

Many rivers to cross: from ICT to knowledge management systems

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Several applications of information and communication technology (ICT) have gained considerable popularity as instruments for knowledge management. Some authors even seem to equate knowledge management with the introduction of specific ICT applications (intranets, groupware, etc.). However, the relationship between ICT and knowledge is no less problematic. Organizational knowledge and ICT refer to distinct sets of conceptions and establishing their relationship is far from trivial. The question then is how to assess the relationship between ICT and knowledge management. Several variables to be considered when answering this question have been identified in the literature: the enabling role of ICT for knowledge processes, the state of the ICT infrastructure, the level of knowledge required for using ICT, other user considerations, etc. However, a more encompassing perspective connecting these individual variables seems to be lacking. The aim of the present paper is to correct this. It argues that five dimensions determine the potential value of ICT applications for knowledge management. These dimensions are summarized in the following question. How and when will ICT, in interplay with other knowledge management measures (dimension 5), help knowledge (dimension 2) as a dynamic (dimension 4), institutional and action-related resource (dimension 3) realize its strategic potential (dimension 1)? The main argument in this paper is that, unless all five dimensions are addressed together, no satisfactory assessment of the status of an ICT application as a potential tool for knowledge management is feasible. Each of these dimensions is of a complex, multidimensional nature. The identification of the five dimensions is therefore only a first step. It needs a follow-up in the form of an elaboration of each dimension. This paper provides the groundwork for such an elaboration.

Introduction

The role of information and communication technology (ICT) in knowledge management causes considerable controversy. On the one hand, many authors have stressed the potential benefits of specific ICTs to knowledge management (e.g. Laudon and Laudon, 1997; Marshall, 1997; Ruggles, 1997a,b; Bair and O'Connor, 1998; Malhotra, 2000b). As an amendment to this position, some authors have stressed that information technology has acted as a catalyst for knowledge management but that it 'cannot deliver knowledge management' (McDermott, 1999) and that technology alone, while clearly being a part of knowledge management, cannot make organizations more 'knowledgeable' (Davenport and Prusak, 1998). On the other hand, ICTs are widely criticized for their limitations in facilitating knowledge processes in organizations. ICTs, so we are told, lead to the commodification and depersonalization of knowledge and promote the mistaken view of knowledge as an object

that might exist independent of knowing subjects (e.g. Hislop *et al.*, 2000; Tsoukas and Vladimirou, 2000). The advocates of an ICT-driven knowledge management approach are blamed for stressing only the codifiable, explicit sides to knowledge while ignoring the tacit sides (e.g. Blackler, 1995; Tsoukas, 1996). A recent review of the knowledge management literature (Swan *et al.*, 1999) suggested that the first ICT-friendly position is the dominant one in the knowledge management arena. This research, based on an analysis of some 400 journal articles in the period 1993–1998, showed that much of the knowledge management literature is biased towards a technological agenda away from wider organizational issues, thereby ignoring social and behavioural factors. Those authors suggested that knowledge management is becoming a spin-off from the marketing efforts of the information systems/information technology industry.

Underlying many of the writings in the first ICT-friendly position is an implicit equation of knowledge management with the use of ICT. What distinguishes

the critical approaches from the mainstream ICT-based knowledge management literature is their separation of knowledge management as a concept in its own right from the use of ICT tools. This separation, which is also present in the perception of some authors adopting the first ICT-friendly position (e.g. Ruggles, 1997a; Davenport and Prusak, 1998; McDermott, 1999), leads to the question as to how knowledge management and ICT are related. An assessment of the relative value of the two positions and an establishment of a possible dialogue between them is only possible on the basis of criteria for assessing the potential role of ICT in knowledge management. The question then is what are these criteria? In other words, what justifies the discussion of the pros and cons of ICTs under the heading of knowledge management? What are the criteria for determining whether an individual ICT application truly earns its honorary title of a knowledge management tool (or, to borrow Davenport and Prusak's (1998) more catchy expression, its label of 'techknowledge')? How are we to look at ICTs from the knowledge management standpoint or, given the diversity in conceptions of knowledge management, from the different knowledge management standpoints?

Several elements relevant to the association of ICT and knowledge management have been identified in the literature. The most popular argument given by adherents of the ICT-friendly position refers to the alleged benefits of ICTs for knowledge processes. In order to identify the potential role of ICT in knowledge management several authors have drawn up lists of what they consider to be relevant applications. For instance, Ware and DeGoey (1998) mentioned work flow tools for knowledge dissemination, databases for knowledge storage, search engines for knowledge interpretation, etc. Laudon and Laudon (1997) included word processors for knowledge dissemination, computer-aided design systems for knowledge creation and groupware and intranets for knowledge sharing. Ruggles (1997b) mentioned mind mapping tools for knowledge creation and synthesis and Internet-based forums and groupware for knowledge transfer. Davenport and Prusak (1998) cited the Internet as a knowledge repository, data and knowledge mining applications for knowledge discovery, etc. These lists all justify the inclusion of specific ICT applications with reference to some knowledge-related process (for other examples see Marshall (1997), Wiig *et al.* (1997), Bair and O'Connor (1998), O'Dell and Grayson (1998) and Malhotra (2000b)). ICT, so the argument runs, might support, enhance or, as some authors claim, even enable such processes as knowledge acquisition, knowledge transfer and distribution, knowledge storage and knowledge creation.

The most popular arguments for questioning the value of ICT offered by adherents of the ICT-critical

position come from related discussions of ICT-induced knowledge codification and the impact of ICT on the balance between the tacit and explicit sides of knowledge (e.g. Junnarkar and Brown, 1997; Ruggles, 1997a,b; Zack, 1998; Hislop *et al.*, 2000; Lindgren and Wallstrom, 2000). If, so the argument goes, ICT only affects the explicit, codifiable sides of, for instance, the knowledge sharing process, the relationship between ICT and the 'whole' knowledge sharing process becomes problematic.

Some criteria for justifying or questioning the role of ICT as a tool for knowledge management have been recognized, most notably the role of ICT in knowledge processes and knowledge codification and the relationship between ICT and tacit knowledge. The obvious questions for assessing the value of these criteria for linking ICT to knowledge management are as follows. How does the discussion concerning the role of ICT in knowledge processes relate to the codified/tacit discussion? Do these criteria cover the whole terrain? What justification is there for addressing these issues and leaving out others? These questions ask for a rationale for identifying criteria. The aim of this article is to find such a rationale by examining a definition of the concept of knowledge management that seems acceptable outside the narrow ICT-based knowledge management arena. The study is of a contemplative nature based on a review of both the general organizational knowledge management literature and the ICT-based knowledge management literature, thereby leading to an assessment framework for valuing the role of ICT in knowledge management. The purpose of developing this framework is not to find the ultimate answer to questions as to how and when ICTs are valuable to knowledge management and how and when they are counter-productive. Rather, the position taken here is that, instead of trying to answer these questions, the more appropriate reaction is to look for more refined questions to replace them. The purpose of the article is to provide such a set of more refined questions, which need to be addressed when looking for a meaningful link between ICT and knowledge management. For illustration purposes the framework that identifies and sorts these more refined questions is then applied to ICT in general and to individual ICT applications that have been put forward as knowledge management applications. The academic relevance of the issues addressed here relates to the intricacies involved when forms of ICT are offered as knowledge management tools. The paper aims to contribute to an understanding of these intricacies. However, the relevance of the discussion goes beyond the level of a theoretical interest, as these questions also reflect the practical problem (or challenge) of how to assess the potential role of ICT in general and specific ICT applications in particular.

Another practical area for which the discussion appears relevant relates to the design of ICT for knowledge management. Understanding the problematic nature of the relationship between the two is essential when considering the functionalities the applications are to offer.

Classes of approaches to knowledge management

In order to be able to assess the value of the individual elements proposed in the literature for linking ICT to knowledge management, some idea of what knowledge management stands for needs to be obtained. Arriving at a clear-cut, unambiguous conception of knowledge management is no trivial task. The growing attention that knowledge management is receiving has led to a proliferation of viewpoints, approaches, theoretical discussions and practical tools and methods. To say the least, these do not converge on a clear and unambiguous notion of knowledge management. In an attempt to provide an overview, Verwijs *et al.* (1999) used two distinctions for sorting the various approaches. First, they distinguished between engineering approaches and management approaches. An engineering approach to knowledge management is based on the presumption that problems can be solved systematically by breaking down the problem into parts, solving the partial problems and integrating the partial solution into an overall solution. A management or holistic approach stresses the need for considering the 'whole' knowledge-related situation, including the organizational context in which problems occur and become meaningful. It argues that the complexities characteristic of knowledge-related issues preclude the full understanding and control of knowledge in organizations in identifiable subproblems. Because the management approach claims that aspects can only be fully understood as related to the context that defines them and not only as elements in themselves, it denies the validity of the thesis underlying the engineering approach, i.e. that a satisfactory solution to knowledge-related problems can be attained by summing up the partial solutions.

Second, Verwijs *et al.* (1999) distinguished between four classes of approaches on the basis of their main focus as regards content: knowledge storage approaches, knowledge processes or knowledge flow approaches, organizational learning approaches and knowledge measurement or knowledge asset approaches. The knowledge storage approaches typically have an engineering focus. They concentrate on explicit knowledge dissociated from the human knowledge carrier, as tacit knowledge can only be stored after having been made explicit. Recently, these approaches have shown a growing interest in the ideas of knowledge engineering and

knowledge-based systems originating from artificial intelligence research (e.g. Abecker *et al.*, 1997; Meltsner, 1997; Van Heijst *et al.*, 1997; Wielinga *et al.*, 1997; Nissen 1999). The knowledge processes or knowledge flow approaches stress the dynamic character of knowledge and its dependence on human individuals ('knowledge only exists if someone has knowledge'). They identify individual knowledge processes (knowledge acquisition, creation, distribution, etc.) and connect these in order to form knowledge chains (e.g. Weggeman, 1996; Dieng *et al.*, 1999). Both engineering and management approaches occur in a knowledge chain or knowledge flow, depending on whether they concentrate on the individual processes or on their mutual relations. The organizational learning approaches, which have a history that is older than knowledge management history, focus on the processes of the learning of individuals in groups (Bateson, 1972; Argyris and Schön, 1978; Senge, 1990; Huber, 1992). While the discussions on organizational learning lack a generally accepted perspective (for example see Garvin, 1993), a common trait of the various approaches is that they all develop a management perspective on a central aspect of how organizations should deal with their knowledge creation. This common focus justifies treating organizational learning discussions as contributors to the knowledge management literature. The fourth class of knowledge management approaches that Verwijs *et al.* (1999) discerned concerns discussions as to how to measure and evaluate the intangible assets or resources of an organization. These discussions seem to converge around the notion of intellectual capital (e.g. Edvinsson and Malone, 1997; Bontis *et al.*, 1999). The intellectual capital approach is a clear example of an engineering approach.

A working definition of knowledge management

The two distinctions made by Verwijs *et al.* (1999) are useful in determining how knowledge management is treated in this article. First, the position taken here is that the concept of knowledge management can only be fully understood as a management concept. This does not rule out valuable contributions from engineering approaches. It does imply that such approaches, including the knowledge engineering approach, will only be an integral part of knowledge management if an additional effort is made to link them to the management focus (see also Hendriks, 1999a,b; Hendriks and Vriens, 1999). Second, the distinction between the four classes of approach (knowledge storage, processes, organizational learning and intellectual capital), regardless of whether it is comprehensive or not, leads to the question of whether these classes of approach connect

to a common basis. The position taken here is that such a common basis can be identified in five components or dimensions of knowledge management. These components are shown in Figure 1. Knowledge management combines the action side with the reflection side. The basic notion underlying the reflection side to knowledge management is that knowledge management does not aim at managing knowledge *per se*. Its aim is to deal with organizational knowledge and its organizational value. Understanding how to design knowledge management measures, including ICT or assess their value presumes an insight into what the key elements of the organizationally valuable knowledge are. In line with the old adage 'look before you leap', this paper will first address the reflection side to knowledge management.

The reflection side to knowledge management includes aspects of relevance and content. The relevance issue refers to the fact that knowledge has been recognized as the basis for gaining a competitive edge (e.g. Hansen *et al.*, 1999 ; Zack, 1999b). One important reason for this is that knowledge, because it is hard to imitate and cannot be appropriated in the same sense as other resources (Mueller and Dyerson, 1999; Hislop *et al.*, 2000), can form the basis of adapting the sustainable uniqueness of an organization as appears necessary or appropriate (e.g. Quinn, 1992; Reich, 1992; Drucker, 1993; Nonaka and Takeuchi, 1995; Teece, 1998; Zack, 1999b; Lam, 2000). Several authors have linked the need for ongoing innovation, which is induced by ongoing and increasing environmental changeability and turbulence, to the need for cultivating organizational knowledge (e.g. Leonard, 1995; Leonard and Sensiper, 1998; Dougherty, 2000;

Hendriks, 2000b). However, while an organization's ability to innovate is firmly linked to knowledge, the role of knowledge in maintaining its current competitive position might also be crucial. For example, consider a consultancy firm that aims to sell what they refer to as 'knowledge assets' many times over without many changes. Organizational knowledge is strategically relevant to this firm in a very different way to an organization that aims to sell 'unique solutions to unique problems' (Hansen *et al.*, 1999, p. 109). These knowledge-related issues are linked to the question of how the organization sees itself in relation to its environment (Hendriks, 2000a) and define the potential role of knowledge for the organization as a whole. This role, which concerns the question of the organizational relevance of knowledge, sets the criteria by which the other issues can be addressed.

As to the content side, three key elements of 'organizational knowledge' may be distinguished. Each of these elements identifies focal points for the design of interventions with knowledge management tools such as ICT or for assessing their potential value. First, in order to direct the design and assessment involved, an insight into the specific characteristics of knowledge is required. The question then is what distinctions can help in gaining a rich conception of knowledge. The distinction between the tacit and explicit sides of knowledge has been mentioned above (e.g. Polanyi, 1966; Nonaka and Takeuchi, 1995). Other relevant distinctions include the distinctions between situated and generic knowledge (Suchman, 1993; Tsoukas, 1994; Bell, 1999) and the classic distinction between procedural and declarative knowledge (e.g. Anderson, 1976). A major challenge on the reflection side of

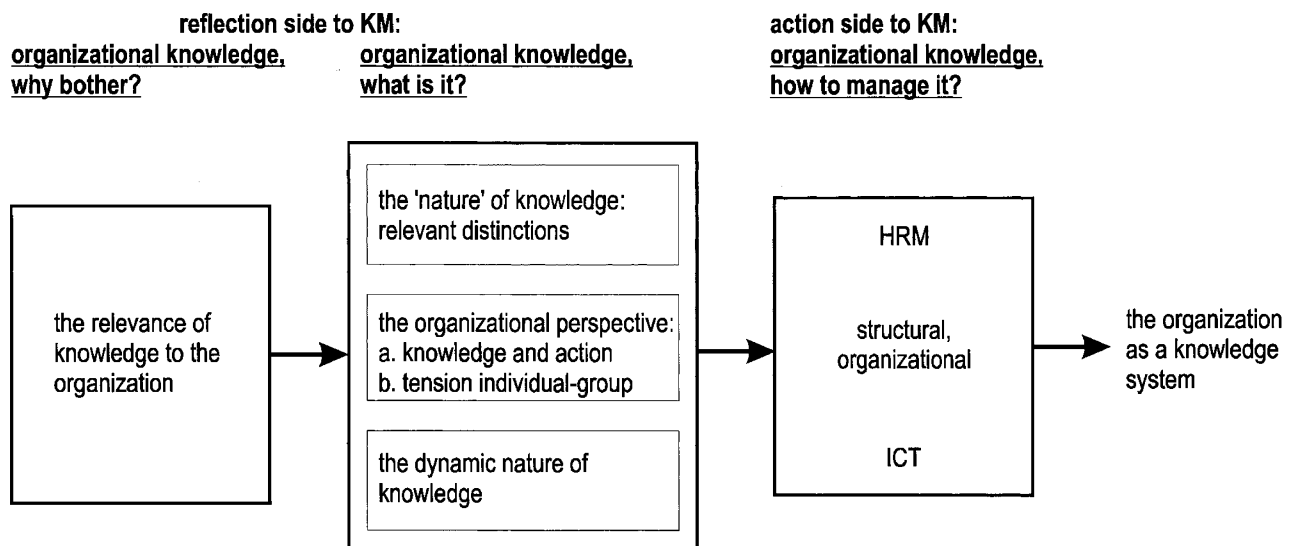


Figure 1 A framework for knowledge management

knowledge management is finding the appropriate distinctions for understanding the nature of knowledge and characterizing the knowledge base of an individual organization with respect to the categories of these distinctions. The associated challenge in designing or assessing knowledge management interventions is to come up with the appropriate measures and tools that give each of these categories the position it deserves.

Second, an understanding of the distinctive organizational perspective on knowledge is called for. Several elements that mark such a perspective have been identified in the literature (Tsoukas, 1994, 1996; Nonaka and Takeuchi, 1995; Davenport and Prusak, 1998). An understanding of 'organizational knowledge' seems to involve two core elements: the action relatedness and group focus of organizational knowledge. With regard to the first element, several authors have stressed that knowledge within an organization is closely linked to action (e.g. Polanyi, 1958; Argyris and Schön, 1978; Huber, 1991; Hedlund, 1994; Nonaka, 1994; Tsoukas, 1994; Blackler, 1995; Nonaka and Takeuchi, 1995; Davenport and Prusak, 1998). New knowledge is not organizationally valuable *per se*, but only when it leads to new actions (new processes, products, etc.). The second element indicates that groups not individuals are the knowledge carriers or agents of organizational knowledge (Hedlund, 1994; Nonaka and Takeuchi, 1995; Spender, 1996; Scarbrough, 1999; Lam, 2000). This element makes it clear that organizational knowledge refers to the concept of knowledge in a metaphorical sense. In a strict sense, only individuals have knowledge. However, knowledge management is not about strengthening the knowledge of individuals, but about rethinking the knowledge of groups (the organization, a network of organizations, departments, organizational functions, etc.). Therefore, a clear although subtle distinction should be made between efforts at improving the performance of individual knowledge workers and knowledge management (e.g. Rochester, 1996; Ware and DeGoey, 1998). This element points to the tension that might arise between efforts aimed at improving knowledge-related elements in the work of individuals that might prove counter-productive for organizational knowledge (e.g. smarter consultants with new products might decide to leave the company to start businesses of their own). The associated challenge on the reflection side of knowledge management lies in identifying the appropriate perspective on the two tensions involved in this dimension: the tension between the cognitive and action-related sides of knowledge and the tension between individual knowledge and group knowledge. The challenge in designing and assessing knowledge management interventions again lies in coming up with an appropriate mix of measures that allows for an adjustment of the organization's

position with respect to both tensions in a reactive or proactive sense.

Third, knowledge is typified by the fact that it renews itself. If knowledge is treated only as a product or a static resource, the perception of what knowledge is will inevitably be incomplete. This calls for a perspective on knowledge processes and knowledge dynamics, that is attention should be given not only to individual processes, but also to the connection between them. If not, individual knowledge processes might well be improved at the expense of the overall knowledge dynamics. For instance, consider an organization investing in the acquisition and retention of knowledge (for example by installing knowledge maps or knowledge databases and search and retrieval systems) without also properly addressing its maintenance. The effect might be that, in future settings, it will become very easy to acquire outdated knowledge. Insight is needed into how knowledge processes form a knowledge chain (Nonaka, 1991), a knowledge value chain (Weggeman, 1996) or a knowledge flow (Hendriks, 2000a; see also, for example, Skyrme, 1998; Dieng *et al.*, 1999). When knowledge management interventions are designed, it is essential to pay attention to their relationships with individual processes, to the interconnections between these processes and to the dynamic character of knowledge.

The action side of knowledge management, which is the last of the five dimensions, refers to the fact that knowledge management, as a management system, involves interventions and measures aimed at influencing the organization as a knowledge system. ICT offers one class of tools and instruments that might be used for shaping interventions. Two other important classes of knowledge management measures are organizational measures (e.g. establishing knowledge centres, communities of practice, knowledge fairs, knowledge brokers and knowledge teams e.g. Malhotra, 2000a; Davenport & Prusak, 1998) and human resources management (HRM) measures (for instance, mentoring, 'knowledge wages' and dual career ladders) (e.g. Bertrams, 1999). As stressed above, designing knowledge management interventions with the use of the tools in these classes should be based on a firm understanding of the organization-specific intricacies of the four other dimensions: the organizational relevance of knowledge, the appropriate categories of knowledge, the specifically organizational perspective on knowledge and the dynamic character of knowledge.

An exploration of these five interconnected dimensions shows that none of the four approaches to knowledge management identified above is identical to knowledge management in an overall sense. All of them offer different contributions to some overarching knowledge management concept. The organizational learning and knowledge processes approaches are richer

in the sense that they address more elements of the five dimensions than the storage and intellectual capital approaches. In this sense, knowledge management can be seen as a concept of scale: the more elements and their mutual relations are addressed in an approach to knowledge management, the more it truly becomes a knowledge management effort.

Five dimensions for linking ICT to knowledge management

While, as was noted in the Introduction, studies addressing ICT and knowledge management have revealed several criteria to be considered when examining this relationship, the specification of these criteria appears haphazard and lacking a rationale for including some and ignoring others. The model of knowledge management presented in the previous section of this paper may serve to provide such a rationale. A closer examination of that model and the argument on which

it is based reveals five dimensions that are essential when assessing the potential value of ICT applications for knowledge management (see Figure 2). The reasons why knowledge is to keep or change its relevance to organizations provide the touchstone for positioning ICT tools within an overall knowledge strategy and knowledge management policy (dimension 1). This first dimension sets the criteria for the other four dimensions. Discussion of the concept of organizational knowledge indicates that ICT should be related to knowledge (dimension 2) as an action-related, institutional or group resource (dimension 3) typified by its dynamic nature (dimension 4). The fifth dimension concerns the place of ICT as a tool for knowledge management and the relationship between ICT and alternative knowledge management measures. Any approach aimed at establishing the value of ICT will have to find a way of dealing with these dimensions individually and as a set. Each dimension covers several questions that address the problems and challenges in the relationship between ICT and knowledge manage-

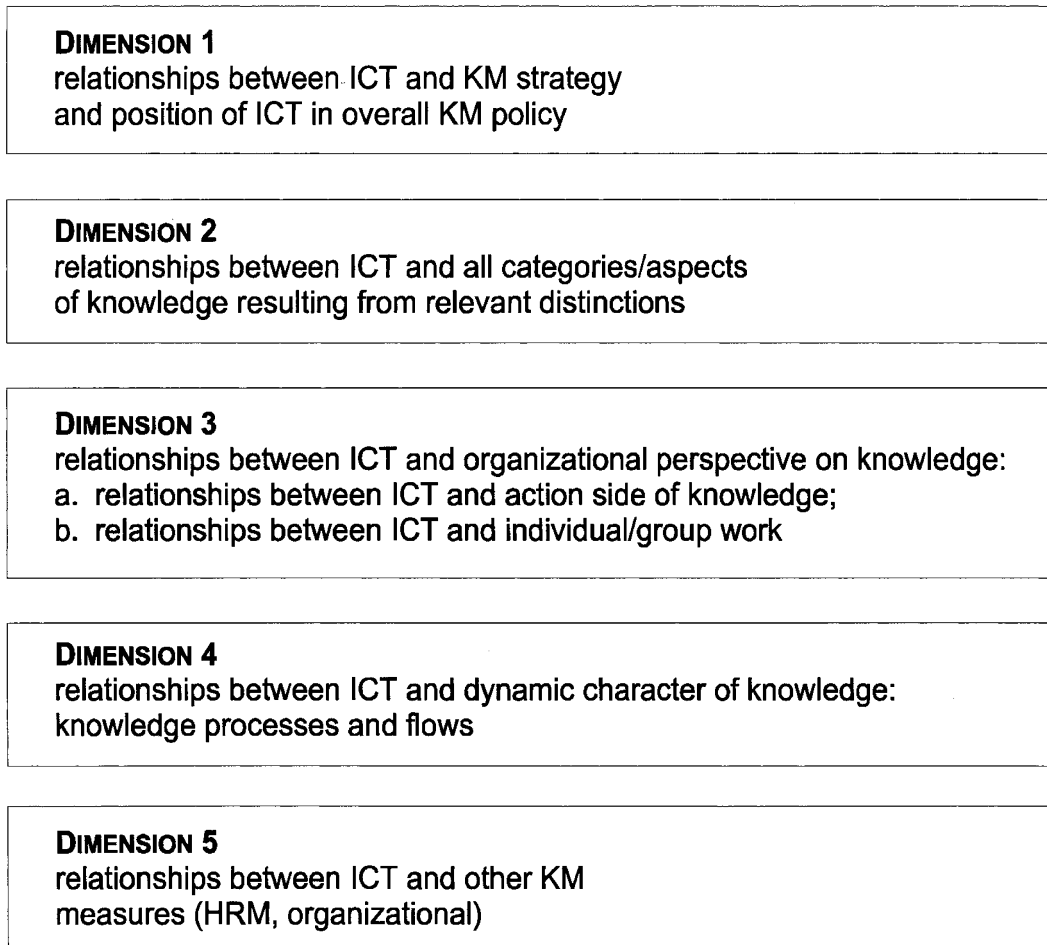


Figure 2 Five dimensions for linking ICT to knowledge management

ment. A short description of the questions in each dimension will now be given, which will be elaborated on in the next section.

- (1) First, assessment of the knowledge management value of ICT presupposes insight into the contribution of ICT to knowledge management objectives and goals. The firm's knowledge mission or competitive strategy translated into knowledge management strategies and knowledge policies should provide these objectives and goals. Pertinent questions are therefore as follows. Does the mission imply a specific choice in the ICT arena, for example ICT as a key driver in the mission, ICT as irrelevant or obstructive to the mission or ICT as something to be aligned with the mission and which consequences as to individual ICT applications should the organization draw from this? Which level of ICT support in general and which choice of individual ICT applications is in line with the organization's knowledge mission? Might ICT be useful in securing the relationship between the knowledge management strategies the organization has adopted and its knowledge mission? If so, for which applications does this hold? Are risks also present in using too much ICT or specific ICT applications either for achieving the mission and vision or for enhancing the effectiveness of the knowledge management strategies?
- (2) Second, whether and to what degree ICT does justice to the nature of knowledge needs to be considered. ICT in itself does not involve a direct link to knowledge as such. It only reflects specific elements or aspects of knowledge, more particularly the information-related aspects. This introduces two questions. First, what are the appropriate distinctions for characterizing knowledge? Second, how does ICT relate to these distinctions. With regard to the first question, the most popular distinction for valuing ICT in knowledge management is between tacit and articulated aspects of knowledge. When addressing the second question this distinction leads to the recognition that ICT applications, in stressing the articulated aspects of knowledge, might lead to undervaluing its essential, tacit sides. While this assessment is valuable, it should not block the view of other relevant distinctions. These might appear equally important or even more important for creating awareness of the pitfalls and limitations associated with ICT use in a knowledge management context. These include Blackler's (1995) distinction between embrained, embodied, encultured, embedded and encoded knowledge (see also Lam, 2000), as well as the other distinctions mentioned above between situated and generic knowledge, structured and unstructured knowledge and declarative and procedural knowledge. The question of which of these distinctions is most useful depends on the concrete situation of an individual organization and the characteristics of the ICT applications under consideration.
- (3) The third set of questions concerns the role of ICT with respect to the organizational perspective on knowledge. The first question here concerns the effect that ICT has on the action side of knowledge: Will the introduction of ICT lead to the enhancement or improvement of knowledge-based actions or will it thwart these? The second question to be asked is how ICT relates to the tension between the individual level where knowledge resides and the organizational level where knowledge gains its institutional value. That is, we need to ask how ICT fits in with the focus of knowledge management on the knowledge of groups or organizational functions. This element of the second dimension distinguishes 'knowledge management tools' from 'tools for knowledge workers'.
- (4) Fourth, ICT might relate to how knowledge becomes valuable for organizations in many ways, both in a positive (enhancing and enabling) role and in a negative (blocking and frustrating) role. It might enhance the knowledge content of the services and products of the organization, it might facilitate as well as hinder the processes of knowledge acquisition, dispersal, application and retention and so on. The questions to be asked here are what are the appropriate processes to be distinguished, how ICT affects these processes, how are the individual processes connected into a chain, how ICT affects these connections and how the status of knowledge as a dynamic resource is affected by ICT.
- (5) Fifth, the question here is how the use of ICT relates to a firm's overall operational knowledge management plan. An organization may have several other programmes in place outside the ICT realm in order to reach its knowledge objectives and goals. Two important classes of measures in this respect are organizational and HRM measures. The relationship between ICT-based and other knowledge management measures defines an important aspect of the status of ICT within the broader knowledge management arena.

Elaborating the dimensions: sorting the questions and answers

Each of the five dimensions will now be addressed in more detail. Each dimension itself is of a complex, multifaceted nature. This section will only elaborate each dimension in a broad, exploratory sense aimed at identifying the types of questions to be asked when valuing ICT in a knowledge management context. Some of these questions have already been asked – and at least partially answered – in the literature. The five dimensions might therefore also serve the purpose of sorting the questions and answers addressed in the literature. This sorting operation will be performed here, not primarily for the purpose of a literature review, but for the purpose of gaining a better understanding of the intricacies characterizing the relations between ICT and knowledge management. In other words, this section will look at answers found in the literature with the aim of gaining a clearer view of the questions to be asked.

The generic lists of ICT tools for knowledge management that were presented in the Introduction might serve as a starting point for a discussion of the five dimensions. How do the justifications given for the composition of these lists relate to the five dimensions? Not all of the drafters of these lists mentioned above provided a justification that could provide an answer to the question as to why they included the applications in their list. Some gave the impression of equating knowledge management with the use of ICT tools, thereby sidestepping the relevance of a justification question (e.g. Bair and O'Connor, 1998). Others avoided the questions by simply replacing the term 'information' with 'knowledge', thus relabelling 'information systems' as 'knowledge systems' and 'data mining' as 'knowledge mining' (e.g. Tsechansky *et al.*, 1999). Their justification seems to be that, if ICT has something to do with knowledge, it also has something to do with knowledge management. However, the argument underlying the five dimensions makes it clear that no ICT application deserves the label of a knowledge management tool purely because of its own characteristics. It is essential when valuing ICT applications as knowledge management tools to consider the situation in which they are used. For example, if groupware is considered a knowledge management tool in one situation, that does not justify treating it as such in all possible situations (as, for instance, O'Brien (1998), Gutwin *et al.* (1999), McQuaid *et al.* (1999) and Roussinov and Chen (1999) seem to imply).

Dimension 1: relationships between ICT and organizational relevance of knowledge

Knowledge is not organizationally relevant as such, but is relevant when and in the way an organization recognizes its relevance or mentally constructs it. The organization's vision, mission and competitive strategy, when translated into knowledge management policy, should provide the criteria for assessing the organizational relevance of knowledge. At the same time the organization's self-perception of its organizational knowledge might guide how it constructs the mental models of its vision, mission and strategies. In order to assess the role of ICT in knowledge management its relationship with these issues concerning the organizational relevance of knowledge should be established. The question to be asked then is how ICT relates to the knowledge management strategy adopted by an organization. Hansen *et al.* (1999) provided at least part of the answer to this question since they advised an organization against investing heavily in ICT if its knowledge management strategy aimed at personalization, i.e. bringing people together for the purpose of exchanging tacit knowledge. ICT, so they suggested, fits in better with a knowledge management strategy aimed at codification, i.e. storing descriptive accounts of knowledge for the purpose of reusability. While the distinction between a codification strategy and personalization strategy is valuable, it begs the question of whether this distinction fully covers the terrain. The two strategies correspond to what Tissen *et al.* (1998) described as firms with a feedback learning style and a social learning style. Their third type of learning organization, the firm with a cognitive learning style, is not covered by the codification and personalization strategies. This type of organization seems to require a different knowledge management strategy. The pertinent knowledge management strategy would in this case stress learning through shared models and favour such ICT support as collaborative mind mapping tools and shared analytical applications. The suggestion of Hansen *et al.* (1999) that the perception of ICT as a knowledge management tool will vary according to the appropriate knowledge management strategy is therefore endorsable. However, some doubt might arise as to the completeness and general applicability of their elaboration of the concept. In general, two questions are appropriate for the evaluation of ICT systems as knowledge management tools at the strategic and policy levels. First, which perception of a knowledge management strategy is relevant in the context of an organization? Second, how do ICT systems fit in with this strategy?

As an example consider an organization aiming to avoid reinventing the wheel by selling the solutions it has provided to one customer to many other customers

(see Hansen *et al.*, 1998). This company presumes that 'the knowledge it sells' has generic qualities that transcend its application in the situation of one particular customer. Such an organization might consider capturing those generic qualities in knowledge repositories. In contrast, a company that aspires to sell exclusive and unique solutions would find use of such knowledge repositories inappropriate. It is more likely to use ICT for facilitating people finding each other (e.g. through electronic yellow pages, expertise databases, automated knowledge maps, curricula vitae, project databases, etc.). In both cases the choice of ICT strategy depends upon the recognition of the organizational relevance of knowledge (i.e. is the knowledge of the first company truly generic and does the second organization envision the generic aspects of its knowledge adequately?). As Hansen *et al.* (1998) stressed 'emphasizing the wrong approach - or trying to pursue both at the same time - can quickly undermine your business' (p. 106). Perhaps even worse would be the complete disregard of a knowledge strategy because that might imply that a solid basis for linking ICT to knowledge management is lacking.

Dimension 2: relationships between ICT and knowledge categories

It is generally acknowledged that knowledge is different from information and data (e.g. Ackoff, 1989). ICT, which facilitates the dispatch of data and information, does not therefore affect knowledge in a direct and complete sense. At best it affects how aspects or elements of knowledge are being dealt with. The same holds true for intelligent, knowledge-based systems. While the information content in these systems is higher than in conventional information systems, they too rely on their users for turning data and information into knowledge. Advocates of knowledge engineering approaches to knowledge management (e.g. Wielinga *et al.*, 1997; Nissen, 1999) sometimes seem to forget that calling a knowledge-based system a 'knowledge system' or 'knowledge sharing system' refers to knowledge in a derived, metaphorical sense. Knowledge as the object of knowledge management is not necessarily the same as knowledge as stored in a knowledge-based system.

The challenge then is to find a characterization of knowledge that is both rich and useful for identifying the starting points for associating it with ICT. A popular approach to dealing with this challenge involves the assessment that knowledge combines tacit and explicit sides. The relevance of tacit knowledge for knowledge creation provides the basis for the identification of both the value and the limitations of ICT as all ICT seems to presuppose the articulation of

knowledge (e.g. Junnarkar and Brown, 1997; Ruggles, 1997b; Zack, 1998). While the value of the distinction between tacit and explicit aspects of knowledge is beyond dispute, it should not block the view of other distinctions that might be even more useful. One such distinction concerns generic versus situated knowledge. This distinction refers to the fact that knowledge involves the application of generic rules within an individual situation. The situatedness of knowledge indicates the fact that, without knowledge of the context, a generic rule is limited in meaning or even, as some maintain, void of meaning (cf. Clancey, 1997; Bell, 1999). A related distinction is the distinction between mimeomorphic and polymorphic knowledge and actions (Collins and Kusch, 1998; Whitley, 2000). Mimeomorphic actions are those that can be reduced to a set of rules (swinging a golf club is an example of a mimeomorphic action), whereas polymorphic actions require an understanding of their context in order to be appreciated (understanding jokes is an example of the latter as different cultures are characterized by different assumptions about what is funny - culture is therefore a relevant contextual factor for understanding a joke). It might be suggested that most ICT applications involve a focus on the generic/mimeomorphic aspects at the expense of the situated/poly-morphic aspects.

Dimension 3: relationships between ICT and the organizational perspective on knowledge

With regard to the first of the discriminating characteristics of organizational knowledge, i.e. its action relatedness, it can be noted that this does not appear to be an explicitly addressed, core issue on the agenda of the ICT-focused knowledge management literature (unlike the broader ICT literature, which does focus attention on the action enabling qualities of information and information systems, e.g. see several contributions in Currie and Galliers (1999)). Yet questions concerning the relationship between ICT use and organizational actions resulting from knowledge are crucial to knowledge management. This means recognizing that the value of its knowledge management is not about changes brought about in the cognitive capacities of the organization but rather the organization's ability to act based on its cognitive capacity. Distributing knowledge with the aid of an intranet will only become relevant to the organizational value of knowledge if it leads people to creative new ideas that are translated into operations or if it leads to the fruitful reapplication of existing knowledge. ICT for knowledge distribution is relevant to knowledge management only if ICT-supported knowledge distribution leads to (improved) action. Introducing ICT aimed at

enhancing the knowledge base or knowledge processes of the organization does not automatically lead to improved knowledge-based actions. The risks associated with ICT are that, because it stresses the information component, ICT might lead to what Davenport and Prusak (1998) called 'deknowledging'. This will occur, for instance, when so much data and information is stored in a knowledge repository that it becomes hard to make sense of the contents of the repository. It will then become a passive storage medium that is not adding to the knowledge base of the organization because it is not linked to any organizationally relevant actions. Therefore, important questions to be asked when valuing ICT as a knowledge management tool are what actions the introduction of ICT will affect and in what way these actions will be affected.

The group aspect, which is the second discriminating characteristic of organizational knowledge, refers to the question of whether individuals or the institution will benefit from knowledge management interventions. The concept of a group is to be understood in a broad sense, not just referring to institutionalized teams but to any system, subsystem or aspect system of which individuals are a part. For instance, the organizational functions of business intelligence or policy making can be seen as groups. As was indicated above, the issues involved here concern the possible tension between individual aspirations of knowledge workers and the shared aspiration of the organization. The leading question for positioning ICT with respect to this tension is therefore in which direction the balance will tip because of the introduction of ICT: will the value of knowledge to individuals change or will its value to the organization also be affected? Two elements define the group aspect of organizational knowledge: a group as a passive entity, represented by the concept of organizational memory (Walsh and Ungson, 1991; Stein, 1995, Stein and Zwass, 1995) and a group in an active sense, represented by such concepts as knowledge communities, communities of practice and knowledge teams (e.g. Fisher and Fisher, 1998; Wenger, 1998; Botkin, 1999; Scarbrough, 1999). ICT applications that are frequently mentioned as supporting groups in a passive sense are knowledge repositories with their associated browsing, search and retrieval tools. Intranets and groupware are typical applications that might be helpful to a group in an active sense. For both classes of applications the challenge lies in assessing whether the knowledgeability of the group or organizational function is affected in a positive sense by the applications. For instance, a question to be addressed for groupware as a knowledge management tool is not whether the anonymity and greater efficiency will induce individuals to become more involved with teamwork. Instead, the question to be assessed is whether the knowledge component in the function of

the group is enhanced through increased participation that is induced by anonymity and efficiency gains. Questions like these determine the knowledge management perspective on applications such as knowledge repositories and groupware.

As another example consider the question of whether word processing software qualifies as a knowledge management tool (e.g. Laudon and Laudon, 1997). An argument for promoting these tools and associated ones, such as document management or imaging systems, as knowledge management tools might be that they fit in with widely accepted ways of explicating and structuring knowledge in the written language and avoid unwanted codification (cf. dimension 2). A rationale for calling word processors 'techknowledgey' might be that much knowledge in organizations resides in an unstructured format in documents and that a word processor may help facilitate many processes relevant to this class of knowledge, including its acquisition, search, retrieval, dispersal and updating (cf. dimension 4). However, this rationale ignores the specific organizational perspective on knowledge that knowledge management presumes. All the knowledge processes mentioned might well apply only to the actions of an individual knowledge worker. Only if these processes are affected by word processors at the group level – which will occur if word processors have a role in 'community building' (cf. McDermott, 1998), for instance through their facilities for group authoring – might there be a case for calling these applications knowledge management tools.

Dimension 4: relationships between ICT and the dynamic character of knowledge

As mentioned above, probably the most popular reasons for linking ICT with knowledge management involve their alleged advantages for knowledge processes. Table 1 presents some of the knowledge processes used as stepping-stones for relating ICT to knowledge management in studies addressing that relationship at a generic level. The distinction of these different approaches leads to the question of which perspective is the most appropriate in an individual situation. It also leads to the question as to how a satisfactory perception of the role of ICT is reached once a particular process perspective has been adopted. This calls not only for keeping an open mind for possible gains but also for potential hazards. As an example consider what Cohen (1998) referred to as 'knowledge management's killer app': the intranet. This obtains high praise as an instrument for knowledge sharing because, through the intranet, it becomes easier to locate other people who might either offer or provide relevant knowledge. Applications such as electronic yellow pages, automated knowledge maps and expertise databases offered via the intranet allegedly connect people.

Table 1 Assessing the knowledge management value of ICT: examples of knowledge process approaches

Authors	Knowledge processes as stepping-stones for valuing ICT as knowledge management tools
Balasubramanian (1995)	Knowledge acquisition, information distribution, information interpretation and organizational memorization
Laudon and Laudon (1997)	Knowledge capture and codification, knowledge sharing, knowledge distribution and knowledge creation
Ruggles (1997b)	Knowledge generation, knowledge codification and knowledge transfer
Davenport and Prusak (1998)	Knowledge capture, knowledge storage and knowledge distribution
Skyrme (1998)	Knowledge identification, knowledge creation, knowledge collection and codification, knowledge storage and knowledge diffusion and use
Milton <i>et al.</i> (1999)	Personalization, codification, discovery, creation and capturing and monitoring
Dieng <i>et al.</i> (1999)	Knowledge growth, knowledge communication, knowledge preservation and knowledge access and use
Balasubramanian <i>et al.</i> (1999)	Capture, transform, disseminate, classify, discover and maintain

However, in order to be able to assess whether or not an intranet may help connect people, a fuller understanding of the process of knowledge sharing is called for. The role of the intranet is particularly linked to removing barriers and enhancing practical abilities with respect to knowledge sharing behaviour. Knowledge sharing also involves more fundamental questions as to whether individuals are able and willing to share their knowledge with others and to absorb knowledge from others. Concepts such as trust, motivation, job-related receptive and expressive capacities, etc., then come into play (cf. Hendriks, 1999c). The relationship between an intranet and these concepts is far from trivial. An intranet and the knowledge map it contains might well create distrust between organizational members or departments and serve to aggravate the political tensions within the organization (e.g. Cohen, 1998; Davenport and Prusak, 1998). In those circumstances an intranet will disconnect people rather than connect them and it will not enhance knowledge sharing but frustrate it. Cohen's (1998) term 'knowledge management's killer app' then takes on a cynical new meaning.

While the various perspectives on knowledge processes and ICT's respective role introduce many relevant issues, questions and answers, they do not fully cover the fourth dimension. At least two additional sets of questions are important. First, improvement of individual processes might lead to the deterioration of the overall chain of knowledge processes (as was illustrated above). The question is therefore how the connection between individual processes is affected by ICT tools. Second, the process perspective does not fully cover the quality of knowledge as a dynamic resource. Gill (1995), for instance, documented how two organizations that were strongly relying on ICT for optimizing their oper-

ations lost their more fundamental capacity for adapting to fundamental changes in their competitive environment. After initial years of success, both companies saw their market share decline dramatically in a short period of time. What they had lost by replacing knowledge functions with ICT was the capacity to rethink the fundamental business model underlying both the knowledge processes and the ICT support for them. If all effort goes into capturing and retaining knowledge 'as it is', the real risk is that knowledge becomes a passive asset instead of an active resource. An assessment of the impact of ICT on the crucial, dynamic side of knowledge is therefore essential.

Dimension 5: relationships between ICT and other knowledge management measures

The reason why the relationship between ICT tools and knowledge is problematic is that these tools primarily address data and information and not knowledge. In a sense, the other two classes of knowledge management measures mentioned above, HRM and structural measures, are more truly knowledge management measures because they represent the two poles of the tension between individual and group knowledge that characterizes the nature of organizational knowledge. Pertinent questions are therefore as follows. How do ICT applications qualify as possible enhancements to other knowledge management measures? Which additional knowledge management measures are needed in order to give ICT a knowledge-oriented flavour? Does using ICT conflict with other operational knowledge management programmes that are already in place? Questions as to the relationships between ICT tools and knowledge

management measures of different sorts are hardly ever asked in the sense indicated. Several authors have voiced their awareness of the idea that the need for integration has to be recognized. For instance, Junnarkar and Brown (1997) emphasized that, for knowledge management to become effective, it requires symbiosis between people, information and information technology. In addition, Davenport and Prusak (1998) stressed throughout their monograph on knowledge management that technologies alone will not lead to improvements in the way an organization's knowledge is managed. However, almost invariably such authors have either pointed to the generic conditions for ICT to become effective or to additional measures to be taken that have no direct relationship with knowledge management. The assessment of ICT as a knowledge management tool requires that an attempt be made to identify the various links with other knowledge management measures. Do some measures presuppose others? Can some measures support others? Is there a risk that some measures might counteract others? If such an attempt is not made, ICT applications are probably being addressed from an information management perspective instead of a knowledge management perspective.

For example, the effectiveness of an intranet for knowledge sharing depends, amongst other things, upon the competencies of individuals for expressing their knowledge and understanding what others say or show. An important factor influencing these competencies is the way labour is divided within the organization. People working in a team-based organization are in a completely different situation from people in specialized jobs who primarily share knowledge with their fellow workers via the desk of a manager. The possible benefits of an intranet for knowledge sharing for the latter organizations are limited because of job-related limitations in the abilities to receive and express knowledge. The question for team-based organizations is whether they need an intranet for intrateam knowledge sharing and whether they want an intranet for sharing between teams. Matters of trust, motivation, sharable content, etc., are likely to take on different meanings within these two situations. Whether or not an intranet may become a medium for knowledge sharing is therefore fully dependent upon the way knowledge work is organized. Moreover, for an intranet to become effective additional measures might be necessary, particularly within the HRM realm (motivational measures, particular reward systems, development programmes, etc.). Whether the intranet is introduced with or without these additional measures will help to determine whether the intranet facilitates knowledge sharing and not just pumping information through the organization.

The relationships between the dimensions

Addressing the dimensions separately might involve the risk of ignoring their mutual relationships. These relationships are equally as important as the individual dimensions on their own because deciding upon the appropriate perspective on the issues addressed in one dimension might depend on the focus chosen in the other dimensions. Some of these links have been identified in the literature. As an example, consider the discussion as to how cross-fertilization of tacit and explicit knowledge in a knowledge spiral calls for a different perspective on ICT in the various stages of organizational knowledge creation (Junnarkar and Brown, 1997; Ruggles, 1997b). As another example, consider how a knowledge management strategy following on a community or social constructivist model of knowledge (Tsoukas, 1996; Swan *et al.*, 2000) will lead to another more limited role of ICT than a knowledge management strategy representing a cognitive model of knowledge. The question of the relationships between the dimensions is therefore not a separate issue but should be treated as an integral part of the discussions within each dimension.

Conclusions

The combination of ICT and knowledge management has similarities with a clash of two Titans of quite different characters. As Ruggles (1997b) put it 'Knowledge is very personal, while technology can be very cold and, by its very nature, calculating' (p. 14). On the one hand, knowledge is characterized by a certain evasiveness or fuzziness. As, for instance, Tsoukas (1996) stressed, knowledge does not exist in the rigid sense of 'being there', but as the product of a social construction process. While knowledge has an aura of general applicability, in its core it has the character of situatedness. ICT, on the other hand, introduces the rigidity of a limited cognitive model of knowledge (Swan *et al.*, 2000), treating reality as something to be recognized 'as it is'. The main suggestion this paper makes is that, when aiming to create a symbiosis of these two Titans, the appropriate perspective is not on answers and solutions but on questions. Instead of asking for the solutions that ICT can bring to individual knowledge-related problems, such as the improvement of knowledge processes, one should focus on gaining insight into the reasons why the relationship between ICT and knowledge management is problematic. The title of the paper indicates this perspective: the linkage of ICT to knowledge management presupposes that we know where the rivers to be crossed are located. Before deciding where to build bridges, at least an initial awareness of the extent of the river system is needed.

Otherwise, there is a real risk that solutions will only go half way or, worse, will point in the wrong direction. As an example, consider the discussion on whether ICT forces unwanted types of codification. (For a discussion of ICT-related codification of knowledge see, for example, Cowan and Foray (1997), Liebowitz and Beckman (1998), Dieng *et al.* (1999), Milton *et al.* (1999) and Zack (1999a) and for a critical assessment of the limitations involved see, for example, Boisot and Griffiths (1999), Mueller and Dyerson (1999) and Marshall and Sapsed (2000)). The suggestion made here is that, before getting too involved with the intricacy of this discussion in isolation, an attempt should be made to understand the broader picture. The individual question of the relationship between ICT, codification and organizational knowledge is but one aspect to be considered when assessing the potential role of ICT in knowledge management. Both at the level of an individual organization and at the general level, it seems appropriate to draw up as complete a list as possible of the other relevant questions before aiming to answer this specific one. This paper has offered criteria for 'as complete a list as possible'. Such a list should contain references to all five of the dimensions presented in this paper, i.e. the relationships between ICT and the organizational relevance of knowledge, the pertinent categories of knowledge, the organizational perspective on knowledge, the dynamic side of knowledge and other knowledge management measures. On the basis of such a list, the perspective for addressing an individual question, such as the codification issue, is likely to gain in focus. It might also result in removing an individual question from the knowledge management agenda, for example because codification is seen as conflicting with other knowledge management measures (dimension 5) or because codification is identified as being beneficial to certain individuals or groups but not to the organization as a whole (an element of dimension 3).

The argument developed in this paper is in line with several other calls for a more holistic approach to knowledge management (e.g. Starbuck, 1992; Spender, 1996; Tsoukas, 1996; Pan and Scarbrough, 1999). Only an approach aiming to grasp the broad spectrum of issues which set the scene for the management of knowledge in organizations might help envision the advantages of ICT as a knowledge management tool while not ignoring its downsides. Clearly, the use of ICT applications may involve both advantages and drawbacks. Among the advantages are their support for people looking for each other (e.g. through an automated knowledge map of the organization) or the facilities they offer for the search and retrieval of relevant documents as a stepping-stone towards knowledge re-creation (e.g. through document management/imaging systems) and associated opportu-

nities for supporting organizational memory (Stein and Zwass, 1995). The risks of ICT for knowledge management include the fact that they might confirm and reinforce organizational structures that obstruct an effective flow of knowledge and promote a conception of knowledge in which the importance of individual human experience is undervalued. As a result of ICT organizations might become more rigid instead of more creative, thus losing their facilities for continued knowledge development (e.g. Gill, 1995; Hendriks, 1999a). However, an overemphasis on only the limitations of ICT, which characterizes some discussions of the relationship between ICT and codification, introduces the real risk of 'throwing away the baby with the bathwater'. In line with the metaphor used above, the risks associated with ICT can be seen as rivers to be crossed in order to connect the individual stretches of land that symbolize the advantages of using ICT. This challenge of building bridges in order to connect islands motivates the call for a holistic approach to knowledge management, addressing not only technical but also social factors (cf. Pan and Scarbrough, 1999). The contribution of this article to such an approach is that the five dimensions presented in the article may sharpen the criteria for assessing whether such an approach adequately addresses the specific issues defining the concept of organizational knowledge and its management.

The argument developed in this paper suggests that there is only limited value in drawing up generic lists of ICT tools for knowledge management as were presented in the Introduction. If questions are asked as to why individual applications appear on such a list and others are left out, the compiler of the list can only provide partial answers. Its possible contribution to knowledge processes alone does not define the value of ICT for knowledge management. ICT and knowledge management appear as quite distinct realms without any obvious and unproblematic bridges linking the two. Their relationship is, as Wijnhoven (1995) put it, 'strikingly problematic'. While it seems too pessimistic to state that 'never the twain shall meet', the discussion of the five dimensions shows that linking ICT to knowledge management is anything but an easy task. Each dimension offers formidable challenges and problems. Anyone trying to assess the value of ICT for knowledge management has therefore many rivers to cross.

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