knowledge organization (document storing, metadata management, and version control) and search and retrieval and solutions for knowledge development and production that include analytical tools. At the University of Washington [University of Washington 2000] an extensive search for KM software has been performed. In comparison with the work conducted in Germany where the focus is on management of knowledge items, knowledge

management at the University of Washington is observed as management of documents, employees and customers. Thus, in addition to KM tools for managing documents they also surveyed solutions for customer relationship management and human resource management.

Noll [Noll 2002] used an automatic method based on the calculation of the co-occurrences of words to analyze software providers' materials and identify topics and subtopics that are most often connected with KM software. Topics that have been identified in this research are: Microsoft-Lotus, search & retrieval, business information, collaboration and document management. Automatic analysis has advantages compared to manual analysis because of the objectiveness and further possibilities for visualizing and analysis of the results. However, some technologies (e.g. e-learning), that are an emerging segment on knowledge management market, due to modest presence in literature in comparison with other topics, have not been identified with this method.

Exploring the contribution of information and communication technologies to the field of knowledge management, Moffett and McAdam [Moffett, McAdam 2003] have focused on three specific areas, namely, collaboration, content management and business intelligence. According to this research, collaborative team building is supported by groupware systems, meeting support systems, electronic mail, intranets and knowledge directories. Content management is based on document management system, electronic publishing system, office automation system, agents and filters. Tools within the business intelligence stream include data warehousing and data marts, data mining tools, and modelling and prediction tools.

Dfouni and Croteau [Dfouni, Croteau 2004] used a web-based Delphi method to reach a worldwide consensus on technologies that support KM initiatives. The Delphi method is a procedure used to "obtain the most reliable consensus of opinion of a group of experts … by a series of intensive questionnaires interspersed with controlled opinion feedback". After three rounds, they have come up with the following conclusions. The ten most critical KM technologies are: portals (internet/intranet/extranet), information retrieval engines, e-mail, collaborative work support tools, document management system, corporate yellow pages of skills and expertise, knowledge maps, electronic discussion boards, e/learning technologies and data mining tools. This research also indicates that top priority is given to technologies that could help in extracting tacit knowledge; however most of the tools (seven out of ten) are actually used for supporting explicit knowledge. These results indicate that the most challenging part of knowledge management initiatives is capturing knowledge embodied within individuals.

Lately Nantel [Nantel 2004] has published a book on knowledge management technologies in a form of reference book for strategic planners. Here he discusses thirty five knowledge solutions from well known software providers, such as *Documentum*, *Hyperwave, Verity, Inxight, Microstrategy, Livelink, Staffware*, and others.

3 Relating Knowledge Processes to Enterprise Business Processes

3.1 Knowledge Management Process

Knowledge management is most often defined as a process of creating value from the intangible assets of the company including knowledge of the employees, business processes, products, customer and supplier information systems, and other [Adamson, Handford 2002]. Knowledge can be classified into explicit knowledge and tacit knowledge [Nonaka 1994]. Explicit knowledge includes everything that could be externalized (transferred from a human head into an electronic form) and shared. Explicit knowledge could be also created through business transformations from data and information that already exist in different formats in an enterprise information system. Tacit knowledge refers to knowledge, which is embedded in individual experience, insights, skills that are highly personal and difficult to communicate. It is also rooted in the activities of teams, product market, customer's potential, organization processes, etc.

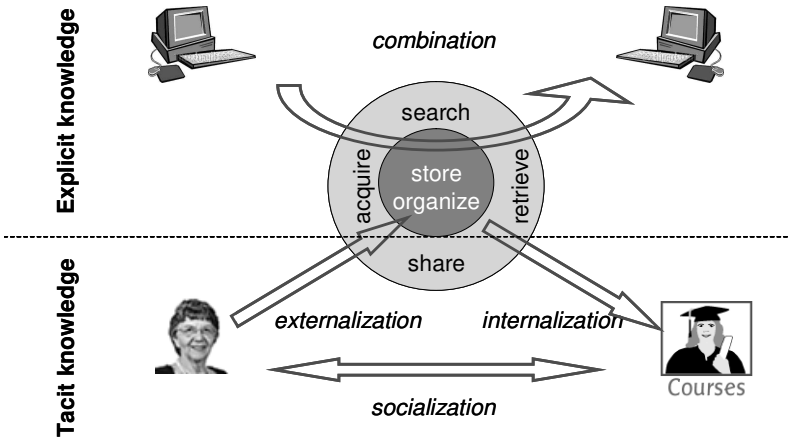

Figure 1: The knowledge management process

Based on the distinction between tacit and explicit knowledge, Nonaka and Tacheuchi [Nonaka, Takeuchi 1995] identified four basic patterns for creating knowledge in organizations [see Figure 1]: *socialization* (from tacit to tacit), *externalization* (from tacit to explicit), *combination* (from explicit to explicit), and *internalization* (from explicit to tacit). Socialization occurs when individuals share tacit knowledge through joint activities, such as face to face conversation, telephone correspondence or various communication styles. Externalization occurs when tacit knowledge is converted into explicit knowledge and stored on paper or in electronic form. Combination involves the conversion of explicit knowledge into more complex explicit knowledge through capturing and integrating new explicit

knowledge. Finally, internalization takes place when one consults some documents and creates her/his own knowledge out of what s/he has learned.

3.2 Enterprise Business Processes

An enterprise is an independent legal economic entity, established with the aim to carry out particular business activities with a positive outcome. Depending on the type of primary economic activities, we distinguish manufacturing enterprises, retail enterprises, service enterprises, public enterprise, etc. The primary economic activities of an enterprise define also the structure of its enterprise business processes. E.g. the business processes of a research and development organization will differ from the enterprise business processes of a pharmaceutical company. Roughly speaking, enterprise information flows could be divided into external and internal flows. External flows are directed towards clients, suppliers, partners and other legal entities. Internal flows are results of information exchange and business interactions between employees inside the enterprise. Both types of processes together form the enterprise business processes, such as: marketing, sales, purchase, customer support, research and development, manufacturing and management.

Smith and Fingar [Smit, Fingar 2002] define a business process as a complete set of dynamically coordinated activities that create values for the customers, and not for the enterprise. Melan [Melan 1992] suggests the following hierarchy of constituents that create a process: a process, a part of the process, activity and working task. A task is a separate working moment, while an activity is a group of working tasks. A number of activities form a sub process and a process is made up of a few sub processes. In order to explain the information flow that creates customer value, as well as profit and competitive advantage, Porter [Porter 1980], the guru of corporate strategic thinking, has introduced a generic model of business activities named a value chain applicable to a wide range of firms. The idea of the value chain is based on the process view of organizations, the idea of seeing an organization as a system, made up of subsystems each with inputs, transformation processes and outputs. The value chain of a company is linked between the value chain of the supplier company and value chain of consumer company resulting in a large stream of activities known as the value system. The profit of a company depends on the ability of effective and efficient execution of business activities, as well as, on the difference in money invested in business activities (including production costs, marketing and sales activities) and price gained on the market. Therefore, the company profit depends on the value system of which the company is a part.

In order to better understand the activities leading to a competitive advantage, the company-specific value-creating activities should be identified. According to Porter, a competitive advantage could be achieved by better understanding of activity costs and their minimization and by focusing on activities that the company carries out better than the competition. Porter defines ten key factors that influence the product price including employees' know-how and learning abilities, the level of vertical integration, the level of horizontal integration and connectedness of activities and time to market. Know-how of the employees and their creativity are substantial factors for achieving a competitive advantage. But, product innovations and business process innovations (e.g. introduction of a new product, new marketing channel or new production line) could also decrease the product price and increase sales.

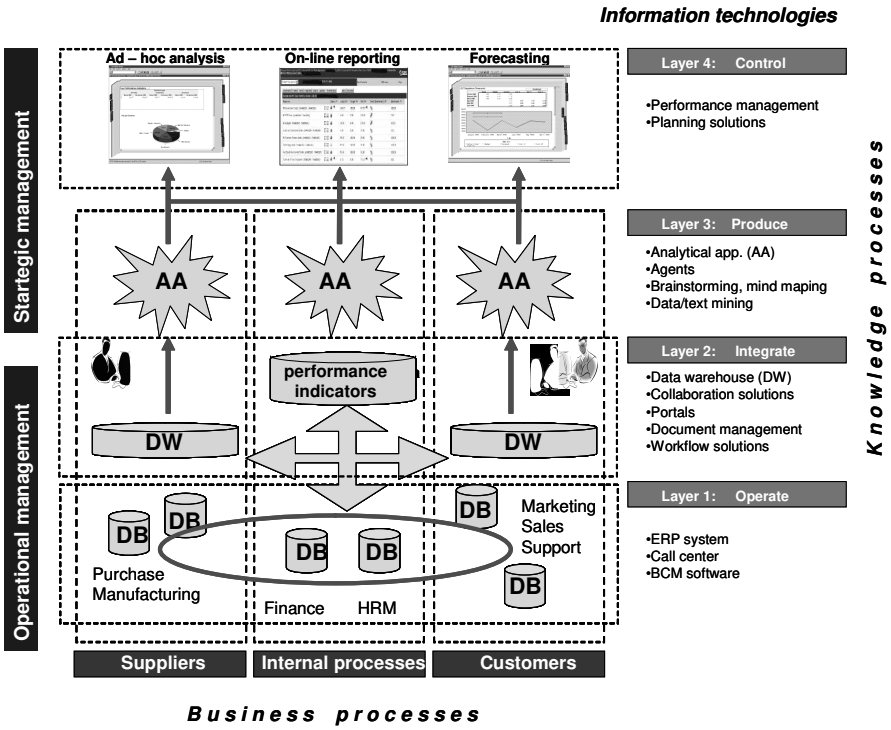

Figure 2: Relating information and knowledge technologies to business processes

Vertically, as is presented in Figure 2, enterprise management processes could be divided into operational business processes and strategic business processes. Operational business processes that are aimed to carry out the daily activities in an effective and an efficient way are based on transactional databases (DB). On the lowest level (Layer 1) enterprise resource management (ERP) systems integrate and automate all aspects of operational business activities from manufacturing and warehousing to sales and finance. Built around a centralized or distributed database, ERP systems are often preserved as back office systems for managing the internal information flows. Integral part of an ERP system is also the human resource management system (HRM). With time the ERP systems integrated functionalities that promptly connect the employees with customers, suppliers or partners e.g. business contact management software (BSC). Other information technologies that have an integrative role on enterprise level are (Layer 2): data warehousing technologies, collaboration solutions, portals, document management, and workflow solutions. While managers on operational level are concerned with the optimization of the workflows, reduction of costs, and utilization of resources, strategic managers (Layer 3 and 4) are concerned with establishment of good position on the market, improving the customer satisfaction, meeting the business objectives and creating profit, protection and development of intellectual capital, etc. On upper levels

specialized decision support applications, operational research techniques, knowledge production technologies and enterprise performance measurement systems are used.

In accordance with the value chain, the business process could be divided horizontally into customer related sub process, internal sub processes and supplier related sub process. In the following subsections we will closely examine the strategies for management of customers, employees and suppliers separately.

3.2.1 Customer Relationship Management

Customer Relationship Management (CRM) is a business strategy that focuses on an individual customer with the aim to build a long lasting profitable relationship and to achieve customer satisfaction and customer loyalty. CRM is a process of learning the customer attitudes and preferences and, according to that, customizing the products and services to best suit their needs. Successful implementation of the process requires tight integration of the front end activities (marketing, sales and service activities) with the back end activities, such as monitoring, planning and decision support. Information infrastructure that enables the process is built of operational CRM solutions, analytical CRM solutions, as well as tools for business process optimization. Operational CRM systems, such as business contact management tools, sales automation tools, direct marketing tools, support operational work with customers: gathering information about customers' personal data, business transactions, contacts with sales, marketing and sales support representatives, etc. While knowledge bases at customer call centres store knowledge (answers to customer questions), they do not produce new knowledge. Analytical CRM systems that are based on information warehouses, on-line analytical processing (OLAP) technologies and other analytical tools, integrate data from different sources, process data into information and knowledge about customers' behaviours, intentions, potentials, and others. In that way analytical CRM systems create valuable knowledge that can be used to direct the future operational and strategic actions.

3.2.2 Supplier Relationship Management

Similarly to customer strategy, the enterprises develop strategies for partners and suppliers management. Partners and suppliers are all legal entities that appear in a value chain and these are: suppliers engaged in a manufacturing process, warehouse suppliers, retailers and other distribution centres, consulting organizations, outsourcing partners, and suppliers of secondary services such as restaurants, facility services, etc. Supplier relationship management (SRM) is a complex process that covers a wide range of activities from planning of business cooperation, materials/products/services supply, distribution of final gods to quality and performance evaluation. Taking into consideration that the business process in modern organization is governed by customer demand, on a more detailed level suppliers related activities involve: collection and evaluation of suppliers' offers, supplier document (invoices, bills) management, supplier relationship analysis that includes delivery time analysis, etc. An integrated SRM solution is technologically identical to a CRM solution. The operational part of the system stores information about suppliers' contacts and transactions, while the analytical part of the system

creates knowledge about suppliers and generates strategies (plans, actions) for supplier management.

3.2.3 Human Resource Management

Human resource management (HRM) is one of the basic business processes that consists of three groups of activities: administrative activities, organizational activities and employee acquisition and development activities. Administrative activities include management of different employee records (personal data, qualifications, holidays, business trips) and legal procedures of hiring/dismissal, as well as payment processing. Organizational activities cover strategic issues of enterprise organizations, systematization of working places, planning of team work, team formation and development, HRM information system, etc. Employee acquisition and development activities are directed towards definition of requirements and standards that employees have to fulfil prior to employment, planning of necessary resources, education and development of employees, and employee performance measurement. HRM system is usually part of integrated enterprise resource management (ERP) system. In addition to ERP, knowledge technologies in the form of WEB agents or corporate yellow pages of skills and expertise are used to facilitate identification of employees with some specific capabilities [Crowder et al. 2002].

3.3 Differentiating Knowledge Processes from Operational Business Processes

In order to differentiate knowledge processes from operational business processes, we will analyze the information/knowledge flows presented in Figure 2 bottom up. Data and information are gathered on operational level (Layer 1). Although knowledge is used in operational activities, e.g. knowledge bases and search engines are used at customer call centres to answer customer questions, knowledge is not produced in this stage. Nevertheless, social network analysis could be used on this level to identify the knowledge flows and set up workflows of best practice. Workflows automated by workflow solutions (Layer 2) map the individual activities of the employees in marketing, sales and customer support centres into integrated business processes.

On upper levels (Levels 3 and 4) strategic management tools are used that not only integrate and transfer knowledge but produce knowledge as well. Based on data warehousing technologies, traditional decision support (business intelligence) tools integrate data from more business sources, and using analytics (Layer 3), turn the data into knowledge about customers, suppliers, processes, employees, etc. One of the main differences between business intelligence and knowledge management is that business intelligence tools manage structured data, while knowledge management tools (as it is most often accepted) manage primarily unstructured data. Equivalent to data warehouses are document management systems and lately portal technologies that aim to provide a unique view of the documentation in house. Both decision support systems and knowledge management systems are used to transform the business data into information and knowledge necessary to make business decisions more easily, thus, to produce actions. Besides the automatic way of creating knowledge, new tacit knowledge is created in a team or group or virtual community as a result of social interactions. Technologies that facilitate knowledge production

thus include collaboration systems, tools that enhance creativity (tools for brainstorming, mind mapping, concept mapping) and problem solving tools (critical path analysis, root cause analysis, decision trees).

Based on the discussion above, knowledge management systems differ from operational information systems in the type of items they are dealing with. On one side operational information systems process data and information, and on the other side, knowledge management systems enhance knowledge creation. The purpose of knowledge management is to change the organization's present pattern of knowledge processing and ensure organizational learning, market and organizational innovations (new processes, products and services) and strategic competence [Firestone 2003a], [Firestone 2003b]. In order to measure the value of knowledge assets and the impact of knowledge management on overall business performance, enterprise performance measurement systems could be used (Level 4). Comparing the planned and actual achievements in four main business areas (customers, finance, internal processes, learning and growth) by using predefined key success indicators, directions for further actions could be generated. Because performance measurement is not the subject of this study, we will omit these software tools from the survey that follows.

4 A Survey of Knowledge Management Solutions

Source	Description
BRINT	BRINT is the world's most reputed and top-ranked resource for business technology management and knowledge management. It is a Web portal of the BRINT Institute founded in 1994 by Dr. Yogesh Malhotra, who is among the world's most influential practitioners and thought leaders in knowledge management. The portal enable communications and exchange of knowledge among its 100,000 registered members.
KMWorld	KMWorld is Web portal of the world KM community. KMWorld is a publisher of the KMWorld Magazine and numerous white papers, as well as, an organizer of the annual KMWorld & Internets Conference and Exhibition. Up to seventy KM solution providers advertise on this portal or take part of the annual exhibition. More than 49,000 professionals read KMWorld NewsLinks.
KMCI	KMCI is portal of the International professional association of KM practitioners founded in 1997. The portal provides KM forums and discussion areas. The KMCI association offers KM certificate programs and publishes KM books and white papers.
KnowledgeBoard	KnowledgeBoard is Web portal of European KM community. Like other knowledge portals, it serves as a knowledge network for KM professionals from academia and industry, as info desk about KM events, as on-line library of KM literature, as well as market of knowledge management jobs.
KMTool	KMTool is YAHOO group of more than six hundred KM professionals. Like other communities, the group members are informed about new KM products, product details, project tools, conference details, vendor assessments, and others via "What's New" newsletter.

Table 1: Internet resources consulted in this research

4.1 About this Study

Company	DM	IR	EIP	CG	EL	WS	DS
Vitalect http://www.ictips.com/					X		
Factiva http://www.factiva-content-management.com	X						X
Business Objects http://www.businessobjects.com							X
Cognos http://www.cognos.com							X
SAP http://www.sap.com			X	X			X
Intelligenxia http://www.intelligenxia.com							X
SAS http://www.sas.com			X				X
SPSS http://www.spss.com							X
ORACLE http://www.oracle.com			X	X		X	X
Tacit Knowledge Systems http://www.tacit.com		X		X			
IBM http://www.ibm.com http://www.lotus.com			X	X	X		X
Microsoft http://www.microsoft.com			X	X			
Intraspect http://www.intraspect.com			X	X			
Sopheon http://www.orbitalsw.com/			X	X			X
Semio (Entrieve) http://www.entrieva.com		X-a		X			
Documentum http://www.documentum.com	X		X	X			
Hyperwave http://www.hyperwave.com	X		X	X	X	X	
Entopia http://www.entopia.com	X	X-a		X			
Vignete http://www.vignete.com	X	X	X	X		X	
OpenText http://www.opentext.com	X	X	X	X		X	
Autonomy http://www.autonomy.com	X	X-s	X				
Hummingbird http://www.hummingbird.com	X	X-a	X	X			
Verity http://www.verity.com		X-s	X				
Stratify http://www.stratify.com	X	X-a	X				
80-20 Software http://www.80-20.com	X	X					
GammaSite http://www.gammasite.com		X-a					
Inxight http://www.inxight.com		X					
Google http://www.google.com		X-s					
Convera http://www.convera.com		X					
Ultimus http://www.ultimus.com				X		X	
QPR http://www.qpr.com						X	
Staffware http://www.staffware.com						X	

DM - Document Management / Content management; **IR** - Information Retrieval (a-automatic document categorization, s-search engine); **EIP** - Enterprise Information Portals; **CG** – Collaboration/Groupware; **EL** – E-learning; **WS** - Workflow systems / Business Process Management; **DS** – Decision support / Business Intelligence

Table 2: Software providers of knowledge management solutions.

Initiated by the need to get an updated picture of the market of knowledge management commercial solutions, we have studied and analyzed the Internet resources of software providers that declare their products as knowledge management solutions as well as shareware resources of some knowledge management portals. The five portals that we most frequently visited in this research are listed in [Table 1]. The initial list of software providers was taken in July 2003 from [KMWorld]. From then on, we have been constantly monitoring the Internet knowledge contents and extended the list with the names of the companies that frequently advertise on mentioned distribution channels. We compared the product portfolios of the software providers and, taking into consideration the previous work on knowledge technologies [see Section 2 Literature review; Kappe 2001], we establish a taxonomy of knowledge technologies that in our view covers all aspects of the knowledge process. Keywords that best describe the functionalities of the solutions are as follows: document management / content management (DM), information retrieval (IR), enterprise information portal (EIP), collaboration/groupware (CG), e-learning, workflow systems / business process management (WS) and decision support / business intelligence (DS). Classifying the KM solution providers (listed in first column) in accordance with selected taxonomy (listed in first row), we obtained Table 2. Sign X in this table means that the software provider has product in selected market segment. In order to point out that one market segment is more developed than another we have used purple rectangles. E.g. e-learning and business process management are emerging segments of the KM market, while enterprise information portals are offered by many providers as part of document management or collaboration solutions.

5 Comparative Analysis of Knowledge Management Solutions

In this section we analyze the functionalities of knowledge management solutions following the market segmentation presented in [Table 2].

5.1 Document Management

Traditional knowledge management tools are based on document management systems (see *Documentum*, *Hummingbird* and *Vignette*), full-text indexing and search engines. The main functions of document management systems are: handling of large amounts of documents that originate from a variety of sources and come in a variety of formats; extract and manage metadata about the documents; manage document versions; manage access permissions; and archive documents for a long time period. The documents reside on file system, e-mail system, document database, Web server and elsewhere. Before registering in a document management system or a knowledge base, knowledge items are first annotated or described with attributes referred to also as metadata (authors, keywords, and links to other documents). Based on metadata, the items are classified using knowledge modelling/representation technologies, such as taxonomies and ontologies and using special categorization algorithms (decision trees, neural networks, and statistics). Knowledge modelling/representation technologies form a bridge between knowledge creation and knowledge use. On one side, in order to be ready for later use, the knowledge has to be externalized in an

electronic form, described with attributes, taxonomies or ontology and registered in a knowledge base. On the other side, complementary tools (search algorithms based on taxonomies and ontologies) are required for knowledge retrieval and presentation.

A taxonomy consists of a hierarchically organized set of topics that companies use to share information, and allows users to easily locate pertinent documents. In addition to taxonomies, ontologies that have been developed within Knowledge Modelling research community describe relationship rules between categories or other data. Roughly, ontologies correspond to generalized database schemes. However, ontologies can be used to describe the structure of semantics of much more complex objects than common databases and are therefore well-suited for describing heterogeneous, distributed and semi structured information sources such as found on the Web (e.g. to describe relationships between documents).

The contemporary knowledge management solutions (e.g. *Hummingbird*) automatically create and extend taxonomies of business topics and classify the business information accurately. *Hummingbird's* automatic document categorization software extracts concepts that best describe the contents of the documents by e.g. applying neural network algorithm on just 10% of documents that have to be organized. After that documents are grouped in groups and subgroups of similar concepts, and as a result a taxonomy for the documents and a classification algorithm are built. Rests of the documents are indexed and automatically classified using the developed classification algorithm and developed taxonomy. Most often (e.g. *Entrieva's SemioTagger*) the indexing and categorization engine are deployed as a "web service" and can operate with any portal, viewer, database engine or business application through standard SOAP protocol. Web services [Cabral et all. 2004] are well defined, reusable software components that perform specific, encapsulated tasks via standardized Web-oriented mechanisms. SOAP is W3C's recommended XML-data transport protocol, used for data exchange over web-based communications protocols (http).

Automatic categorization tools are integrated into solutions provided by *Entopia, Inxight, GamaSite, Megaputer intelligence, Stratify* and others.

5.2 Knowledge Acquisition, Search and Retrieval

Information retrieval (IR) technologies traditionally cover search engines based on full text indexing. The main part of a search engine is an indexing and categorization server that organizes up to billions of documents which can be searched by keywords. The crawlers of these search engines review the available documents in regular intervals and register them in an index. Web search engines like *Google, Altavista, Yahoo* store the pre-processed information about documents in information containers (catalogs).

Nowadays, full text indexing method is not sufficient for searching information in contents enriched with video and sound records. Therefore, this method is supplemented with technologies, such as: ontology based indexing, search/indexing agents, knowledge description schemes (semantic nets, knowledge maps), natural language processing, text mining, and information visualization.

Ontology based indexing is a method of integrating semantic knowledge about contents, services and processes of a domain in the indexing process. The process of defining the domain entities (contents, users, and tasks) is metadata

generation. The process of assigning meaning to domain entities is ontology generation. Semantic content descriptions based on ontologies enable software agents in distributed systems to co-operate and to perform complex operations such as searching, filtering, integrating information and reasoning. Software agents operate in virtual domains including operating systems, computer applications, databases and on Internet and act on their users' behalf and without extensive user intervention. As an example, a software agent could be used to find expertise in knowledge intensive organizations [Crowder et al. 2002] or a speech agent could be used to facilitate visually impaired persons to commit library (searching/retrieving) operations [Dendrinos 2002].

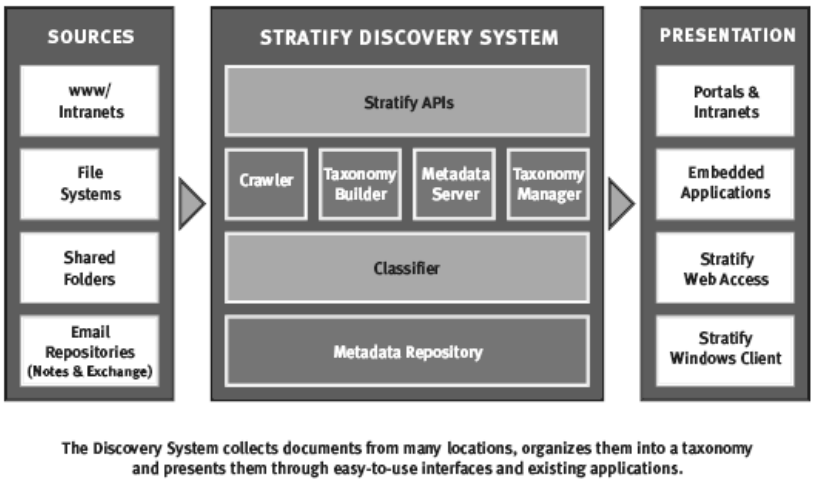

Figure 3: Stratify Discovery System.

Lately, with the development of newest portal standards and technologies, search and retrieval tools are often implemented as portlets that could be easily integrated via web services (.NET, Java Web services) in different software environments. We could point out here a complete range of Java based portlets provided by *Autonomy* that are compatible with *IBM*, *Oracle, SAP, Sybase*, and other portals.

Intelligent agents and other sophisticated search tools are provided by: *Verity, Autonomy, Convera, FAST, Google, Excalibur, Dataware Technologies*, and others. More details about enterprise search vendor landscape could be found in Giga Research Report from year 2003 [Giga 2003].

5.3 Collaboration Solutions

Sharing knowledge between people is the most important and efficient way for an individual to gather knowledge. Unlike other corporate resources, knowledge is enriched when it is shared, and is not diminished through use. With the introduction of the Internet and other collaboration technologies, team work is not limited to a small group of people in one enterprise and is spread to partners, suppliers or other

members of interest. Thus, groups of people organized in public self-organizing workgroups and specialized communities (communities of interest, communities of practice) generate knowledge that is shared, not individualized.

Collaboration systems include groupware systems, videoconferencing software, e-learning solutions, project management systems, and collaboration portals. Groupware systems (e.g. *Lotus Domino* by *IBM* and *Microsoft Exchange*) promote collaborative work of geographically dispersed organized units and sharing of highly unstructured information (document libraries, events calendars, mail inbox, contact lists). For example, they optimize the work of knowledge workers by enabling them to track revisions to a document as it moves through a collaborative editing process. Project management systems (see *Primavera Systems*) are a kind of groupware systems where all aspects of project work are documented: project teams, activities, schedules, documents, meetings, etc. By these systems the activities of team members are coordinated and planned. The most relevant collaboration solutions (portals, workflow solutions and e-learning solutions) will be explained in detail in the coming subsections.

Characteristics common to all collaboration solutions are the built pull/push technologies. Pull techniques retrieve knowledge on users' requests (e.g. e-mail system, document management system, search engines). Contrary, push techniques that are implemented on publisher side broadcast contents (news, seminars) to users' address similar to television broadcasting (e.g. Push Application Server by BackWeb). In both types of technology software agents play an important role. They analyze the customer behaviour and retrieve/broadcast contents that are really interesting for the user i.e. personalize the delivery.

Whether communication occurs through messaging services or on-line services, synchronously or asynchronously, the key to successful and efficient communication is a robust communications infrastructure supporting traditional telephone networks, Internet and wireless devices. Other relevant issue for cooperation is the interface of the collaboration solution. In order to amplify collaboration and knowledge transfer, a collaboration solution should integrate a multi channel - multimodal interface. Besides access to relevant documents through search and retrieval tools, a collaboration solution should enable chatting and videoconferencing. Chatting is communicating synchronously through a text channel. Videoconferencing (see *Linktivity*) is cooperation of a group of dispersed members that could see each other via a web camera and talk to each other. Videoconferencing substitutes face-to-face communication which is the most efficient way of knowledge transfer. Videoconferencing is widely used in e-learning applications.

5.4 E-learning Solutions

E-learning or learning via internet (intranet and extranet) is an emerging segment of the KM market that covers a wide set of applications and processes, including web-based learning, virtual classrooms, digital collaborations, and distance learning [File et al., 2003]. E-learning technologies have changed the way the teaching process and the student evaluation process are performed. But not just in the framework of the classical education organizations, e-learning technologies have accelerated the knowledge transfer, reduced the knowledge transfer costs, shortened the learning

times and, as a result, increased customer and employee satisfaction in profit oriented organizations.

E-learning products like other collaboration solutions could be divided into asynchronous and synchronous solutions. In a synchronous learning model instructors offer the course content, using multiple Web-based audio and videoconference technologies, information and file sharing and sending, chat mode, white board accessible for all participants, etc. Asynchronous e-learning means that the user can take the training independent of any schedule. Examples of this type are auto-managed courses taken via Internet or CD-ROM and stored audio/video Web presentations or seminars. In addition to mentioned characteristics, e-learning solutions provide education management capabilities as well. These tools manage registration, plan and schedule courses.

5.5 Business Process Optimization

Established business processes together with the know-how of the employees are the main intangible assets of the enterprises. Therefore, business process modelling and analysis (BPMA) tools that enable organizations to document, model, analyze, understand and improve their business processes are here observed as knowledge management tools. BPMA tools [Khan and Little 2002; Yeich and Zeid 2002] are not mere process mapping tools, but rather use statistical modelling to analyze business processes under various scenarios, identify critical flaws and find ways of optimizing the whole business process. With the development of portals, workflow automation solutions became their integral parts. Process portals allow portal users to initiate processes, complete tasks, check status and otherwise employ business process management from their personalized workplace.

5.6 Enterprise Information Portals

Enterprise Information Portal (EIP) is a personalizable, Web-like user interface with the ability to consolidate information, applications and business processes from various internal and external sources on one screen, so that knowledge workers are given a single point of access to all information relevant to perform their job. Besides the integration role, the primary purpose of the portal is:

- to ensure information access to the right users while restricting sensitive material from unauthorized users,
- to enable users to organize their own personal workplace to view content/applications they are interested in while having all irrelevant information automatically filtered out,
- to enable safe information exchange within Portal communities,
- to simplify business operations with suppliers (B2B), customers (B2C) and partners.

As the first portals that appear on the market in the late 1990s were HTML-based collections of documents, they did not distinguish from the standard Web applications based on Web and application servers. As a result, not only the vendors of web content/document management solutions (*Documentum*, *Hyperwave*, *Hummingbird*), but also the providers of business information systems (*IBM, SAP, SAS, ORACLE, Microsoft* and others) came out with their own portal solutions. Nowadays, portal

products come with pre-built collaboration solutions (e.g. *Microsoft Exchange, IBM Lotus Domino, Documentum eRoom*). The emphasis of the current generation of portal technologies is on integration based on portal servers where web services play the main role. Generally, a portal consists of presentation layer and business logic/administration layer. The first one is composed of personalizable portlets (interactive Web mini-applications, servlets, JSPs), local or remote to the portal, that render markup fragments (news, weather, sports, and so on) that the portal can aggregate into a page. Business logic and administration layer is responsible for security, search /spidering/categorization operations, business process integration (scheduling jobs, orchestration of web services), and other administrative tasks on enterprise database/web/application servers. We could point out here integration of *Documentum eRoom* portlets with *BEA WebLogic* portal server.

5.7 Knowledge Production

Although most knowledge management software providers connect knowledge management with efficient management of existing documents and other structured, semi structured and unstructured items, knowledge production is at the heart of knowledge management. Production is a creative process that delivers new knowledge. New tacit knowledge is created in a team or group or virtual community as the result of the social interactions between human actors. However, new tacit knowledge is created in the head of individual student that acquire information via e-learning system or knowledge retrieval system as well. Thus, we could conclude that knowledge visualization interfaces [Eppler 2004] concerned with presentation of the discovered/communicated knowledge to the user and collaboration systems are information infrastructures that enhance knowledge creation. According to File and Wentling to group of knowledge creation tools [File, Wentling 2003] belong also software tools that enhance creativity (tools for brainstorming, mind mapping, concept mapping) and problem solving algorithms (critical path analysis, root cause analysis, decision trees).

New explicit knowledge, as was previously discussed [see Section 3 Relating knowledge processes…], is a result of several business transformations where intelligent data and text mining algorithms (decision trees, neural networks, case-based reasoning, genetic algorithms, forecasting algorithms, etc) are applied to structured or unstructured data and information. Data/text mining is concerned with detecting new and interesting pieces of information in large databases/large collections of text documents. Typical data/text analysis tasks include searching for trends, discovering relationships among events, terms and documents, categorizing or condensing information. Data and text mining techniques are incorporated as decision support tools in integrated business intelligence solutions from *IBM, SAS, ORACLE, Cognos, Business Objects*, etc.

Except in-house knowledge production, knowledge could be captured from outside. Scanning of project documentation, buying information about customers, or hiring new people are examples for knowledge capture. Most document management systems support this function.

6 The Role of Knowledge Management Solutions in Modern Organizations

Among the broad spectrum of definitions of the term "knowledge management", for both (classical) hierarchically organized companies and modern network organizations, we have accepted the following definition: "Knowledge management is a process of creating value from the intangible assets of the company including knowledge of the employees, business processes, products, customer and supplier information systems, and other [Adamson, Handford 2002]". Knowledge processes supported by knowledge infrastructures improve individual and team creativity and facilitate innovation, but a question arises here: "To what extent could the created value be utilized on market?" or "How to transform the knowledge assets into valuable goods and services preferred by customers?" A knowledge management strategy should give answers and future directions for overcoming these dilemmas.

Like other management strategies (discussed also in this article), knowledge management initiatives are expected to make the most of the intellectual capital, enable innovation and competitiveness necessary to survive on the market, satisfy customers, and hence, create profit. There are three key aspects relevant to knowledge management strategy: people including external human factors, processes and technology. Analyzing the knowledge management technologies we did not neglect the other two aspects. On the contrary, we paid special attention to the collaboration solutions that connect people inside the enterprise and with the environment (clients, suppliers, and partners). Binding people and applications, workflow solutions document knowledge about processes that is unique for an enterprise and is a source of a competitive advantage on market. In modern just-in-time businesses, enterprise efforts are directed towards precise estimation of customer requirements and preferences. New technologies including high-speed networks, mobile telecommunications, video-conferencing, virtual reality software alter the way the organizations do their business and communicate with their customers, suppliers, and partners and also dislocated employees. They enable binding of enterprises into virtual organizations, associations or alliances with the aim to exchange information, knowledge and experience, and to respond agilely to customer requirements [Malhotra 2000]. Knowledge management solutions related to the customer processes are the following: domain-specific knowledge bases to promptly answer customer questions in call centres; sophisticated sales and marketing tools to better track the interactions with the customer; intelligent knowledge-based systems to learn more about customer preferences, behaviours, profitability, and overall potential; business process modelling and analysis tools to optimize and automate the customer processes, etc.

7 Summary

In this paper, we have presented an extensive analysis of technologies that support knowledge processes in enterprises and came to the following conclusions:

1. A type of knowledge technology covers many aspects of the knowledge process. For example, collaboration solutions not only organize the

knowledge items in a way that best suits the community, but connect people and facilitate knowledge transfer and creation. Collaboration solutions are also used in operational business processes, where knowledge is distributed to clients and as such serves to satisfy customer needs. In particular, we could point out knowledge portals that integrate the different processes in enterprises into a unified business process.

2. Knowledge use in internal or external business processes relies on all previously discussed knowledge technologies.
3. Knowledge representation techniques, search and retrieval tools, all types of collaboration solutions are forming a bridge between knowledge creation and knowledge utilization. On one side they are used to enhance creativity and on the other side, they optimize knowledge work and improve efficiency and productivity.

Comparing operational and strategic business processes, we concluded that operational business processes, supported by enterprise information systems, collect data and information only. Knowledge in human heads or in intelligent business modules are a result of processing of data and information collected on operational level. We did not link the knowledge processes to specific departments because we assume that knowledge integration occurs on a departmental, and later, on an enterprise level and that knowledge development and production (especially of explicit knowledge) occur as parts of strategic business process through whole organization. Strategic performance measurement solutions could be used to measure the impact of knowledge management on overall business performance and direct actions on a strategic as well as on an operational level.

Analyzing the internet resources of commercially available knowledge management solutions, we established a taxonomy that helped us to segment the knowledge management market. The given insight into knowledge management market is a good starting point for strategic planners to easily begin a knowledge management initiative.

Acknowledgments

This research has been done under IT.1.24.0041.A project funded by the Ministry of Science and Environmental Protection of the Republic of Serbia.

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