A strategy-based ontology of knowledge management technologies

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Abstract

Purpose – *The purpose of this paper is to distinguish and describe knowledge management (KM) technologies according to their support for strategy.*

Design/methodology/approach – *This study employed an ontology development method to describe the relations between technology, KM and strategy, and to categorize available KM technologies according to those relations. Ontologies are formal specifications of concepts in a domain and their inter-relationships, and can be used to facilitate common understanding and knowledge sharing. The study focused particularly on two sub-domains of the KM field: KM strategies and KM technologies.*

Findings – *''KM strategy'' has three meanings in the literature: approach to KM, knowledge strategy, and KM implementation strategy. Also, KM technologies support strategy via KM initiatives based on particular knowledge strategies and approaches to KM. The study distinguishes three types of KM technologies: component technologies, KM applications, and business applications. They all can be described in terms of ''creation'' and ''transfer'' knowledge strategies, and ''personalization'' and ''codification'' approaches to KM.*

Research limitations/implications – *The resulting framework suggests that KM technologies can be analyzed better in the context of KM initiatives, instead of the usual approach associating them with knowledge processes. KM initiatives provide the background and contextual elements necessary to explain technology adoption and use.*

Practical implications – *The framework indicates three alternative modes for organizational adoption of KM technologies: custom development of KM systems from available component technologies; purchase of KM-specific applications; or purchase of business-driven applications that embed KM functionality. It also lists adequate technologies and provides criteria for selection in any of the cases.*

Originality/value – *Among the many studies analyzing the role of technology in KM, an association with strategy has been missing. This paper contributes to filling this gap, integrating diverse contributions via a clearer definition of concepts and a visual representation of their relationships. This use of ontologies as a method, instead of an artifact, is also uncommon in the literature.*

Keywords *Knowledge management, Technology-led strategy, Communication technologies, Information operations, Cataloguing*

Paper type *Research paper*

Introduction

Since the wide acceptance of knowledge as a critical economic resource, organizations have been struggling to deal with it effectively in an effort that has become known as knowledge management (KM). Several factors have been identified as enablers to this effort, and technology is certainly one of them. An adequate description of technologies that support the creation, transfer and application of knowledge, however, has been challenging. This is due partly to the dynamics of technology in general, which develops at an accelerating pace in a wide range of areas, but also to the complexity of the KM field itself, which includes conflicting perspectives on knowledge and approaches to its management.

> **"Since the field of KM is relatively new, existing approaches are varied and diverse."**

Technologies that can support KM, or KM technologies, have been described in many ways. The usual approach is to associate them with knowledge processes (Alavi and Leidner, 2001; Nonaka *et al.*, 2001; Marwick, 2001; Jashapara, 2004; Becerra-Fernandez *et al.*, 2004), but the processes identified vary widely, hindering a more general understanding. Alternative approaches have been to describe commercially available technologies (Hoffmann, 2001; Wenger, 2001; Luan and Serban, 2002; Lindvall *et al.*, 2003; Tsui, 2003), technologies as part of KM system architectures (Tiwana, 2002; Maier, 2004), and as applications for business (Binney, 2001). Although these approaches contribute to the understanding of KM technologies, a treatment of how they contribute to strategy has been missing.

This study proposes a description of KM technologies according to their support for strategy. The need to link KM programs in general to business strategy has been frequent in the literature (Hansen *et al.*, 1999; Zack, 1999; Horwitch and Armacost, 2002). Existing frameworks for KM implementation also usually include considerations of strategy (Rubenstein-Montano *et al.*, 2001; Mentzas, 2001; O'Dell *et al.*, 2003). Moreover, research on information systems and information technology in general has also been concerned with strategic alignment for a long time (Earl, 1989, 1996; Scott Morton, 1991). We then conclude that such an approach can provide useful insights into KM technologies and their use. Our method for exploring the connections between KM technologies and strategy is based on the concept of ontologies. Broadly defined, an ontology consists of terms, their definitions, and descriptions of their relationships. Among many possible benefits, ontologies can be used to facilitate common understanding and sharing of knowledge in a particular domain. In the next section, we further describe this concept and the chosen method for this study. The subsequent sections follow the method described, exploring the concept of KM strategy in the third and of KM technologies in the fourth. We describe the proposed ontology in the fifth section, and present our conclusions in the last one.

An ontological approach

Ontology is a discipline of philosophy that studies the categories of things that exist or may exist in a given domain. The product of such study, called an ontology, is a catalog of those types of things (Sowa, n.d.). The term was borrowed by computer scientists in the mid 1980s as a means to represent information and knowledge. It gained momentum in the 1990s, when it became widely accepted that information systems should be made interoperable (Welty, 2003). A further thrust came with the proposal of the semantic web, an initiative to embed meaning into web pages so that they become machine understandable (Berners-Lee, 2000). Current uses of ontologies include development of information systems, application integration, organization of content in web sites, categorization of products in e-commerce, structured and comparative searches of digital content, standard vocabularies in expert domains, product configuration in manufacturing, among many others (McGuinness, 2002). Ontologies can be designed with increasing levels of formality, from simple glossaries and thesauri to rigorously formalized logical theories. The higher the degree of formality, the less ambiguity and the stronger the power for automated reasoning (McGuinness, 2002; Uschold and Gruninger, 2004).

There are many methods for developing ontologies, and each has strengths and weaknesses. Noy and McGuinness (2001) suggest a process that includes the following steps: step 1: determining the domain and scope of the ontology; step 2: considering the reuse of existing ontologies; step 3: listing important terms; step 4: defining classes and their hierarchy; step 5: defining properties of classes; step 6: defining restrictions on properties;

step 7: listing examples in classes. Since our objective is to facilitate understanding and communication among humans, and not computers, the high degree of formality described in their process is not required. We adapted it to the following:

- Definition of the domain and scope (step 1 in Noy and McGuinness' method).
- Identification of key terms and concepts, and their relationships (step 3).
- Definition of the structure of the ontology as a hierarchy of categories (step 4).
- Survey of KM technologies according to the ontology (step 7).

The domain and scope of the ontology derived quite directly from our research objective: besides KM technologies themselves, we focused on the concept of KM strategy, which links KM to strategy. We then reviewed the literature in search of terms, definitions and relationships, and designed an ontology of KM technologies based on their distinct contribution to strategy. The next sections describe our findings.

Understanding KM strategy

We found in the literature three different meanings associated with the term KM strategy. The most common of them interprets it as an approach to KM, a fact that reflects the diversity of perspectives presented in the field and the lack of consensual models. A second meaning relates KM to strategic management, and defines KM strategy as knowledge strategy, a critical element of knowledge-based competitive strategy. A third meaning, usually employed in practical contexts, conveys a KM implementation strategy when mentioning the term. All three meanings shed light on the relation between technology, KM and strategy, and are used to develop the ontology.

KM strategy as an approach to KM

Numerous authors mean a particular approach to KM when they use the term KM strategy. Different approaches to KM reflect the distinct perspectives, conceptualizations, and methodologies that emerge from particular disciplinary backgrounds, specific interpretations of what knowledge is and how it can be managed, and the varied backgrounds and agendas of those involved in KM. Since the field is relatively new, existing approaches are varied and diverse. It is possible, however, to group them into some relevant types.

The most common approaches to KM seem to be technology-oriented; they emphasize the explicit nature of knowledge, and tend to interpret it as an object that can be stored in repositories, manipulated, and transferred via information and communication technologies. These approaches are also described as the content perspective on KM (Hayes and Walsham, 2003), the object, product or stock perspectives on knowledge (Alavi and Leidner, 2001; Mentzas *et al.*, 2001), codification or system strategies for KM (Hansen *et al.*, 1999; Choi and Lee, 2002), and technocratic schools of KM (Earl, 2001). People-oriented approaches, on the other hand, emphasize the tacit nature of knowledge, and tend to interpret it as a social, context-dependent process of understanding that requires human communication and cognition in order to emerge. These approaches are also described as the relational perspective on KM (Hayes and Walsham, 2003), the process or flow perspectives on knowledge (Alavi and Leidner, 2001; Mentzas *et al.*, 2001), personalization or human strategies for KM (Hansen *et al.*, 1999; Choi and Lee, 2002), and behavioral schools of KM (Earl, 2001).

"The most common approaches to KM seem to be technology oriented."

> **"The key elements of a knowledge strategy are knowledge domains and knowledge intents."**

These two prominent types, technology- and people-oriented approaches, reflect a major division in the KM literature and practice. Some authors favor one over the other. Others argue that both can be effective, but there is a trade-off between them: if an organization emphasizes one, it should avoid the other (Hansen *et al.*, 1999). We believe that a balance is preferred, and an organization can benefit from using both approaches in different circumstances (Umemoto, 2002), or even combining them into a hybridization strategy (Umemoto *et al.*, 2004). Other relevant types of approach include asset-oriented ones, focusing on the economic value of knowledge, thus referred to as intellectual capital or intangible asset (Stewart, 1997; Sveiby, 1997; Edvinsson and Malone, 1997), and those that are process-oriented, focusing on the increase of effectiveness in business processes by the provision of context-specific knowledge at the task level to employees (Heisig, 2001; Maier and Remus, 2001)

KM strategy as knowledge strategy

The knowledge strategy concept builds on the knowledge-based view of the firm developed by authors in the field of strategic management, and links KM to business strategy. That view argues that a firm's unique knowledge is the key source of its competitive advantage, allowing it to combine conventional resources in distinctive ways and provide superior value to customers (Kogut and Zander, 1992; Spender, 1994; Nonaka, 1994; Grant, 1996; Teece *et al.*, 1997). A knowledge strategy identifies this unique knowledge, either existing in the firm or required for a projected situation, and drafts ways to develop and/or capitalize on it (Zack, 1999, 2002; Von Krogh *et al.*, 2001).

The key elements of a knowledge strategy are knowledge domains and knowledge intents. Knowledge domains are areas of interest and expertise that comprise strategic knowledge resources (Von Krogh *et al.*, 2001; Van der Spek *et al.*, 2003). Domains can focus on external or internal issues, and be more general or more specific. Examples of domains are industries, markets, and customers, which focus on external opportunities and threats; organizational functions and processes, which focus on internal capabilities; and products, services, and technologies, which try to connect internal capabilities to identified opportunities. Knowledge intents are the substance of a knowledge strategy, and are derived from the comparison between existing and required knowledge resources, resulting in the identification of knowledge gaps and/or surpluses (Zack, 1999, Van der Spek *et al.*, 2003). Knowledge resources can exist internally or be available externally; thus, generic knowledge intents are: to leverage existing internal knowledge; to acquire existing external knowledge; or to create new knowledge (Von Krogh *et al.*, 2001).

The literature on knowledge-based strategy refers to a dichotomy between exploitation, the application of existing knowledge, and exploration, the creation of new knowledge (March, 1991; Von Krogh *et al.*, 2001; Grant, 2002). Both are necessary, in fact, and companies should seek a balance, using exploitation to provide the revenue required for exploration, which is the basis of long-term revenues (Zack, 1999; Ichijo, 2002; Chakravarthy *et al.*, 2003). In the ontology, we refer to these concepts as knowledge creation (exploration) and transfer (exploitation).

KM strategy as KM implementation strategy

Authors concerned with the practice of KM sometimes use the term KM strategy to refer to strategies for implementing KM. A KM implementation strategy is a general plan that provides guidelines for making decisions and attaining results from KM initiatives. This

concept of KM strategy applies mainly to the executives and managers responsible for the KM function or KM programs in an organization.

Existing KM implementation frameworks (Wiig, 1999; Soliman and Spooner, 2000; Rubenstein-Montano *et al.*, 2001; O'Dell *et al.*, 2003; Wong and Aspinwall, 2004a), which help practitioners design particular implementation strategies, include a myriad recommendations. These recommendations can be summarized in three topics: securing a set of required conditions; choosing and prioritizing a set of KM initiatives; and establishing evaluation criteria. First, among the elements that are often cited as required conditions for (or indicators of) successful KM programs, we can include senior management support, alignment with strategy and business requirements, consideration of organizational dynamics and culture, and involvement of key personnel and stakeholders (Wiig, 1999; O'Dell *et al.*, 2003; Wong and Aspinwall, 2004b). Second, the actual implementation happens through a series of KM initiatives designed to support knowledge processes, usually balancing human- and technology-oriented approaches. A frequent recommendation is to prioritize initiatives according to a trade-off between opportunity (easy to carry out) and strategy (valued business results), and to implement them in stages, starting with pilot projects that provide lessons for further expansion (O'Dell *et al.*, 2003; Wong and Aspinwall, 2004a). And finally, almost all frameworks mention the need for evaluation criteria to assess results and provide for accountability. This includes the need to identify expected business benefits and develop a business case, collect anecdotal evidence, and adopt performance indicators and metrics, both KM-specific and business-driven (Rubenstein-Montano *et al.*, 2001; O'Dell *et al.*, 2003; Del-Rey-Chamorro *et al.*, 2003).

Descriptions of implementation approaches include both top-down and bottom-up. The necessary considerations tend to be the same; only the order in which they are presented seems to be different. Top-down approaches usually start by securing the required conditions and establishing evaluation criteria, while bottom-up ones start with local initiatives that expand later by focusing on the other elements.

Linking KM technologies to KM strategy

It is possible to understand the relationship between KM technologies and business strategy by analyzing the three meanings associated to KM strategy (mapped in Figure 1). We say that a given KM program is strategic if: there is a knowledge strategy in place, which defines the knowledge intents that support a particular knowledge-based competitive strategy; and the program includes a set of KM initiatives that directly or indirectly support those knowledge intents. Since KM technologies are always used in the context of KM initiatives, if those initiatives support a knowledge strategy, then the technologies have strategic value. Additionally, KM initiatives are naturally associated with a particular approach to KM, the most prominent being personalization and codification (Hansen *et al.*, 1999). If those initiatives support a knowledge intent, then it is possible to identify four ways in which KM initiatives can be used strategically. By combining the generic knowledge intents creation and transfer with approaches to KM, we have the following ideal types of KM initiatives: creating knowledge according to a personalization approach; creating knowledge according to a codification approach; transferring knowledge according to a personalization approach; and transferring knowledge according a codification approach (Figure 2). KM technologies can support all four types of initiatives.

Understanding KM technologies

We next review existing studies describing KM technologies, or technologies that support knowledge management and knowledge processes. The most frequently used approach describes technologies in association with knowledge processes. Alternative approaches describe commercially available technologies, technologies as part of KM system architectures, and as applications for business. We analyse each of these in search of criteria for building the ontology.

Figure 1 Conceptual map of KM strategy

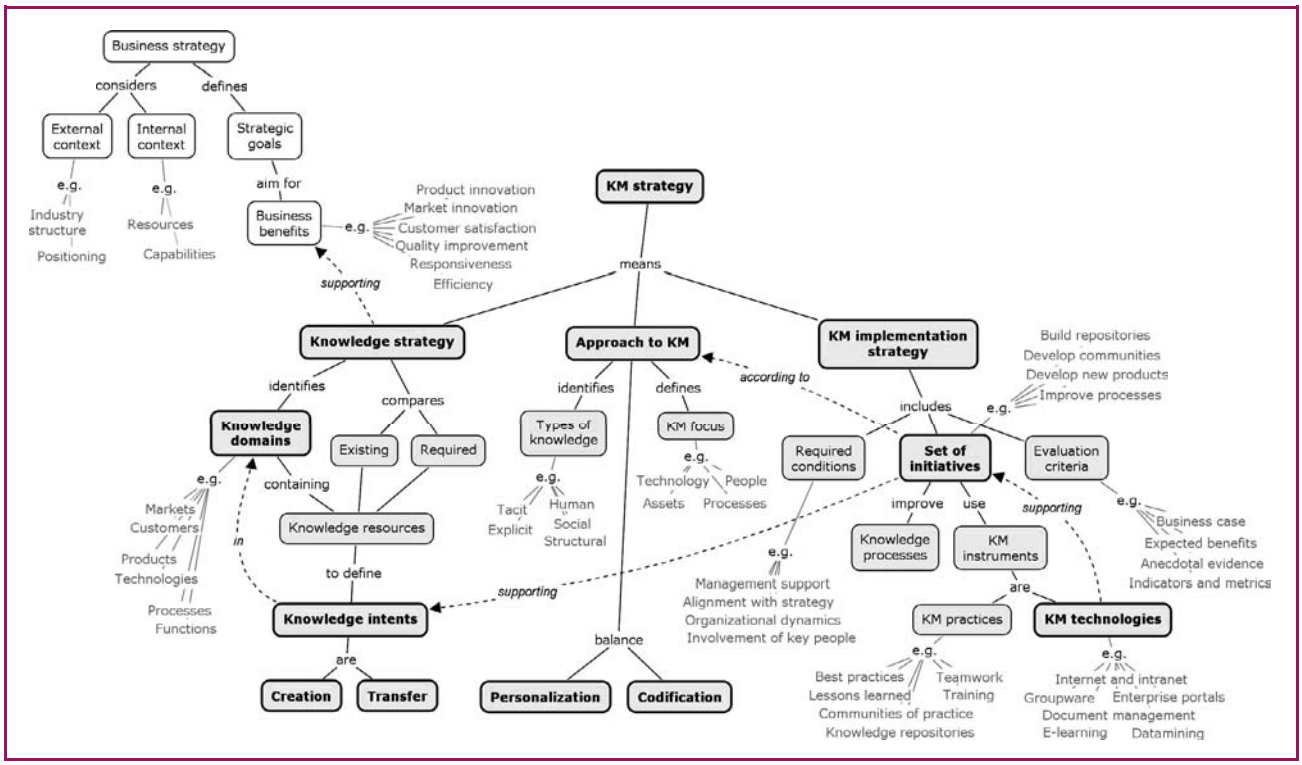


Figure 2 Four generic types of KM support for strategy

	Personalization	Codification
Creation	Knowledge creation through personalization	Knowledge creation through codification
Transfer	Knowledge transfer through personalization	Knowledge transfer through codification

Technologies supporting knowledge processes

The most frequent way to present KM technologies is to associate them with knowledge processes, e.g. creation, storage and retrieval, transfer, and application; or socialization, externalization, combination, and internalization. Studies using this approach usually adopt a particular perspective of KM, identify a set of core processes, and list technologies that can be used to support them (Nonaka *et al.*, 2001; Marwick, 2001; Alavi and Tiwana, 2003; Becerra-Fernandez *et al.*, 2004; Jashapara, 2004). Their objective is either to demonstrate that technology can actually support KM, or to illustrate how a particular KM model can be implemented with the aid of technology. Those studies provide a good explanation of how technology can be used for KM. However, the processes chosen to describe the range of activities in KM vary widely, depending on each author's particular interpretation of what

knowledge management (Table I) consists of. For instance, Nonaka *et al.* (2001) base their work on the well known SECI spiral of knowledge creation: socialization, externalization, combination, and internalization, which focuses on interactions among people and emphasizes the social nature of knowledge. Alavi and Leidner (2001), although trying to balance the social and technical aspects of knowledge, choose processes that tend to interpret it as product: creation, storage and retrieval, transfer, and application. Becerra-Fernandez *et al.* (2004) adopt a technical slant and emphasize a knowledge engineering approach, proposing the processes discovery, capture, sharing, and application. Although the technologies listed in those studies are surprisingly similar, the way they are grouped and organized reflects particular interpretations of KM.

What is evident from an analysis of those studies is that knowledge processes are too complex and context-dependent to be used as a general criterion for classifying KM technologies. Knowledge processes occur at many different levels – individual, group, organizational – and are deeply inter-related. For instance, Nonaka's SECI model aims at the creation of knowledge at the organization level, but there is much capturing, sharing, storage, retrieval, application, etc., happening at individual and group levels. In a similar way, knowledge can be created at the individual, group and organizational levels, and what is creation in one level may be interpreted as transfer at another level. This complexity becomes apparent if we try to associate technologies with knowledge processes. Alavi and Tiwana (2003), for instance, cite e-learning as a technology for knowledge creation. They are focusing on the individual level, since e-learning is used mainly as a tool for disseminating existing knowledge to employees. Nonaka *et al.* (2001), on the other hand, cite communication and collaboration technologies like videoconferencing and groupware, focusing on knowledge creation at the group level. For proper understanding, therefore, any given set of knowledge processes requires additional explanation about their focus and scope. In isolation, they are prone to misinterpretation.

Alternative approaches to understand KM technologies

A second type of study describes commercially available KM products and solutions implemented in existing KM initiatives (Hoffmann, 2001; Wenger, 2001; Luan and Serban, 2002; Lindvall *et al.*, 2003; Tsui, 2003; Maier, 2004; Rao, 2005). This approach provides a practical perspective on KM technologies, focusing not on conceptual categories but on groupings derived from the comparison of actual solutions. Combined, these studies provide a comprehensive survey of the technologies and applications available to practitioners, from a practice perspective. Such wide coverage, though, also presents a drawback: groupings are usually numerous and vary significantly in functionality and scope, requiring additional analysis for an adequate organization and description of KM technologies. Some authors combine this approach with others, like the association with knowledge processes or the description of a KM system architecture.

Table I Knowledge processes in the literature

Authors	*List of knowledge processes*
Alavi and Leidner, 2001	Creation, storage and retrieval, transfer, application
Hoffmann, 2001	Create, store, distribute, apply
Nonaka *et al.*, 2001	Socialization, externalization, combination, internalization
Becerra-Fernandez *et al.*, 2004	Discovery, capture, sharing, application
Jashapara, 2004	Organizing, capturing, evaluating, sharing, storing and presenting
Maier, 2004	Discovery, publication, collaboration, learning
Wong and Aspinwall, 2004a	Acquiring, organizing, sharing, applying
Rao, 2005	Creation, codification, retrieval, application, distribution, validation, tracking, personalization

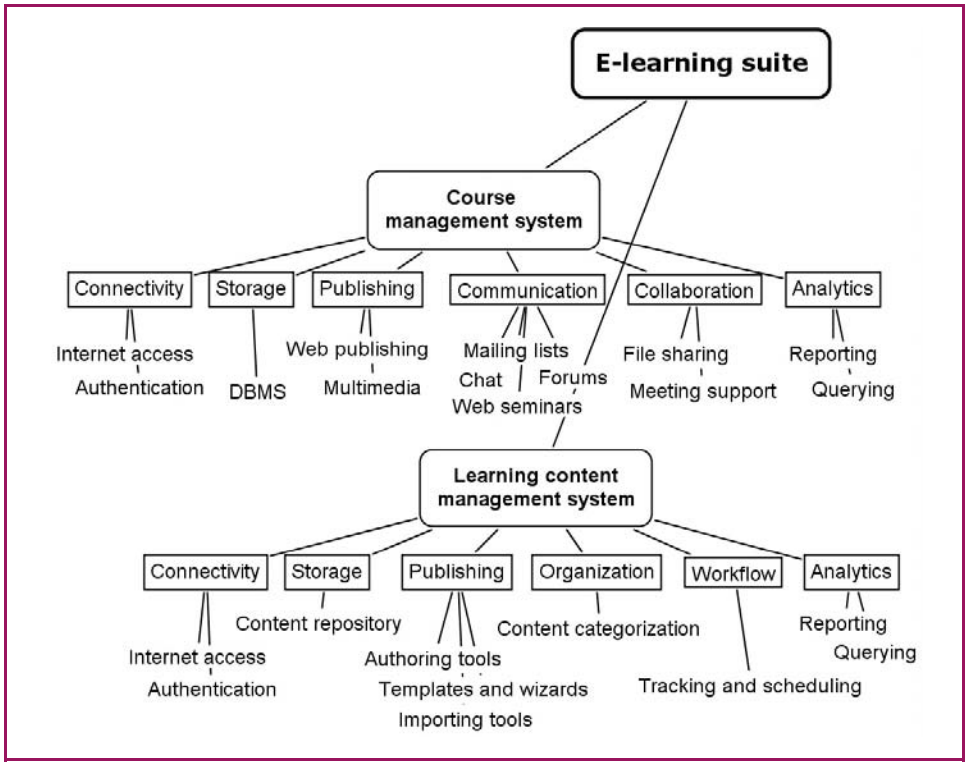
A third type of study proposes the development of integrated platforms for KM. These suggest layered architectures that provide the infrastructure required for a complete set of knowledge processes and activities (Tiwana, 2002; Luan and Serban, 2002; Lindvall *et al.*, 2003; Maier, 2004). Layered architectures are a standard way by which information and communication technology in general are implemented, and a KM system architecture provides indications on how to integrate different types of technologies among themselves and into the existing infrastructure. A major contribution from this approach is the distinction between component technologies and systems. The notion of integration is a characteristic of technology in general: components are integrated into systems, which are integrated into even larger systems, and so on, in a continuous process of combination and association (Figure 3). This distinction is critical for a proper understanding of KM technologies.

A fourth type of study focuses on technology selection from a managerial point of view. These relate KM technologies to business needs, and classify them according to business applications (Binney, 2001; Tsui, 2003). The focus is on the function KM technologies perform in the organizational context, and they are grouped according to the kind of support they provide to business: operations, decision making, asset management, process improvement, innovation, and so on. A major contribution from this type of approach is the distinction between generic KM applications, which can be used throughout the organization, and domain-specific ones, which are designed to work in particular functions or processes like customer service, strategic planning, or engineering. This distinction is also important for an adequate understanding of KM technologies.

Basic categories of KM technologies

The analysis of existing approaches to identify, describe, and organize KM technologies reveals that the usual approach relating them to knowledge processes is problematic. It also provides some useful criteria for distinguishing and explaining them: one is the distinction between component technologies and systems, and the other is the distinction between domain-independent, generic KM applications, and domain-specific, business-driven ones.

Figure 3 Technology as systems, subsystems and components



Their combination yields three main categories which can be used to differentiate KM technologies: component technologies on one side, and KM systems on the other. KM systems, in turn, can be divided into generic KM applications, and business-driven ones. These three categories form the structure of the ontology.

KM technologies according to strategy

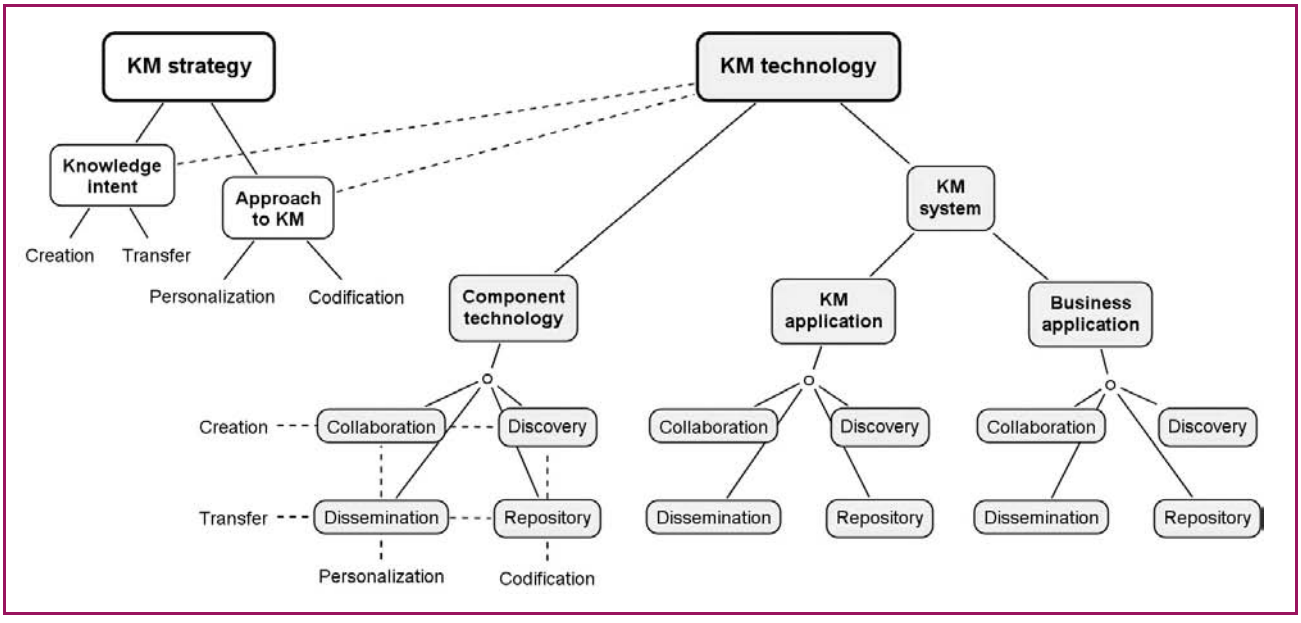
The review of previous studies on technologies' supporting role to KM revealed three basic categories of KM technologies: component technologies, the building blocks of KM systems; KM applications, the generic KM systems; and business applications, the business-driven ones. Furthermore, it showed that understanding KM technologies in terms of knowledge processes can be misleading, since those processes are heavily context-related and dependent on subjective interpretation. We suggest instead explaining them in terms of the four types of support to strategy uncovered in the review of KM strategy.

An analysis of the conceptual map of KM strategy depicted in Figure 1 reveals that the key concepts regarding the strategic use of KM technologies are knowledge intents, approaches to KM, and KM initiatives. The map shows that KM technologies are implemented in the context of KM initiatives, which, if strategically designed, adopt a particular approach to KM to achieve specific knowledge intents. Two prominent approaches to KM are personalization and codification, and two generic knowledge intents are knowledge creation and transfer. These approaches and intents can be combined to further describe each of the three basic categories of technologies according to the following types:

- *Collaboration* technologies, supporting the creation of knowledge according to a personalization approach.
- *Dissemination* technologies, supporting the transfer of knowledge according to a personalization approach.
- *Discovery* technologies, supporting the creation of knowledge according to a codification approach.
- *Repository* technologies, supporting the transfer of knowledge according to a codification approach.

The structure of the resulting ontology is shown in Figure 4. Next, we present a survey of existing KM technologies according to the proposed ontology.

Figure 4 Structure of the ontology of KM technologies



Component technologies

A comprehensive survey of technologies is a challenging task, since their quantity and variety is astounding. Their integration in multiple levels makes the task even more difficult. We present below a fairly extensive list of component technologies, grouped according to functionality to facilitate understanding. Some of the technologies are fairly common and widespread in organizations, and we could term them infrastructure technologies. Others are more specific, sometimes implemented transparently in other applications, and a few of them are cutting-edge, innovative ones:

- *Storage*. Databases, repositories, file-servers, data warehouses, data marts, etc.
- *Connectivity*. Internet, security, authentication, wireless networking, mobile computing, peer-to-peer, etc.
- *Communication*. E-mail, mailing lists, discussion groups, chat, instant messaging, audio/video conferencing, web seminars, voice over IP, etc.
- *Authoring*. Office suites, desktop publishing, graphic suites, multimedia, etc.
- *Distribution*. Web, intranets, extranets, enterprise portals, personalization, syndication, audio/video streaming, etc.
- *Search*. Search engines, search agents, indexing, glossaries, thesauri, taxonomies, ontologies, collaborative filtering, etc.
- *Analytics*. Querying, reporting, multi-dimensional analysis (on-line analytical processing, OLAP), etc.
- *Workflow*. Process modeling, process engines, etc.
- *E-learning*. Interactive multimedia (computer-based training, CBT), web seminars, simulations, learning objects, etc.
- *Collaboration*. Calendaring, file sharing, meeting support, application sharing, group decision support, etc.
- *Community*. Community management, web logs, wikis, social network analysis, etc.
- *Creativity*. Cognitive mapping, idea generation, etc.
- *Data mining*. Statistical techniques, multi-dimensional analysis, neural networks, etc.
- *Text mining*. Semantic analysis, Bayesian inference, natural language processing, etc.
- *Web mining*. Collaborative profiling, intelligent agents, etc.
- *Visualization*. 2D and 3D navigation, geographic mapping, etc.
- *Organization*. Ontology development, ontology acquisition, taxonomies, glossaries, thesauri, etc.
- *Reasoning*. Rule-based expert systems, case-based reasoning, knowledge-bases, machine learning, fuzzy logic, etc.

These myriad technologies can support KM in multiple ways, fitting more than one of the collaboration-dissemination-discovery-repository categories. In Figure 5, we present the functional groupings according to their most relevant types of support to strategy.

Knowledge management applications

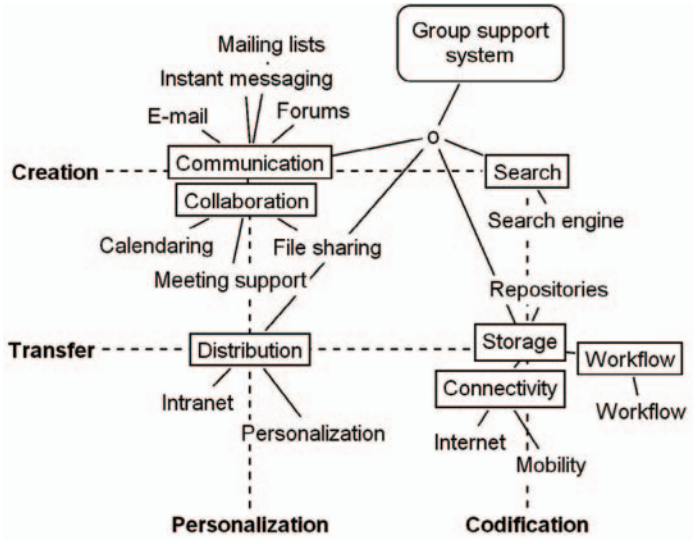
KM applications usually integrate numerous component technologies into systems with well defined functionality. Component technologies are from any of the strategic contribution quadrants, not necessarily the same as the intended system (Figure 6). We describe next the main KM applications found in the survey:

- *Document management*. Automate the control of electronic documents through their entire life-cycle. Provide functions such as store and archive, categorization,

Figure 5 KM component technologies according to the type of support for strategy

	Personalization	Codification
Creation	*Collaboration* **Connectivity** **Communication** **Authoring** **Collaboration** **Community** **Creativity** **Workflow**	*Discovery* **Storage** **Search** **Analytics** **Data mining** **Text mining** **Web mining** **Visualization**
Transfer	*Dissemination* **Connectivity** **Communication** **Authoring** **Distribution** **E-learning** **Collaboration** **Community**	*Repository* **Connectivity** **Storage** **Authoring** **Search** **Workflow** **Organization** **Reasoning**

Figure 6 Component technologies integrated into KM applications



navigation and search, versioning and access control. Some have imaging functions that allow the digitalization of paper documents.

- *Content management*. Manage the whole Web publishing process. Manage authors and the content creation process, separate content from layout for standardized output, support multimedia repositories, automatic page-generation via templates, and staging of new content.
- *Process management*. Also known as workflow, automate the flow of tasks and information across business processes. Include workflow engines for handling cases, and tools for modeling processes, accessing external applications, and monitoring and managing operations.

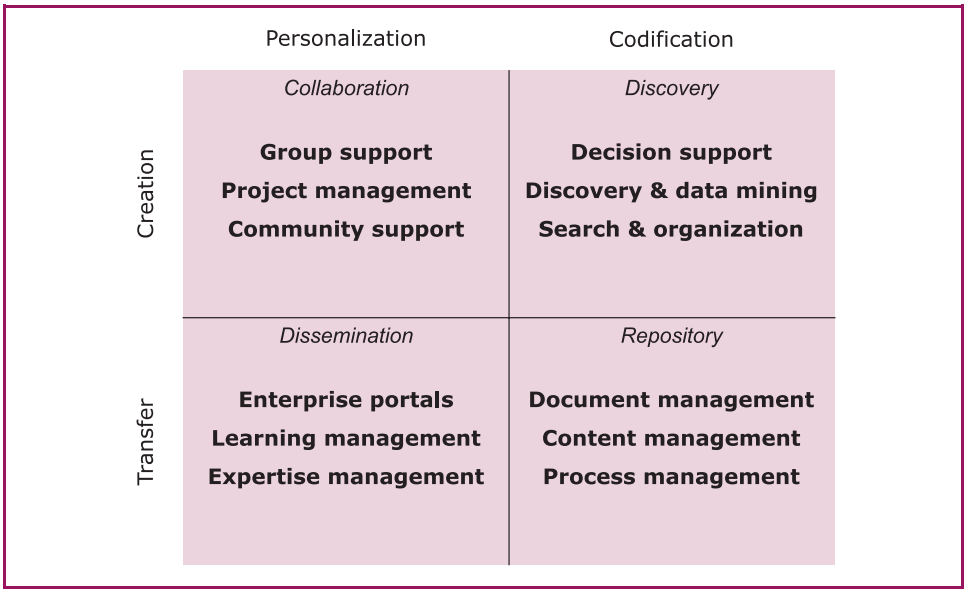
- *Group support*. Also known as groupware, support the work of groups and teams. Include tools for communication (both synchronous and asynchronous), coordination (like calendaring, meeting support and workflow), and collaboration (file repositories, group decision making).
- *Project management*. Support the management of project activities and resources. Include functions for defining and organizing activities and tasks, assigning responsibilities and deadlines, allocating personnel and other resources, and identifying milestones, critical paths and constraints.
- *Community support*. Coordinate interaction in large groups. Include tools for communication and interaction, both synchronous and asynchronous, management of participation levels, including leading and facilitating roles, identity profiling, and collective decision making.
- *Decision support*. Also known as business intelligence, integrate a series of tools for decision making. Include query and report of operational data, managerial dashboards like the balanced scorecard, and decision models and techniques for structured and unstructured situations.
- *Discovery and data mining*. Support the identification of patterns and associations in large amounts of data, including tools for cleaning and organizing data into data warehouses, and a series of analytical techniques and visualization tools. Used in a variety of domains, from finance, to customer behavior, to web navigation.
- *Search and organization*. Facilitate access to and organize unstructured content. Identify key words and topics in documents from varied sources, generate indexes and taxonomies automatically, categorize documents in topics according to relevance, and use domain-specific ontologies for specialized classification.
- *Enterprise portals*. Integrate access to a wide range of information and systems at a single point of entry. Allow controlled access to operational and managerial applications, and personalized presentation of content, along with workflow management, communication and collaboration.
- *Learning management*. Support the development and delivery of online courses in a variety of formats, from individual self-paced to group-based instructor led. Include functions like content creation and management, communication and interaction, and assessment and performance reporting.
- *Expertise management*. Provide expertise brokerage in large communities. Include functions like identification and profiling of experts, communication tools for questioning and answering, rating of answers and experts, and repositories for reusing contributions.

KM applications fit the strategic contribution quadrants better than component technologies. Although each type of KM application has some functionality that fits other quadrants, the main purpose and core function of the application best suits one of them (Figure 7). Commercial solutions available in the market, though, are offering full-featured KM suites that integrate several KM applications, reflecting the incessant trend toward higher levels of integration.

Business applications

KM systems may also focus on specific business processes and functions. KM functionality has usually been included as modules of the larger integrated enterprise systems that have conquered organizations during the last decade. The first of these was called enterprise resource planning (ERP), and offered integrated control of all operations, from purchasing to manufacturing to sales, including back-office functions like finance and human resources. Soon after came customer relationship management (CRM), integrating marketing, sales and customer service; supply chain management (SCM), integrating suppliers, manufacturers and retailers in the supply chain; and more recently, business intelligence (BI), integrating managerial control and decision making (Turban *et al.*, 2002).

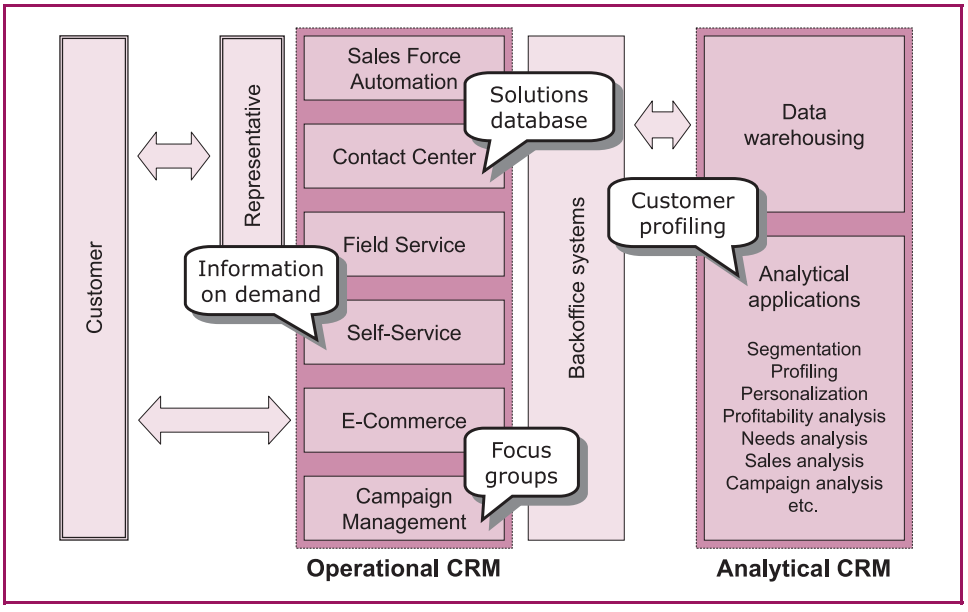
Figure 7 KM applications according to the type of support for strategy



These large integrated enterprise systems are not KM systems *per se*, but include KM functionality in some of their modules and subsystems. A complete CRM suite, for example, presents KM functionality in all four strategic-contribution quadrants (Figure 8):

- *Repository* application: a customer representative at the contact center offers customer service using scripted responses for typical cases, which are collected in a database an updated as new problems and solutions arise.
- *Discovery* application: analytical CRM collects information from all points of contact (sales, contact center, web site) into a data warehouse, allowing analysis and data mining for customer profiling and segmentation.

Figure 8 KM functionalities in a customer relationship management system



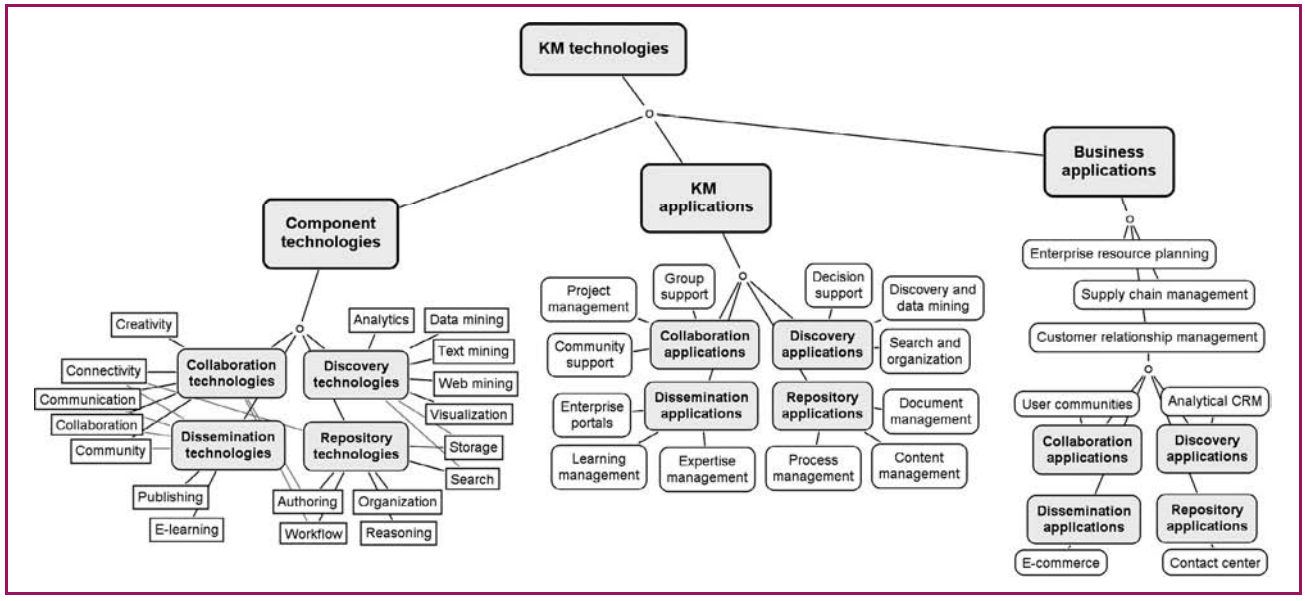
- *Dissemination* application: an e-commerce web-site works much like a corporate portal, offering personalized information and e-mail alerts, along with access to some back office systems like inventory, logistics, and accounts receivable.
- *Collaboration* application: the marketing department may take advantage of user communities or discussion groups to conduct market research, conducting focus groups over the Internet for detecting consumer preferences or testing concepts.

KM functionality in business applications, therefore, is always tied to a particular knowledge domain, usually represented by a business process or organizational function. Thus, it is not possible to categorize the business applications themselves in the strategic-contribution quadrants, only specific modules and functions. Figure 9 shows the complete ontology with the KM technologies identified in the survey. Since component technologies are too numerous, only the functional categories are included.

Conclusions

In this paper, we sought to describe KM technologies according to their support for strategy. By following an adapted method for designing ontologies, we explored two sub-domains of the KM field: KM strategy and KM technologies themselves. Our findings can be summarized in three main points. First, we found three different meanings associated with the term KM strategy: approaches to KM, or ways of managing knowledge that reflect particular conceptualizations of it; knowledge strategies, or business strategies that seek competitive advantage based on knowledge; and KM implementation strategies, or general plans providing guidelines for designing and implementing KM initiatives. Second, we found that the usual association of technologies with knowledge processes in the existing literature is inadequate for explaining their relationship with business strategy. A better alternative is to associate them with KM initiatives based on particular knowledge strategies and approaches to KM. The literature identifies two generic knowledge strategies, creation and transfer of knowledge, and two prominent approaches to KM, personalization and codification. Third, we found that technologies used for KM can be integrated in multiple different levels. Some of them are used mainly as part of larger systems, while others are adopted as fully functional applications. Also, KM applications are either generic KM systems that can be adapted to a range of business functions, or specific business-oriented systems that offer some KM functionality. Thus, we propose the classification of KM technologies into three main types: component technologies, the building blocks of KM

Figure 9 A strategy-based ontology of KM technologies



systems; KM applications, the generic KM systems; and business applications, the business-driven ones.

The main theoretical contribution of this study is an ontological framework linking technologies, KM and strategy. It includes two main parts: a conceptual map describing the key concepts related to KM strategy and their inter-relationships (Figure 1), and an ontology of KM technologies, grouping them according to type of support for strategy (Figure 9). As implications for research, we suggest that a contingency approach focusing on KM initiatives may be useful to explain how KM technologies can support strategy. KM initiatives naturally follow specific approaches to KM, and may or may not support particular knowledge strategies. Further research may be conducted to identify and describe exemplary KM initiatives that connect specific knowledge intents (e.g. new product development, customer profiling and segmentation, operational processes improvement) to typical KM approaches and technologies.

As implications for practice, we argue that the conceptual map on KM strategy can help managers in the design of particular, context-specific KM strategies, pointing to the key elements that must be considered and indicating how they influence one another. The ontology of KM technologies, on the other hand, can help in the selection of KM technologies suiting particular KM initiatives, once the knowledge intent and the approach to KM are known. And finally, the ontology also indicates three alternative modes for the adoption of KM technologies. An organization implementing a KM solution can choose among: developing custom KM systems from available component technologies; purchasing off-the-shelf domain independent KM applications that provide the required functionality; or purchasing off-the-shelf domain-specific business applications that embed KM functionality. The actual selection of KM technologies and mode of adoption depends on many factors not included in the ontology, like existing infrastructure, application portfolio, urgency, and budget, to cite but a few. Notwithstanding, the ontology provides useful guidance for practitioners, either by suggesting appropriate combinations of technologies, in the case of in-house development, or by offering purchasing criteria for adequate selection of commercial alternatives.

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