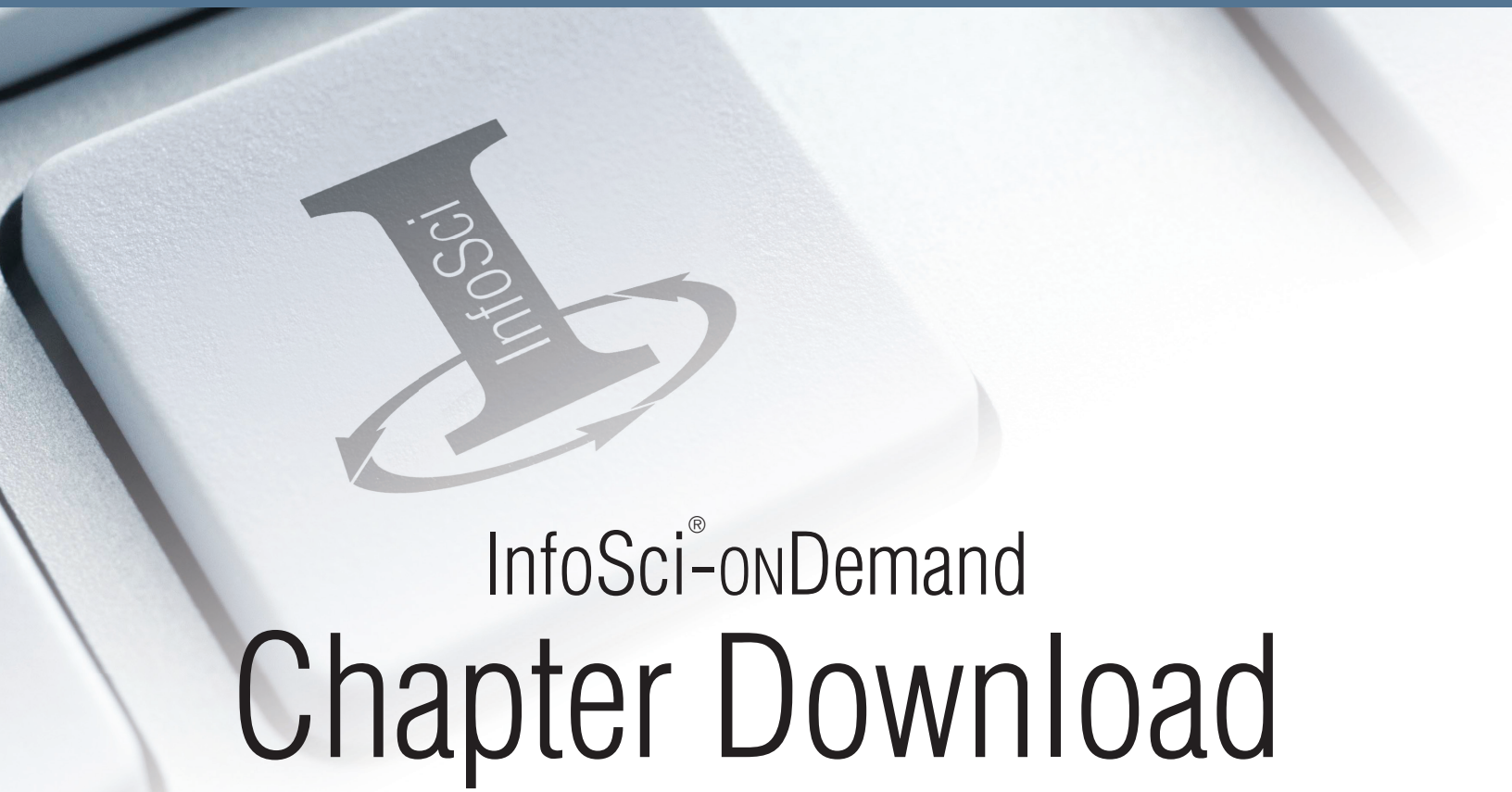

Chapter 19
Distributed Knowledge Management

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Category: Managerial Aspects of Knowledge Management

INTRODUCTION

In dynamic markets (characterized by the specialization of work, outsourcing processes, just-in-time and distributed productions, etc.), firms have moved from hierarchical structures to networked models. These are based on both intraorganizational networks among strategic units, divisions, groups, and so on; and interorganizational networks, such as industrial districts and knowledge networks (Hamel & Prahalad, 1990). Production is based on the coordination of a constellation of units, some of which are part of the organization (administration, R&D [research and development], etc.), and others refer to different companies (such as specialized outsourcing production, logistics, etc.). All these units might not totally be controlled by a unique subject, and might grow and differentiate their activities in an autonomous way, coexisting as in a biofunctional system (Maturana & Varela, 1980) and creating unexpected combinations of processes and products (Chandler, 1962).

From a knowledge management (KM) point of view, the need of sharing knowledge among units in a very complex organization, or among networked organizations, increases the importance of introducing new ICT technologies and effective KM systems. For a long time, KM systems and ICT technologies have been proposed and applied as neutral tools whose implementation within the firm does not have any impact on knowledge flows. In particular, for technical reasons, centralized systems (for instance, enterprise knowledge portals [EKPs]) have been developed with the aim of making knowledge sharable and available in

DOI: 10.4018/978-1-59904-931-1.ch019

a general, objective, context-independent form, avoiding the persistence of noncorrect and nonconsistent information. Opposed to that point of view, studies focused on structuration theories (Giddens, 1984; Orlikowski, 1991) do not consider technology as a neutral asset of organizations. According to these theories, there are strong relationships and interdependencies among human actions, institutional roles (the organizational model de facto), and the technology architecture of KM systems applied within the company. One of the most important results in this area is that ICT technologies and KM systems should be shaped on the processes, practices, and the organizational models in which they are implemented; otherwise, they are bound to failure. As a consequence, in a complex organization composed by a constellation of units that manage in an autonomous way specialized processes, ICT technologies and KM systems must take into account the distributed nature of knowledge, and should allow coordination among autonomous units. In such a scenario, a KM system should satisfy two different needs: supporting the creation of specialized knowledge within a unit, and enabling the coordination of knowledge (and activities through which knowledge is exchanged) among units. These dual needs reflect the tension between the necessity for both highly specialized organization of work and flexible intergroup cooperation within and outside the organizations. This is reflected in the duality between the need for highly articulated local perspectives that make up the communication and knowledge-creation tissue of each community, and the need for sharing cultures and instruments that allow communication across different units (Mark, Gonzalez, Sarini, & Simone, 2002).

The first aim of this article is to describe how, according to structuration theories, a centralized KM system can be replaced or supported by a distributed one, in which the fact of having multiple and specialized "local knowledge bodies" is viewed more as an opportunity to exploit than as a problem to solve. The second aim of this article is to present a specific approach to designing systems for managing knowledge distributed across different units, called distributed knowledge management (DKM), whose principles and main concepts will be introduced and explained in the second part of this article.

BACKGROUND

Even though current KM systems use different technologies, tools, and methodologies (for in-depth discussion, see Davenport & Prusak, 1997; Nonaka & Takeuchi, 1995; Stewart, 2001; Wenger, 1998), most projects eventually lead to the creation of large and homogeneous knowledge repositories, in which corporate knowledge is made explicit and is collected, represented, and organized according to a single, supposedly shared, vision. Such a vision is meant to represent a shared conceptualisation of corporate knowledge, and thus to enable communication and knowledge sharing across the constellation of units composing the entire organization. All these activities are based on the common assumption that raw forms of knowledge, called implicit knowledge by Nonaka and Takeuchi, and tacit knowledge by Polany (1966), can be "cleaned up" from all contextual elements, and that the resulting "objective form" of knowledge can be explicitly represented in an abstract (independent from the original context) and general (applicable to any similar situation) form. This standard architecture of KM systems reflects a traditional view of management, in which managers try to centralize the control on the company processes by allocating and distributing resources and tasks to employees, and monitoring the proper execution of tasks and use of resources. This view of the managerial function leads to an approach to KM where processes of knowledge (resource) production and dissemination (tasks) must be centrally driven (allocated) and controlled (monitored). This condition is met only if knowledge is thought of as an object, which can therefore

be kept separate from the people who produce it. Otherwise, as far as knowledge remains embedded within subjective dimensions, it becomes a resource that falls outside the boundaries of managerial control.

The typical outcome of this kind of vision is the creation of an EKP, namely, an interface (Web based) that provides a unique access point to corporate knowledge (Davenport & Prusak, 1997). Such an architecture is generally based on the following:

- technologies like content management tools, text miners, search engines, and so forth, which are used to produce a shared view of the entire collection of corporate documents
- common formats, such as HTML (hypertext markup language), XML (extensible markup language), and PDF (Portable Document Format), which are used to overcome the syntactic heterogeneity of documents from different knowledge sources
- chats and discussion groups, which are used to enable social interactions

Most business operators claim that this traditional approach is the right answer to the needs of managing corporate knowledge. However, many KM systems are deserted by users, who instead continue to produce and share knowledge as they did before, namely, through structures of relations and processes that are quite different from those embedded within the corporate-wide KM system. For instance, workers continue to use nonofficial tools such as shared directories, personalized and local databases, and so on (Bonifacio, Bouquet, & Cuel, 2002; Bonifacio, Bouquet, & Manzardo, 2000). In theory, KM systems are sold as systems that combine and integrate functions for the contextualized handling of both explicit and tacit knowledge throughout the entire organization or part of it. But, in practice, traditional KM systems manage knowledge according to a technology-oriented approach, which considers the cleaned-up and objective knowledge as the good and sharable knowledge (best practices, documentations, etc.) within the firm and among companies. In spite of the declared intention of supporting a subjective and social approach (through community and groupware applications), the way most KM systems are designed embodies an objective view of knowledge and reflects a marginal notion of sociality. In other words, KM systems aim at managing knowledge in an abstract, general, and context-independent form without taking into account the fact that knowledge is dependent on the context of production (the particular viewpoint of the individual), is embedded within subjective dimensions (the daily practice of work), and is not straightforwardly replicable.

Many authors who stressed the subjective nature of knowledge argued also that meanings are not externally given; rather, individuals give meaning to situations through subjective interpretation. Interpretation is subjective since it occurs according to some internal interpretation schema not directly accessible to other individuals. These schemas have been called, for example, mental spaces (Fauconnier, 1985), contexts (Ghidini & Giunchiglia, 2001; McCarthy, 1993), or mental models (Johnson-Laird, 1992). Internal schemas can be made partially accessible to other individuals through language since language is not just a means to communicate information, but also a way of manifesting an interpretation schema. As a consequence, when interpretation schemas are deeply different, people will tend to give a very different meaning to the same facts. Conversely, in order to produce similar interpretations, people need to some extent to share interpretation schemas, or at least to be able to make some conjectures on what the other people's schemas are. For in-depth discussion, see the notions of paradigms in Kuhn (1970), sociotechnical frames in Goffman (1974), and thought worlds in Dougherty (1992). Since we are talking about organizations, and thus about a collective level, it is relevant to consider that without this intersubjective agreement (or at

least believed agreement), communication cannot take place, coordinated action is impossible, and meaning remains connected just at an individual level (Weick, 1993). Thus, this approach leads to some significant consequences.

- Knowledge is intrinsically subjective as the meaning of any statement is always dependent on the context or on the interpreter's schema, which can be either explicit or implicit.
- At a collective level, groups of people can assume they share (or have a reciprocal view on) some part of their intrinsically subjective schemas. These common parts can emerge from participation and reification processes of the community's members, who share (or understand) the others' meanings through practices (Wenger, 1998). In other words, we can say that the intrinsically subjective schema can be shared, or at least coordinated, in the intersubjective agreements of the community's members.

As a result, the notion of knowledge as an absolute concept that refers to an ideal, objective picture of the world leaves the place to a notion of local knowledge, which refers to the different partial interpretations of portions of the world or domains that are generated by individuals and within groups of individuals (e.g., communities) through a process of negotiating interpretations. According to knowledge network theories (see Cross & Parker, 2004; Hildreth & Kimble, 2004), different and specialized actors that coordinate each other move beyond information sharing to the aggregation and creation of new knowledge, and obtain benefits from network communications and engagement strategies. Finally, the network of relationships, the local knowledge developed within a community, the inner motivation that drives people to share knowledge, and the knowledge they produce lead to the creation of an environment that sustains variety and is rich in creativity, namely, one that is innovative. As a consequence, many big organizations now consider communities, their autonomy, and their contextualized and local knowledge as vital components in their organizational KM strategies. Thus, local knowledge appears as the synthesis of both a collection of statements and the schemas that are used to give them meaning. Local knowledge is then a matter that was (and is continuously) socially negotiated by people that have an interest not only in building a common perspective (perspective making for Boland & Tenkasi, 1995, or single-loop learning for Argyris & Schoen, 1978), but also in understanding how the world looks like from a different perspective (perspective taking for Boland & Tenkasi, or double-loop learning for Argyris & Schoen). Therefore, rather then being a monolithic picture of the world as it is, organizational knowledge appears as a heterogeneous and dynamic system of local knowledge that lives in the interplay between the need of sharing a perspective within a community (to incrementally improve performance) and of meeting different perspectives (to sustain innovation).

MAIN FOCUS OF THE ARTICLE: DISTRIBUTED KNOWLEDGE MANAGEMENT

In this article, we present a new approach to KM called DKM. It provides an original managerial and technological solution to the complementary needs of creating and consolidating (local) knowledge within communities, and of sharing and reproducing knowledge across them. It is based on the assumption that subjectivity and sociality are potential sources of value rather than problems to overcome, and on the idea of modeling organizations as constellations of knowledge nodes (KNs)-this way taking into account autonomous and locally managed knowledge sources-which need to cooperate and negotiate knowledge with

others to sustain innovation. Thus, the continuous interplay of multiple instances of local knowledge and the interactions at the boundaries between different communities are critical factors for innovation and for the creation of new knowledge (Brown & Duguid, 1991).

Principles of DKM

DKM is based on two very general principles:

1. **Principle of Autonomy:** Each organizational unit should be granted a high degree of autonomy to manage its local knowledge. Autonomy can be allowed at different levels. We are mainly interested in what we call semantic autonomy, that is, the possibility of choosing the most appropriate conceptualisation of what is locally known (for example, through the creation of their own knowledge maps, contexts, ontologies, etc.).
2. **Principle of Coordination:** Each unit must be enabled to exchange knowledge with other units not through the adoption of a single common interpretation schema (this would be a violation of the first principle), but through a mechanism of projecting what other units know onto its own interpretation schema.

These two principles must support two qualitatively different processes: the autonomous management of knowledge locally produced within a single unit, and the coordination of the different units without a centrally defined view.

If a complex organization can be thought of as a constellation of autonomous units, an important issue is how this socially distributed architecture can be modeled to design an architecturally distributed computer-based system for supporting KM processes. To this end, we introduce the concept of the knowledge Node as the building block of a model for designing DKM systems.

The Definition of Knowledge Node

A KN can be viewed as the reification of organizational units, either formal (e.g., divisions, market sectors) or informal (e.g., interest groups, communities of practice, communities of knowing), that exhibit some degree of semantic autonomy. Each unit, in fact, can cope with KM only if the processes of knowledge (resource) production and dissemination (tasks) can be locally driven (allocated) and controlled (monitored). Moreover, each unit exhibits semantic autonomy through the development of local interpretation schemas (visions of the world). Each KN represents the following:

- **Knowledge Owner:** An entity (individual or collective) that has the capability of managing its own knowledge both from a conceptual and a technological point of view. Notice that most often knowledge owners within an organization are not formally recognized, and thus their semantic autonomy emerges in the creation of artifacts (e.g., databases, Web sites, collections of documents, archives, practices, and so on) that are not necessarily part of the official information system.
- **System of Artifacts:** An important assumption of DKM is that different organizational units tend to (autonomously) develop working tools that suit their internal needs, and that the choice and usage of these tools is a manifestation of their semantic autonomy. This may be for historical reasons (for example, people use old legacy systems that are still effective), but also because different tasks may require the use of different applications and data formats to work out effective procedures and to adopt a specific and often technical language. Examples of local applications are software systems, procedures, and other artifacts, such as relational databases, groupware, and content

management tools, and shared directories. Even if technologies and data formats are the same for two or more KNs, the appropriation (i.e., the local understanding and using of specific uses in a given setting) of each KN can be very different, depending, among other things, on the local interpretation schema.

- **One or More Locally Shared Conceptual Schemata:** It is a special artifact that represents (in an explicit or implicit way) a community's perspective. In simple situations, it can be the category system used to classify documents; in more complex scenarios, it can be an ontology, a collection of guidelines, or a business process. We can say that a schema is the reification of a KN's perspective, and its continuous, autonomous management is a powerful way of keeping a unit's perspective alive and productive.
- **Brokers and Boundary Objects:** They are individuals and objects (Bowker & Star, 1999; Wenger, 1998) legitimated by people to represent and understand (i.e., has direct access to) the locally shared conceptual schema of a KN. Brokers and boundary objects have the main aim of supporting knowledge owners to create and locally manage one or more shared conceptual schemata, and of meeting other brokers or analysing boundary objects that reify and express other local schemata. For instance, a personal agent could be a broker of a KN that knows its locally conceptual schemata and coordinate it with others.

KNs in a Case Study

In the past, we have analysed some complex organizations. A paradigmatic case study is Pizzarotti & C. S. p. A. Its business is focused on construction and prefabricated buildings, and KNs have been unveiled looking at knowledge owners, the systems of artifacts, the locally shared conceptual schemata, and, more importantly, the kind of knowledge that is exchanged within groups and the way in which people negotiate and coordinate knowledge across the whole organization. Through a large number of interviews, we discovered that building yards, registered offices, and cross-organizational communities have their own structures and their own ways of working to solve specific problems that depend on the kind of production and other local environmental factors (e.g., the weather, local customers and suppliers). Then they can be considered KNs. Though the firm does not formally recognize the existence of some of these units, every KN expresses semantic autonomy through specialized systems of artifacts that are used and appropriated in the way that best suits the local needs. For an in-depth description, see Cuel, Bonifacio, and Grosselle (2004).

A Methodology to Unveil Knowledge Nodes within a Complex Organization

In order to develop a KM system based on the DKM approach, an effective methodology of analysis is necessary. This methodology should take into account two relevant aspects, which reflect the two DKM principles.

- identifying the borders of existing KNs within the firm (principle of autonomy)
- identifying the way knowledge is exchanged across the whole organization through negotiation and coordination processes (principle of coordination)

Both aspects are based on social relations within and across communities in the firm, which can be analysed using different methodologies such as social network analysis (SNA) or ethnography. On one hand, SNA and other quantitative methodologies provide a good and general perspective on the organization, and allow the researcher to perceive the real structure

of the organizational model by considering the relations among people and groups. They do not allow one to identify the reason why some groups are strategic and others are not. On the other hand, ethnography and other qualitative methodologies are based on the participation of the observer within the firm. The observer tries to achieve a detailed understanding of the circumstances, the strategies, and the power of the few subjects being studied, but cannot determine the significance of what she or he observes without gathering broad statistical information.

In the DKM approach, these two kinds of analysis are not sufficient to unveil KNs since it is difficult to identify the KNs' boundaries and knowledge-exchanging processes. As a matter of fact, individuals belonging to an organizational unit are socially interconnected to achieve different objectives and are often part of two or more units, thus using more than a conceptual schema. Therefore, it seems necessary to develop both quantitative and qualitative analysis in different phases through multiple series of questionnaires, ethnographic interviews (Spradley, 1979), and focus groups. The analysis should be organized in three phases: understanding the main picture of the firm, unveiling KNs and their relations, and validating the first results through focus groups or meetings with experts and workers involved in the organization activity. For an in-depth description, see Cuel (2003).

FUTURE TRENDS

The distributed approach to KM has many important implications, both from a managerial and technological perspective.

Managerial and Organizational Impacts of DKM

From a managerial standpoint, a distributed approach to KM poses fundamental challenges to the traditional model of the managerial function. In particular, managers should abandon the widespread practice of having a unique and homogeneous materialization of knowledge represented as a knowledge-based asset. Managers are requested to change their control processes, imposing strategic directions on innovation processes and enabling knowledge materialization from the ground.

Moreover, even if socially the attitude of sharing knowledge within a group is embedded in worker practices, managers should try to avoid personal or group behaviours of competitiveness and detention of knowledge, and should promote knowledge sharing and coordination across the whole organization. Therefore, managers should work out new roles (for instance, the roles of knowledge manager and broker) that determine new skills for knowledge coordination and negotiation (Argyris & Schoen, 1978; King & Andersen, 2002), and create a culture (using wage incentives, group bonuses, etc.) that allows people to identify themselves within the company as part of a whole and to share knowledge for a common, real gain. People's power should derive more from sharing useful knowledge within the firm and among groups than from owning it.

Technological Impacts of DKM

From a technological standpoint, distributed architectures presuppose the explicit recognition of the distributed nature of knowledge. Distributed architectures should sustain autonomy at different levels: the technological (different groups may use different technologies), the syntactic (different groups may use different information formats), and, most of all, the semantic (different groups may generate different systems of meaning, namely, local schemata). From a group's or a community's perspective, a distributed system supports the exploitation and representation of a community's schemata; this is the layer upon which a community's members produce and nego-

tiate common views. Contexts can be represented as local ontologies (for instance, using Context OWL; Bouquet, Giunchiglia, van Harmelen, Serafini, & Stuckenschmidt, 2003), taxonomies, and, in general, theories through which community members interpret their environment and make sense of organizational events. Although theories conceptualise local events and thoughts, new methodologies and tools are needed for allowing workers (with no knowledge on formal logic or computer science) to create and manage local schemata. These methodologies and tools should allow both the creation of a schemata from scratch (analysing documents, repeated occurrences within databases, etc.) and the chance for management to make sense of processes on concepts through very simple visualization systems.

CONCLUSION

The DKM approach satisfies the managerial needs of creating and consolidating knowledge within each KN and of coordinating it across a constellation of KNs. Therefore, brokers and boundary objects should assume an important role, facilitating coordination processes and allowing communication between KNs, thus increasing innovation opportunities within the organization. As we said, these processes can be facilitated by the creation of a collaborative culture and attitude. Moreover, new organizational roles are needed that allow people to both identify themselves within the firm as part of a whole and to see knowledge sharing as way to achieve a common gain.

The centralized approach is not necessarily in conflict with the decentralized one. Depending on the type of knowledge, the environment, and the structure of the organization, it is beneficial to apply a more centralized (e.g., for secured and general knowledge) or a more decentralized KM approach (e.g., for ad hoc and specific knowledge). In particular, traditional and centralized KM systems, developed according to the technology-driven approach, can be effectively used in an organization in which the environment is stable and the need of efficiency is stronger than the pressure toward innovation. Problems arise when the KM systems create a mismatch between the social process of knowledge creation and sharing (organizational models de facto, processes and practices of KM) and the technological architecture (Camussone & Cuel, 2003). Therefore, two dual processes can be produced by the introduction of a noncoherent KM system: The information systems' architecture will be appropriated or shaped according to the modus operandi of its users (some functionalities of the system will be deserted by users, and others will be shaped on the users' daily work), or the organizational model, processes, and shared practices will change and adapt to the functionalities imposed by the KM system. From this, it follows that a KM system should be designed to be consistent with the distributed social form in which knowledge is created within organizations, finding its right level of centralization and decentralization. As a consequence, the composition of units in the organizational models and the composition of KNs should be compatible, and from this standpoint, they should therefore be analysed or at least planned during the designing phase. Currently, there is not a unique methodology of DKM architecture design, and different types of groups, units, and so forth can be unveiled as KNs. Finally, there are many technology-driven approaches that allow developers to design KM systems, and only few of them take into account organizational features (see Davenport, Long, and Beers, 1998) to analyse how politics, information strategies, behaviours, and culture should be considered for a successful KM system.

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KEY TERMS AND DEFINITIONS

Brokers and Boundary Objects: Individuals or objects (Bowker & Star, 1999) that are legitimated to know and represent (i.e., have direct access to) the locally shared conceptual schema of a knowledge owner.

Distributed Knowledge Management Approach: A knowledge management approach based on the duality of perspective making and taking, the localization and centralization of knowledge, and the autonomy and coordination of organizational units. In this approach, subjectivity and sociality are considered as potential sources of value rather than as problems to overcome.

Distributed Knowledge Management System: A KM system that supports two qualitatively different processes: the autonomous management of knowledge locally produced within a single unit, and the coordination of the different units without centrally defined semantics.

Knowledge Node: A knowledge node can be viewed as the reification of an organizational unit, either formal (e.g., divisions, market sectors) or informal (e.g., interest groups, communities of practice, communities of knowing), that exhibits some degree of semantic autonomy.

Knowledge Owner: An entity (individual or collective) that has the capability of managing its own knowledge from a syntactical, semantic, and technological point of view.

Locally Shared Conceptual Schema: A special artifact that explicitly represents the community's perspective. In simple situations, it can be the system of categorization used to classify documents; in more complex scenarios, it can be an ontology, a collection of guidelines, or a business process.

Principle of Autonomy: Each organizational unit should be granted a high degree of autonomy to manage its local knowledge. Autonomy can be allowed at different levels, the most important of which is the semantic level. Semantic autonomy allows the unit to choose the most appropriate conceptualisation of what is locally known (for example, through the creation of personalized knowledge maps, contexts, ontologies, etc.).

Principle of Coordination: Each unit must be enabled to exchange knowledge with other units, not through the adoption of a single common interpretation schema (this would be a violation of the principle of coordination), but through a mechanism of mapping other units' contexts onto its context from its own perspective (that is, by projecting what other units know onto its own interpretation schema).

System of Artifacts: The system of documents, processes, mental models, and so forth that different organizational units tend to (autonomously) develop while satisfying their internal needs. The choice and usage of these tools is a manifestation of the units' semantic autonomy. This may be for historical reasons (for example, people use old legacy systems that are still effective), but also because different tasks may require the use of different applications and data structures (i.e., text documents, audio, or movies) to work out effective procedures and to adopt a specific and often technical language.

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