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Abstract

In recent years, e-collaboration systems have emerged as an essential enabler of communication and collaboration within and between enterprises. Current trends in the area of e-collaboration emphasize the importance of effective collaborative knowledge management support in e-collaboration systems. Our research aims at proposing an intelligent infrastructure for the reconciliation of knowledge management and e-collaboration systems. We introduce a conceptual framework for designing and building the new infrastructure that supports specific characteristics of collaborative knowledge management in e-collaboration systems. The paper articulates how this framework enables efficient knowledge exploration and exploitation, and concludes with implications and recommendations for future developments in this area.

Keywords: E-collaboration systems, Knowledge management systems, Collaborative knowledge management, Conceptual framework, Information-driven.

1 Introduction

The advent of the World Wide Web and, more broadly, the development of information and communication technologies have contributed to increase online collaboration between organizations across virtually all industrial sectors around the globe. Consequently, e-collaboration systems have emerged as an indispensable infrastructure for facilitating communication and collaboration as well as strengthening relationships between enterprises (Bafoutsou and Mentzas, 2002). Collaborative services such as e-mail, instant messages and document sharing are useful applications on the Internet for exchanging ideas, documents and knowledge-artefacts between enterprises, especially networked organizations.

Although e-collaboration systems are becoming a common workplace for enterprises, there is still little focus on collaborative knowledge management, so that enterprises could generate more value from their knowledge-based assets (Jones, 2001). We believe that collaborative knowledge management initiatives are indispensable for future e-collaboration systems in order to effectively support innovation and organizational learning. For this reason, our research aims at proposing an intelligent infrastructure for the reconciliation of knowledge management and e-collaboration systems.

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The objective of this paper is to introduce a conceptual framework for designing and building a new infrastructure that supports specific characteristics of collaborative knowledge management in e-collaboration systems.

The paper is structured as follows. First, we briefly introduce the conceptual foundation for the reconciliation of knowledge management and e-collaboration systems. We then present the *information-driven knowledge management* (IDKM) framework that includes two complementary processes: knowledge exploration and knowledge exploitation. An illustrative example shows that the proposed framework is pertinent and efficient. Finally, we draw a conclusion and outline future research directions.

2 Conceptual foundation

First, we briefly introduce the basic concepts related to e-collaboration and knowledge management systems. We then present the main limitations of existing methods in knowledge management along with new insights pertaining to knowledge management requirements for e-collaboration systems. On this basis, we recommend an intelligent infrastructure for collaborative knowledge management.

2.1 E-collaboration systems

This section discusses the concepts of e-collaboration and e-collaboration systems. "E-collaboration" is defined as collaboration using electronic technologies among different individuals to accomplish a common task (Kock and D'Arcy, 2002). It is often referred to as computer-mediated communication or computer-supported cooperative work.

An "e-collaboration system" is a computerized system or software which is designed to help individuals and organizations involved in a common task in order to achieve specific goals. E-collaboration is considered as an area of both research and industrial development and can be conceptualized as encompassing six basic elements: the collaboration tasks, e-collaboration technology, individuals involved in collaborative tasks, the mental schemas possessed by these individuals and the physical and social environments that surround them (Kock, 2005). Consequently, research on e-collaboration should place special emphasis on the importance of structuring activities to module electronic communication during e-collaboration, in order to bridge cultural gaps as well as different assumptions in social groups (Rutkowski et al., 2002).

Several studies have evaluated and proposed several classifications of e-collaboration systems. Malone and Crowston (1994) were first to define a taxonomy based on dependencies between participants and coordination processes used to manage those dependencies. A variety of dependencies are analyzed and identified, such as managing shared resource, managing producer/consumer relationships, managing simultaneity constraints, and managing task/subtask dependencies. Ellis (2000) provided a framework for classifying e-collaboration systems based on three conceptual elements: a technology space (T-Space), an interaction space (I-Space), and a set of fuzzy mappings between these spaces. For their part, Bafoutsou and Mentzas (2002) introduced a classification of e-collaboration systems based on four categories: Group file and document handling, Computer conferencing, Electronic meeting systems, and Electronic workspace. Each category of e-collaboration systems may use one or several collaborative services.

2.2 Knowledge management systems

"Knowledge management systems" (KMS) refer to a class of information systems that is applied to manage organizational knowledge (Alavi and Leidner, 2001). In other words, KMS are information systems built upon the knowledge infrastructure that support and enhance the activities of knowledge management. Now, there are two basic concepts related to such system, namely knowledge and knowledge infrastructure.

"Knowledge" is defined as '*information possessed in the mind of individuals related to facts, procedures, concepts, interpretations, ideas, observations, and judgments*' (Alavi and Leidner, 2001). Here we review the relation between data, information and knowledge: information is defined as data processed to be useful and knowledge refers to the application of data and information. The transformation from data to information and from information to knowledge varies along some dimensions such as context, usefulness, or interpretability.

Knowledge classifications are often based on knowledge components or tacit-explicit knowledge. According to the *knowledge-component classification*, there are different types of knowledge such as know-what (declarative), know-how (procedural), know-why (causal), know-when (conditional) and know-with (relational) (Garud, 1997). According to the *tacit-explicit knowledge classification*, there are two types of knowledge: tacit and explicit (Nonaka, 1994). Tacit knowledge is comprised of both cognitive and technical elements referring to an individual's knowledge and expertise, while explicit knowledge is articulated, codified and communicated in a symbolic form and/or a natural language.

Knowledge management approaches often focus on exposing individuals to potentially useful information and on facilitating assimilation of information, and generally include four basic activities: creating, storing, transferring and applying knowledge (Alavi and Leidner, 2001). Their purpose is to allow enterprises to leverage their information resources and knowledge assets by remembering and applying experiences (Watson, 2003; Ergazakis et al., 2005). For this reason, the objectives of knowledge management approaches are to make knowledge visible, to show the role of knowledge in organizations, to develop a knowledge-intensive culture, and to build a knowledge infrastructure (Davenport and Prusak, 1998).

"Knowledge infrastructure" for enterprises includes three facets: the structure, the culture and the system (Beijerse, 2000; Chan and Chao, 2008). The structure facet of a knowledge infrastructure aims at allowing individuals to render their knowledge productive; the culture facet aims at motivating people to share their knowledge; and the system facet aims at transforming information into knowledge.

2.3 Collaborative knowledge management

Collaborative knowledge management refers to knowledge management in a collaborative environment within and between organizations. Collaborative knowledge management allows individuals to share documents, make comments, engage in discussion, create schematic diagrams, and thus provides valuable support to organizational learning (Jones, 2001). In the context of a network of enterprises, a network member who shares knowledge with other members gives value to that knowledge for the network as a whole. In this paper, we use the term 'knowledge attribute' to address the characteristics of collaborative knowledge management. Understanding the characteristics of knowledge and knowledge artefacts used and produced in e-collaboration systems provides a basis for the framework to support collaborative knowledge management. E-collaboration systems serve not only as a container for data, information and knowledge but also importantly as a tool for knowledge co-creation and sharing. Based on our observation and involvement in the development of e-collaboration systems, we propose four key attributes of collaborative knowledge management: scope, orientation, evolution, and decentralization.

The *scope knowledge attribute* clarifies the focus of an e-collaboration system. Most e-collaboration systems tend to narrow their focus down to a subset of topics in order to achieve a specific competitive advantage (Rosenzweig, 2009). They are usually purpose-built to concentrate on a specified scope of knowledge pertinent to a community of participants. The heterogeneity of the participant base may be high and includes diverse types of users such as engineers, technicians, professionals and the general public, and thus provides an opportunity for the development of rich knowledge in specified areas of common interest. E-collaboration systems may be tailored to certain areas of business activities; they may serve in part as intranets and have more restricted flows of external knowledge or be more opened to support the widespread trend towards inter-organizational collaboration (Wang, 2005). In this sense, each e-collaboration system has a policy that may range on a continuum from fully open to highly restricted access that will, of course, significantly influence knowledge generation and sharing.

The *orientation knowledge attribute* relies on the exploration *vs.* exploitation dichotomy that is broadly used in the fields of organisational learning and strategy (March 1991). For example, the academic culture has an orientation towards exploration, and is likely to engender more openness and collaboration in knowledge exchange. On the other hand, an orientation towards exploitation, which is common in commercial activities, may incite collaborators to be more selective in knowledge co-creation and sharing. As such, e-collaboration systems may have different orientations, whether exploratory (focusing on pre-competitive issues) or exploitation (focusing on competitive matters); therefore, these orientations will tend to enable or restrict creation and sharing of knowledge within a system.

The *evolution knowledge attribute* monitors the gradual development of an e-collaboration system. Recent studies show that e-collaboration evolves from intra- to inter-organizational collaboration, from vertical to horizontal collaboration and from operational to strategic collaboration (Wang, 2005). Correspondingly, this implies an evolutionary nature for knowledge in e-collaboration systems and therefore contributes to support the development of dynamic capabilities within organizations (Teece et al., 1997). Any view of the system offers a snapshot of the knowledge available at a point in time, and dynamic systems involve users who take part in enhancing this knowledge base over time through collaboration.

The *decentralization knowledge attribute* concerns the way an e-collaboration system opens access to its pool of knowledge resources. As these are often created in a bottom-up approach (i.e. by the users) such systems also typically entail relatively modest control mechanisms, as these come at the cost of flexibility and can constrain users' ability to interact with the system (Harris, 2009). The accuracy and reliability of knowledge depends heavily on the user base and tend to be organized, developed and monitored in a highly decentralized manner. Topic experts may monitor areas of knowledge and apply a certain degree of control on the input of participants, but practices will vary from one system to another, and, by their nature, e-collaboration systems are designed to enable the creation and consumption of knowledge in a decentralized manner (Harris, 2009).

2.4 Intelligent infrastructure for collaborative knowledge management

As was observed in the different e-collaboration system classifications, these systems often concentrate on providing collaborative services (Malone and Crowston, 1994; Ellis, 2000; Bafoutsou and Mentzas, 2002). There is comparatively less focus on the support of collaborative knowledge management in e-collaboration systems (Jones, 2001; Dustdar, 2004; Cricelli and Grimaldi, 2010). Furthermore, current e-collaboration systems are more oriented towards knowledge exploitation than knowledge exploration (Szulanski, 2000; Sarker et al., 2005, Paroutis and Al Saleh, 2009; Grace, 2009).

Indeed, most critical problems faced by e-collaboration systems result from a lack of appropriate mechanisms for knowledge exploration in creating, organizing and then accessing efficiently knowledge resources (Bechky, 2003). Consequently, when an enterprise has used its e-collaboration systems for a rather long time, it becomes harder to find the right information at the right time. Moreover, there are other important challenges in transferring knowledge within networks of enterprises, such as differences in language, locus of practice, and conceptualization of the product (Bechky, 2003). Consequently, there are five types of problems constituting failures of knowledge transfer in a network: failure to communicate and retain contextual information, unevenly distributed information, difficulty communicating and understanding the salience of information, differences in speed of access to information, and difficulty interpreting the meaning of silence (Crampton, 2001).

Therefore, there is a need for a hybrid infrastructure that concurrently provides collaborative services and concentrates on effective collaborative knowledge management. It is the reason why we suggest an intelligent infrastructure for the reconciliation of knowledge management and e-collaboration systems. This reconciliation aims at identifying and capturing specific knowledge components produced and used by participants, and at describing how they are transferred and applied in the network. To obtain superior performance from a network, both knowledge exploration and exploitation need to take place simultaneously.

3 Information-Driven Knowledge Management Framework

The main objective of the *information-driven knowledge management* framework (IDKM), proposed in this study, is to support the reconciliation of knowledge management and e-collaboration systems. As in Figure 1, the collaborative services and knowledge management activities co-exist and work together in a coherent manner.

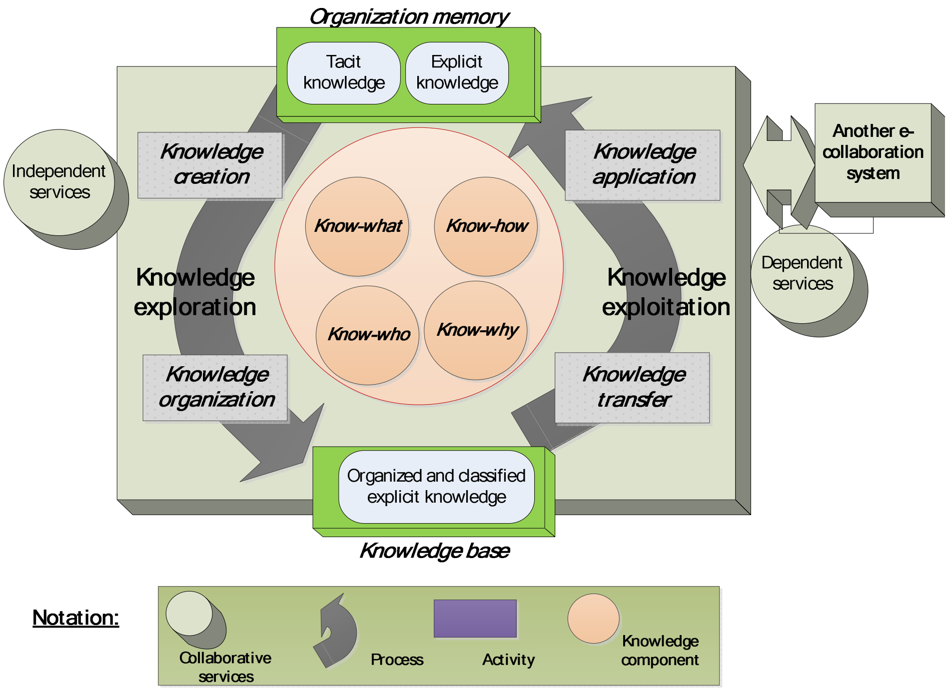

Figure 1. Overall structure of an IDKM based e-collaboration system

Referring to e-collaboration systems, an e-collaboration system based on the IDKM framework is a transparent box that provides different collaborative services. There are two types of collaborative services: independent and dependent services. Dependent services need cooperation with other e-collaboration systems for their realization. According to Bafoutsou and Mentzas (2002), here are these collaborative services: Bulletin board, Discussions, E-mail, E-mail notifications, Online paging/messaging, Chat, Whiteboard, Audio/video conferencing, Task list, Contact management, Screen sharing, Surveys/polling, Meeting minutes/records, Meeting Scheduling tools, Presentation capacity, Project management, File and document sharing, Document management, and Synchronous work on files/documents. Collaborative services may integrate different e-collaboration systems in order to enable the exploration and exploitation of knowledge in a decentralized manner. Each collaborative service uses and produces contents of the e-collaboration systems, which are considered as knowledge resources.

Referring to knowledge management systems, the IDKM framework requires the support of all knowledge management processes (knowledge exploration and knowledge exploitation) as well as two knowledge classifications (knowledge components and tacit-explicit). Knowledge exploration means creating and storing knowledge through individual's cognitive processes (tacit knowledge) or collaboration processes (explicit knowledge) (Nonaka, 1994; Alavi and Leidner, 2001). Knowledge exploitation means enhancing the intellectual capital of an enterprise with existing knowledge in the knowledge base (Choo and Bontis, 2002). The process of knowledge exploration concerns the creation and organization of different knowledge (tacit and explicit) in the organization memory; meanwhile, the process of knowledge exploitation concerns the transfer and application of classified and organized explicit knowledge in the knowledge base (Figure 1).

Referring to collaborative knowledge management in e-collaboration systems, we use the classification proposed by Garud (1997) because its different knowledge components would help enterprises to overcome the challenges faced today as mentioned in Bechky (2003). For instance, know-what knowledge component is used for overcoming the difference in language; know-how knowledge component for overcoming the locus of practice; and know-why knowledge component for overcoming the issue related to the conceptualization of the product. Each content as a knowledge resource will be assigned to one or a subset of knowledge components. Knowledge components will be classified and organized according to their scopes which are described by 'semantic contexts'. The IDKM framework provides the mechanisms to specify the interrelations between knowledge components. The knowledge structure encompasses knowledge components and their interrelations and helps to manage and enhance knowledge resources in a coherent manner. Each knowledge component will be linked to one or several contents stored in e-collaboration systems. Furthermore, the way participants work together, called overlap protocols in our approach, will clarify the roles and responsibilities of each member based on the information dependencies between them.

From outside, an IDKM e-collaboration system provides a set of dependent and independent collaborative services. From inside, this system supports a set of activities of knowledge management that manage the content used and produced by collaborative services and their corresponding knowledge components. Enterprises may adapt these activities and knowledge components to conform to their particularities (i.e. scope, orientation, evolution and decentralization).

From our viewpoint, the most important characteristics of knowledge management systems are information-driven. Information defines what data will be processed to be useful and can be transformed into knowledge. It is the reason why our framework is based on information and its name begins with "information-driven". In the following, we point out the key concepts representing knowledge components based on the static, dynamic, rules, organizational and collaboration aspects of information (Le Dinh & Pham Thi, 2012). The major part of these concepts can be found in the literature of information modelling, especially the object-oriented paradigm (Rumbaugh et al., 1998). There are also new concepts such as those related to the rule, the organizational and the collaboration aspects. Moreover, in our framework, we are able to specify intra- and inter- relationships between concepts of different aspects at a coherent manner.

Understanding the knowledge attributes, knowledge management activities and knowledge components provides a basis for understanding and applying the IDKM framework to manage knowledge in e-collaboration systems. We now introduce the framework according to its four main activities: knowledge creation, organization, transfer and application.

3.1 Knowledge creation

The objective of knowledge creation is to develop new contents or to improve old contents within the organization's knowledge. Knowledge resources created by this activity are represented by know-what, know-how and know-why knowledge components.

The "know-what" describes knowledge artefacts known in e-collaboration systems, which relate to a phenomenon of interest. Know-what is often generated through 'learning-by-using' (Garud, 1997). In a network, know-what often refers to collaborative products and services. For instance, a classification of products according to network members' votes would indicate which are of higher or lower relevance and form a basis of 'know-what' in an e-collaboration system. Such a classification could also be made explicit through automated mechanisms that would present documents accessed and provide information to users in terms of papers that may be of interest, for example. In the IDKM framework, the know-what is represented by the structure of information that describes what types of information exist, their substructure, as well as their interrelations. The key concept of this aspect is the concept of classes. A *class* is defined as an object type and a set of objects of this type. An *attribute* of a class is a function corresponding to every object of this class and to a set of objects of other classes. A class can define its *subclasses*, whose interpretation is the subset of objects of its super-class for which the dynamic specialization condition is evaluated to be 'true'.

The "know-how" describes the understanding of the generative processes that constitute phenomena. This knowledge component is generated through 'learning-by-doing' whereby knowledge about how to perform a process accumulates with experience overtime (Garud, 1997). Know-how knowledge components in e-collaboration systems are usually related to logistics, production, sale, and delivery of products and services. This type of knowledge can be particularly valuable as it involves taking knowledge that is usually tacit or unknown to certain users and making it explicit and therefore, knowable for these users. For example, in research-oriented systems, it could be represented in the form of explicit description and sharing of research artefacts such as exact methods, steps (and even apparatus) to reproduce experiments. In our approach, know-how corresponds to the transition of information. The key concept of the dynamic aspect is the concept of processes. A *process* performs a transformation of information that invokes a set of methods and changes a set of dynamic states. *Dynamic states* of an object are situations during which certain functions are made available. A *method* of a class performs a specific function.

The "know-why" describes the understanding of the principles underlying phenomena that is obtained through 'learning-by-studying'. This process involves experimentation and simulation to understand the principles and theories underlying the function of a system (Garud, 1997). In a network of enterprises, the know-why knowledge component often refers to business rules that are put in place to help an enterprise achieve its business goals. Rules can apply to deliverables, processes, people, and behaviour of systems. In e-collaboration systems, they could be extracted collectively through various hypermedia and communication tools such as discussion forums, blogs, text and video chat. In the IDKM framework, the know-why aims at guaranteeing the coherence of information. The key concept of this aspect is the concept of rules. Such *rules* represent the business rules of an organization. The *scope* of a rule represents the semantic context within which it operates. The *risks* of a rule relate to a potential incoherence in the information.

3.2 Knowledge organization

Knowledge organization, also referred to as knowledge storage, aims at forming the organization memory, which itself includes semantic and episodic memories (Alavi and Leidner, 2001). *Semantic memory* refers to general, explicit and articulated knowledge. *Episodic memory* refers to context-specific and situated knowledge. The IDKM framework uses the two concepts of the organizational aspects of information for knowledge organization: semantic unit of information and responsibility zone. A semantic unit of information covers a coherent subset of knowledge components to represent the organization memory. A responsibility zone (RZ) represents a know-who knowledge component.

A "semantic unit of information" depicts a context of knowledge application that includes a coherent representation of all the structure, the transition and the coherence of information within an organization, or a unit of an organization. Each semantic unit has a particular goal. Each organization potentially has many different semantic units. In e-collaboration systems, collaborative services use and produce contents, such as linked wiki pages, messages, and audio, video and document files. Therefore, the semantic memory is stored as a set of contents. Each content must specify the subset of knowledge components to which it corresponds.

The "know-who" refers to either groups or individuals who may provide resources or be knowledgeable about a knowledge component. The degree to which know-who knowledge components in an organization can be accessed will be a reflection of its culture and policies. The concept that represents the know-how knowledge component is the responsibility zone (RZ) concept. A *responsibility zone* is a part of an organization that assumes a responsibility for information inside a semantic unit. In the context of a network of enterprises, a responsibility zone may correspond to an individual, a group, or an organization (Sarker et al., 2005).

3.3 Knowledge transfer

Knowledge transfer may occur at different levels and in different ways: transfer of knowledge between individuals, from individuals to explicit sources, from individuals to groups, between groups, across groups, and from groups to the organization (Alavi and Leidner, 2001; Sarker et al., 2005).

There are five basic elements that can potentially influence the transfer of knowledge: channel, message, context, recipient, and source (Szulanski, 2000). Channels, such as such as discussion forums and chat, are used by individuals or groups. Messages exchanged in the network vary in terms of length, synchronicity and contents. Contexts are based on the way inter-organizational teams work. Recipients are remote groups for each focal source. In the IDKM framework, shared objects are artefacts transferred between participants. They are used and produced by collaborative services such as messages, wiki pages, forum postings, and files. Operations on a shared object are indeed operations on contents such as creation, modification and deletion. The IDKM framework uses the information dependencies between participants to determine the way of working together in the network. Information dependencies are represented by concepts of the collaborative aspects of information such as overlap situations and overlap protocols.

An “overlap situation” occurs when there is at least one shared object that is common between different responsibility zones. There are possibly two types of overlap situations: i) *with borders*: there are shared objects but no shared operation, and ii) *with overlaps*: there are shared objects and shared processes performing operations on those shared objects. Overlap situations can be handled by coordination processes, called overlap protocols.

An “overlap protocol” is a protocol that not only allows each RZ to perform its own processes locally, but could be aware of the processes in other RZ that can influence its own processes. In order to support a variety of dependencies as mentioned in Malone and Crowston (1994), we propose the following overlap protocols: Ownership-based overlap protocol, Service-based overlap protocol, and Network-based overlap protocol. These protocols correspond to Hierarchy, Market and Network theories of coordination (Veryard, 1994) and will be performed according to the roles proposed by Ellis (2000). The *ownership-based overlap protocol* determines which RZ would play the role of the Keeper for each shared object. The keeper of the object takes the responsibility for creating, maintaining, and sharing it. The other RZ (as the users) may communicate with the keeper to obtain information about this object. *Service-based overlap protocol* appoints which RZ would play the role of the Coordinator for each shared object. The coordinator of the object takes the responsibility for providing services related to this object. This protocol allows other RZ (as the requesters) to send a request to the coordinator to perform an operation. A *network-based overlap protocol* allows each RZ, as a Communicator, to inform about its own operations, or to be aware of operations on a shared object performed by others RZs.

3.4 Knowledge application

The objective of knowledge application is to apply the organization’s memory to a special use or purpose. There are three primary mechanisms for knowledge application: directives, organizational routines, and self-contained task teams (Grant, 1996). *Directives* refer to the specific set of rules developed through the conversion of tacit knowledge to explicit knowledge for efficient communication. *Organizational routines* refer to the development of process specifications that allows individuals to apply and integrate their specialized knowledge without the need to communicate what they know to others. *Self-contained task teams* are teams of individuals with the prerequisite knowledge and specialization that are formed for problem solving.

The IDKM framework supports two types of mechanisms, namely directives and organizational routines. It can enhance knowledge application by facilitating the capture, updating and enforcing directives. Directives can be represented by different forms of contents used by collaborative services. Organizational routines can be represented by a set of processes embedded into e-collaboration systems so that systems themselves become examples or standards of organizational forms.

4 Illustrative example

One can take as an illustrative example a Canadian enterprise, named IS-Coordination. This enterprise provides IT services in the e-business domain (such as building an e-commerce system, setting up an intranet, or implement an enterprise system). IS-Coordination outsources some business processes to its Asian partners. In order to collaborate efficiently with its partners, the company intends to build an e-collaboration system based on open-source software.

4.1.1 Knowledge creation

In the case of IS-Coordination, there are three types of knowledge components: know-what, know-how and know-why (Section 3.1). Concerning know-what knowledge components, there are class concepts such as *Project*, *Project manager*, *Customer*, *Supplier* and *Partners*. The *Project* class has attributes such as *Start-date*, *Project type*, *Deliverable*, *Duration*, and *Estimated cost*. Each know-what knowledge component may have its object concepts. For example, the *Project* class concept may have object concepts such as *Project-A*, *Project-B* and *Project-C* (Figure 2.a).

There are some know-how knowledge components, which are represented by process concepts such as *Project defining*, *Project planning*, *Project cancelling*, *Project executing* and *Project closing*. Dynamic states of the objects of the *Project* class are *Project-started*, *Project-manager-assigned*, *Project-in-progress*, *Project-suspended*, *Project-manager-released* and *Project-Ended* (Figure 2.b). The *Project defining* process invokes the *Start-a-project* and *Appoint-a-project-manager* methods and changes to the *Project-started* and *Project-manager-assigned* dynamic states.

In our example, there is a know-why knowledge component, called *Rule-1*. This rule is related to the *Project* class concept that requires that '*the project must begin on start-date and the project manager must be appointed before or on that date'*. The scope of this rule covers the *Project* and *Project manager* class concepts. One of its risks is the modification of the *Start-date* attribute concept (Figure 2.c).

4.1.2 Knowledge organization

A semantic unit concept (Section 3.2) called '*project context*' is proposed for the e-collaboration systems of IS-Coordination. Thanks to this concept, one can access within a given project the other concepts linked to business information and knowledge about its customer and signed contract. One can also access information on the different suppliers that provide products and services for this project as well as the partner who executes the outsourced services. For example, there is a wiki page linked to the *Project* class concept which has a *Project* type as '*Building an e-commerce website*'. This wiki page describes the method and the technology used by the enterprise and its partners for building an e-commerce web site. There is also a document file linked to the *Documentation writing* process concept that contains the guidelines for manual and documentation writing.

The episodic memory of IS-Coordination includes the lessons learned after project termination. This memory depends on the specific context (such as partners, project type, customers, and/or suppliers) and is stored in discussion forums. The semantic unit of '*Project context*' is managed by the '*3R-team'* responsibility zone. There is a learned lesson in a discussion forum linked to this semantic unit that is specified as '*Building an e-commerce web site for a retail shop with a fixed price: a lesson learned'* (Figure 2.d).

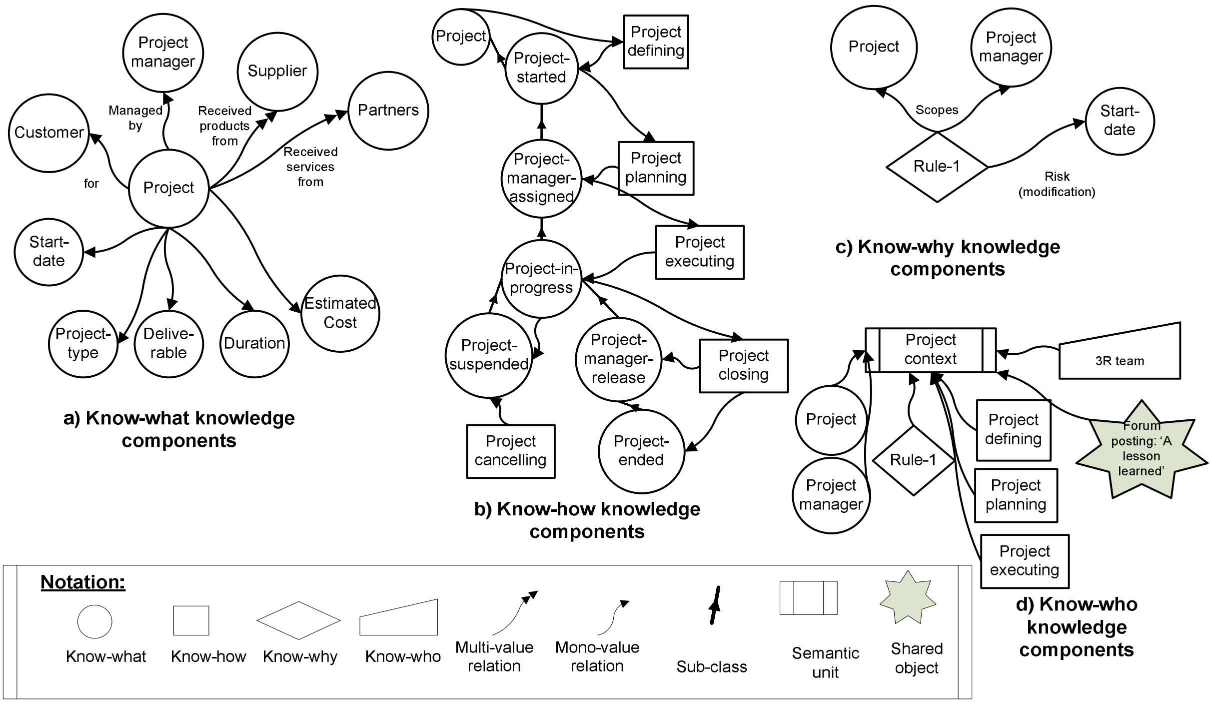

Figure 2. Examples of know-what, know-how, know-why and know-who knowledge components.

4.1.3 Knowledge transfer

One may ascertain how IS-Coordination shares its knowledge resources with its partners. Firstly, there is a partner, called the XYZ partner, that is interested in the document file that contains the guidelines for a '*Documentation writing'* process. This is a *with-borders overlap situation* (Section 3.3) because only IS-Coordination can operate on this file. The *ownership-based overlap protocol* is selected: IS-Coordination is the *keeper* and the XYZ partner is a *user*. As a user, the XYZ partner can access the e-collaboration system and download the file. Secondly, there is another partner, called ABC partner, which is an IT service provider in India and has long experience in e-commerce system development. This partner is interested in consulting and enhancing the wiki page on the '*Building an e-commerce website*' service. This is a *with-overlaps overlap situation* because both IS-Coordination Inc and the ABC partner can operate on the wiki page. The *network-based overlap protocol* is used: both organizations are *communicators* of this knowledge component. The ABC partner can access IS-Coordination's e-collaboration system and modify the wiki page if necessary.

4.1.4 Knowledge application

With regard to knowledge application in the IS-Coordination example, and concerning directives (Section 3.4), '*best practices'* related to the e-commerce system development processes are documented and made available using the *Document sharing* collaborative service. Concerning organizational routines, IS-Coordination uses a collaborative service such as *Document synchronization* to coordinate the working processes. This mechanism enforces an automatic routing of documents used in these processes on individuals who collectively work with these documents.

5 Conclusion

The objective of this paper was to introduce a conceptual framework, called information-driven knowledge management framework (IDKM). IDKM is an intelligent infrastructure supporting efficient collaborative knowledge management. We believe that the IDKM framework provides a suitable solution for creating and exploiting an e-collaboration system as a common ground between networked enterprises so that they can capture and transfer their knowledge to others.

To the best of our knowledge, there have been as-of-yet few efforts made to support knowledge management in e-collaboration systems. Nunamaker (2001) suggests a framework to integrate two conceptual hierarchies, which correspond to KMS and e-collaboration systems. Gopalakrishna et al. (2004) suggests a KMS in the form of XML (Extensible Markup Language) documents. Now, there is an important difference between the IDMK approach and these two approaches. Firstly, the IDKM framework proposes a unique infrastructure that reconciles both knowledge management and e-collaboration systems. Secondly, the framework is at a higher level of abstraction and independent from technology choices.

With respect to the implications of our work in practice, when an enterprise intends to employ an e-collaboration system¸ the IDKM framework provides principles and guidelines to organize their knowledge base and to share it with its partners. Concerning the implications for research, much work remains to be carried out to apply the IDKM framework on a broader scale, especially for applying the framework to current technologies related to collaborative services such as semantic web, cloud computing, information intensive services, and web services.

For the time being, we have concentrated on validation and application of the framework in practice, especially to support SMEs (small and medium enterprises) in networking or joining a network. We are currently working on identifying a set of predefined collaboration patterns so that SMEs can select and reuse them according to their inter-organizational relationships, the nature of their collaboration projects and their management styles. Furthermore, we are also building a prototype of an e-collaboration system that supports collaborative knowledge management, including knowledge exploration and exploitation. Such a system would allow enterprises to create their own networks, and then select and customize collaboration patterns to conform to their specific characteristic of collaborative knowledge management (i.e. knowledge attributes). Collaborative services available and managed in the network would be provided directly by the system or indirectly by service providers.

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