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Research article

Managing knowledge and managing knowledge work: what we know and what the future holds

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Abstract

In this paper we review the recent IS literature on knowledge and consider different assumptions that underpin different approaches to this broad research area. In doing this we contrast those who focus on knowledge management with those who focus on knowing as practice and examine how contexts, processes and purposes need to be considered whichever approach to knowledge one is adopting. We also identify how recent IT developments, especially in relation to social software and the digitization of everything, are presenting new opportunities (and challenges) for how organizations can manage both knowledge and knowledge work. This presents IS scholars with new research agendas for examining and understanding the relationships between technology, organization and society.

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Introduction

The industrial revolution was propelled by technological and social innovations and access to what economists describe as the 'traditional factors of production' – land, labour and capital. Importantly, in this mix, labour is treated as a factor of production, no different from land and capital – it is a resource that must be acquired and managed, just like any raw material or piece of technological equipment used in production. The hands/body were what mattered, rather than the brain, at least for the majority of employees. Indeed, the whole premise of Taylor's (1911) Scientific Management was that firms were inefficient because employees were using their brains, to ensure that they did the minimal amount of work – described as systematic soldiering. They could do this because they, and not their managers, had knowledge about the work they were doing. Taylor's idea was to transfer all knowledge to managers (an entirely different and very small group compared with the basic labourer) so that labour could be more efficiently utilized as a resource (and according to critics, further exploited as such – Braverman, 1998). Therefore, 'labour' did not include those scientists/inventors who created and developed the breakthrough technologies, nor the managers, who organized production to generate profits.

However, as global competition increased in the post-war era, driving the need for increased innovation to maintain a competitive advantage (Bolwijn and Kumpe, 1990), and as the provision of services became as important as the production of goods (Oliva and Kallenberg, 2003), there was a gradual recognition that 'labour' needed to be seen as more than simply the hands/body needed to carry out physical work. Firms also needed the workers' brains[1] (their knowledge), since relying only on a small cadre (managers and scientists) for developing and introducing innovation was slow and a waste of talent. Thus, the term the 'knowledge economy' was born, popularized by the late Peter Drucker, initially in his book 'The Age of Discontinuity' in 1969 but really catching on in the academy in the 1990s, when the knowledge-based view of the firm emerged as a central idea in the strategy literature (Grant, 1996; Spender, 1996). While in some ways this was a revolutionary idea – that all workers could potentially contribute useful knowledge to add value to a firm – in other ways the conceptualization of knowledge (rather than physical labour) did not change that much because knowledge has most commonly continued to be treated as a resource, that can be managed, hence the popularization of the term knowledge management (KM) (Scarbrough and Swan, 2001).

The term KM is used in both the popular and academic literature, to refer to the general idea that organizations can generate value by improving the ways in which they create, capture/store, distribute/transfer and effectively use/apply knowledge (Grant, 1996; Choo, 1998). KM is related to business value because knowledge is fundamental to both improving efficiency and innovating, the two basic processes that enable organizations to compete. Therefore, organizations must use resources efficiently (or a competitor will move into their niche and, by using the same resources more efficiently capture the market) and must be flexible (i.e., innovate) in order to adapt to the changing competitive environment (Thompson, 1967). This competitive need to focus on efficiency and/or innovation has been related to processes of knowledge exploration and knowledge exploitation. Knowledge exploration refers to using and creating new knowledge – to produce new products, services, organizational arrangements or business models. Knowledge exploitation involves ensuring that knowledge that is potentially available within a firm is actually accessed and used so that costly reinvention and repeating the same mistakes are avoided. It was assumed that there was a trade-off between exploration and exploitation (March, 1991), just as there was an assumed trade-off between efficiency and flexibility (i.e., innovation), but today firms are advised of the importance of being ambidextrous (Tushman and O'Reilly, 1996). Ambidextrous organizations both explore and exploit knowledge to improve efficiency and simultaneously to innovate and so gain (or perhaps not lose) competitive advantage (Durcikova *et al.*, 2011).

Knowledge, then, came to be seen as a resource, which needed to be 'unlocked' from employees' brains through appropriate management. And so the 'discipline' of KM was born (McInerney, 2002) and very quickly became a fashion, if not a fad (Raub and Ruling, 2001; Scarbrough and Swan, BJM, 2001). Moreover, due to the relevance of IT in supporting KM, the IS community has addressed considerable research effort to the topic of KM. For instance, from the AIS e-library between 1998 and 2013, a search on KM revealed only 212 articles in 1998 and then a steady increase to a peak in 2011 of 1555 articles.

Whether the fashionable term KM will survive is not certain (indeed the AIS-database search shows that after 2011 its popularity is waning), but the idea that knowledge (and associated data/information) is important to firms is beyond doubt. However, some argue that treating knowledge as a resource that can be managed like any other (tangible) resource, while dominant in the IS (and more general management) literature, is not the most helpful approach (Alvesson and Karreman, 2001). Instead, some authors focus on managing the knowledge work rather than the knowledge itself (Newell *et al.*, 2009). In this paper we consider both of these literatures. First, we consider the resource view (which we link to a knowledge-as-possession epistemology, Cook and Brown, 1999) and review research that has identified how organizations can use IT to improve processes that facilitate using knowledge as a resource. Second, we cover the literature that treats knowledge-as-a-practice or better knowing-as-a-practice (i.e., papers adopting an epistemology of practice) and so focuses on managing the knowledge work. From this knowledge-as-a-practice perspective, rather than treat IT as a passive container that enables knowledge (as a resource) to be stored and shared, IT is considered an active participant in knowledge work.

Method and structure adopted for review

A systematic literature review involves identifying, selecting and synthesizing concepts and themes on a particular topic and stipulating inclusion and exclusion criteria with the aim to identify a relatively short (and representative) number of papers for in-depth analysis (Randolph, 2007). In this paper, we began with the basket of eight IS journals and identified papers from 2000 (i.e., after the major review of KM provided by Alavi and Leidner, 2001) where knowledge or knowledge management had been used in the abstract. We extended beyond this basket as we followed up on references and themes from this initial set. In this extension, we included papers in related disciplines, where the papers appeared to have significance for the topics being discussed in the IS literature.

Based on the literature that was identified, we structure the review as follows. In the first section, we focus on KM initiatives where IT has been used in attempts to improve the storing and sharing of knowledge within an organization (otherwise called KMS, Knowledge Management Systems); in this section we consider what influences the success of such KMS. In the subsequent section we build on this review of KMS to explicitly examine the assumptions underlying different approaches to KM – for example, repository and network approaches. This highlights that while much of the IS research on KM has been based on examining how IT can improve the extent to which knowledge, seen as a precious resource, is shared across an organization, there is also considerable IS research that considers knowing as a practical accomplishment. We turn to this in the penultimate section, where we review the IS literature that focuses on knowledge work (rather than knowledge *per se*) and that considers IT as an actor in this knowledge work. Our final section considers new approaches to KM – approaches we refer to as crowd and sensor approaches – and identifies opportunities for IS research that seem especially relevant based on these developments. This last section extends beyond a review of the literature, because the developments discussed are only just emerging. Instead, in this section and the conclusion, the paper provides some ideas for what future research might focus on, given these developments.

What do we mean by knowledge?

Before we turn to the substantive content of this review, it is helpful to reflect on what we mean by knowledge. If we think about doctors, for example, we can note that they conduct an examination using various pieces of medical equipment like a stethoscope and from this decide what is wrong with the patient and what is the cure; a trainee cannot do this, especially if the diagnosis is not straightforward. Therefore, we can say that the doctor *has knowledge* that the trainee does not, and that the doctor *acts knowledgeably*, while the trainee cannot. What distinguishes the expert and the novice is the ability to differentiate within and between the complex patterns of data and information that they draw upon in the particular situation of action based on some type of pre-existing framework derived from theory or past experience. As Tsoukas and Vladimirou (2001) put it, knowledge is: 'the individual ability to draw distinctions within a collective domain of action, based on appreciation of context or theory or both' (p. 979).

What is perhaps worth noting in relation to this definition is that there can be cases where an individual (or even a collective) believes that they can draw distinctions from available data in conjunction with some theory or experience and then act, apparently, knowingly, but where actually the distinctions are not valid or true. For example, the old 'science' of phrenology was based on measuring a skull to assess a person's psychological attributes. We now know that there is no validity in this approach but for a time it was seen as 'truth'. While sometimes validity does not matter (think for example of the fact that we now know that Newtonian mechanics is not true in all circumstances, and yet this knowledge did, and still can, help us to develop new technologies) at other times it most certainly does (as when a person was placed in an asylum because of a phrenologist's report). Moreover, the problem is not simply that the distinctions may not be valid; there is also the issue of whether the valid distinctions are actually understood and practiced validly. For example, a novice may believe that they know how to make discriminations, for example, in terms of being able to read an MRI-scan image, when actually they are missing some fundamental aspects of the image so that they actually make an incorrect diagnosis – that someone does not have cancer when in fact there are clear signs that they do. The phrenology example shows that what counts as knowledge is socially and historically contingent while the novice MRI-scan reader example shows that there are many examples where knowledge is not effectively shared and practiced within an organizational context but that this may go unnoticed – sometimes until there is some type of disastrous consequence. These issues demonstrate the complexity of the knowledge concept and perhaps explain why organizations are so interested in better 'managing' knowledge sharing or knowledge work, while simultaneously often not doing either very effectively.

With this caveat in mind, we can nevertheless view knowledge as the ability to discriminate and so draw meaning in a particular context, based on some understanding derived from theory or past experience in interaction with a collection of other actors (other people and objects like the stethoscope). Thus, we can see knowledge as the combination of the understandings that are possessed by individuals or collectives (including knowledge possessed not simply in the brain and body of the individual but also in organizational routines) and the actual interactions with other actors in a particular knowledge work situation. It is the combination of possessed knowledge and the situated work practice that produces knowledgeability. As we will, discuss, however, much of the literature has focused on managing knowledge (as a resource) and only more recently has research focused on managing knowledge work (i.e., the situated practice in an equipped context that produces work that is knowledgeable (Gheradi, 2012).

Knowledge management initiatives and knowledge management systems

KM, then, is normatively expected to increase value for an organization by improving the way in which knowledge is explored and exploited for innovation and/or efficiency gains and is assumed to involve a set of processes for the capture/storage/sharing and use of knowledge. KM initiatives are specific projects implemented in organizations that are directed at improving these knowledge processes to achieve some more or less clearly specified performance benefit. Many such KM initiatives involve at least some use of IT (and often IT is the central vehicle through which organizations attempt to improve their management of knowledge, Scarbrough and Swan, 2001). KMS, then, involves the use of IT by an organization to improve the creation, storage, sharing and use of knowledge to enhance some aspect of organizational performance and so extract business value (Tanriverdi, 2005). A lot of the IS literature focuses on KMS (e.g., what influences the success of a KMS, see below) and this is our focus in this section of the paper.

There are different types of IT that are introduced under the umbrella of a KMS. The dominant type of KMS that has been introduced in practice has been a *repository system* (where knowledge is stored on a database for future search so that knowledge can be used across time as well as space). Another type of KMS has been a *network system* (which connects employees who can then share knowledge directly, or at least virtually across space). We will later discuss differences (and similarities) between these two KMS approaches, but for now it is sufficient to note that many KMS involve elements of both a repository and a network, allowing for search of a database through an intranet, for example, as well as connection to individuals, for example, through the use of organizational yellow pages directories which allow people to identify those to get in touch with based on a specification of their knowledge, skills and experience. Of course, IT-systems other than specific KMS, like Enterprise Systems, can influence knowledge processes within a firm (Joshi *et al.*, 2010), but in order to limit the purview of this review, we mainly concentrate on research that has specifically focused on KMS. Moreover, as we discuss later, these repository and network types of KMS are today being supplemented with new types of IT, especially social software.

The empirical literature certainly shows that some KMS initiatives have been successful (Kulkarni *et al.*, 2006), albeit more recently, there have been attempts to identify a more nuanced account of the circumstances in which a KMS is successful. For example, Ko and Dennis (2011) examined a repository type of KMS introduced for a sales force in a pharmaceutical company and found that this had led to significant improvements in performance that increased over time. However, they found that those with more job experience were able to use and gain benefits from the KMS more quickly than those with less experience; although eventually the less experienced caught up in terms of performance gains.

Despite reported successes, there is also considerable empirical research providing examples where KMS have not been successful (Smith *et al.*, 2001; Brydon and Vining, 2006) or at least have run into difficulties after a period of time (e.g., Mehta *et al.*, 2007). This includes network-type KMS (as well as repository-type KMS which are more commonly studied in the IS literature) designed to support knowledge sharing in communities of practice (Venters and Wood, 2007).

Perhaps we should not be surprised at these reported difficulties in obtaining value from a KMS, since the IS literature has long discussed how many IT projects do not meet the expected goals that were set (Sauer, 1993). Moreover, the IT productivity paradox literature (Brynjolfsson, 1993) draws our attention to the fact that IT implementation and

productivity gains are not straightforwardly linked. The IT productivity paradox was identified based on finding that from the 1970s investments in technology (and in particular IT used for office automation) did not appear to be related to gains in productivity in the same way as investments in technology had previously done (e.g., in relation to factory or farming automation). Brynjolfsson (1993) suggested a number of reasons for this paradox, including: that gains do exist but measurement is not accurate; that gains at the individual firm level are at the expense of other firms, so that there is no net gain to the economy; that gains take a while to materialize; and that there are not gains because of the difficulties of implementing IT. He favoured the first explanation, but subsequent authors have pointed to the need to go beyond simple cause-effect accounts of the relationship between IT and economic value (essentially a deterministic assumption) and instead recognize that value (at the national or firm level) will depend on the context in which IT is deployed and how IT is actually used (Pinsonneault and Rivard, 1998). In other words, IT does not itself create performance improvements and productivity gains, rather it depends on the conditions of use and it often takes time to develop benefits from IT adoption.

This general literature on obtaining value from IT at the firm and national economic levels is clearly also relevant in respect of KMS and some research has considered what influences the likelihood of obtaining such value. For example, Dulipovici and Robey (2013) consider how to derive business value from a KMS. Based on a case study, they show how a KMS that was initially aligned to the organizational strategy (the KMS being adopted to support knowledge sharing across functional boundaries for the benefit of clients) became misaligned as different groups within the organization developed different representations of the KMS that shaped how the KMS was actually used. This literature suggests that we need to consider in more detail the conditions that influence the success of KM and KMS initiatives. We turn to this issue next.

The literature has identified many reasons why organizations do not always gain benefits from a KMS and in turn the conditions that influence the success of such initiatives. In organizing this literature we use the framework provided by Newell *et al.* (2009), which indicates that attempts to manage knowledge can be considered in relation to three dimensions of knowledge work: *enabling contexts, processes and content or purposes*. This alerts us to the idea that KM initiatives must pay attention to the unique context and consider how this can enable or constrain KM; we also need to attend to processes that can prompt individuals and groups to share (or alternatively hoard) knowledge; and finally such initiatives must not lose sight of the purpose and goals of introducing a particular KM/KMS initiative. We use this framework next to present research that has examined the influences on KMS success (or failure).

An enabling context: promoting a knowledge sharing culture

The culture or climate of the firm has been found to be an important factor in the success, or perhaps more accurately, failure of a KMS (DeLong and Fahey, 2000; Gottschalk, 2000; Bock *et al.*, 2005). Indeed, Butler and Murphy (2007) argue that the mixed findings about the success of KMS can be explained, at least in part, by considering the cultural context, in particular the organizational context. Some studies have also looked at the impact of national culture. Thus, a meta-analysis on the impact of culture, both national and organizational, on KM, covering the period 2000–2010 (Jacks *et al.*, 2012) revealed that most research has focused on organizational rather than national culture. In terms of national culture, this meta-analysis revealed that those studies that have been undertaken identify the importance of uncertainty avoidance and power distance (Hofstede, 1980) as having most influence on knowledge sharing; while at the organizational level, trust and openness are most important, with these influencing knowledge sharing directly but also indirectly through business leadership's vision and strategy. We briefly review specific literature that covers these points.

Organizational culture, the dominant pattern of basic assumptions, perceptions, thoughts, feelings, and attitudes held by members of an organization (Schein, 1990), is often presented as one of the biggest challenges to effective KM (Gold *et al.*, 2001; Alavi *et al.*, 2005/6; Hassell, 2007). While the focus on specific values that promote effective KM differs across the research that has been undertaken, in general, this literature points to the importance of a collaborative, open, trusting community where knowledge sharing is valued and rewarded (Jarvenpaa *et al.*, 2004; Kotlarsky and Oshri, 2005; Kankanhalli *et al.*, 2005; Ling *et al.*, 2009; Marett and Joshi, 2009); and where such a culture is promoted by leadership (Nguyen and Mohamed, 2011) and potentially also by other types of IT-initiatives that require more integrated work processes, for example, across different business units, like an ERP (Lee and Lee, 2000; Newell *et al.*, 2002).

Trust, in particular, stands out as important (Lee and Choi, 2003), especially affect-based, rather than cognitive-based, trust (Huang *et al.*, 2010). The effects of trust on knowledge sharing has been demonstrated, for example, in the context of virtual teams (Staples and Webster, 2008) and where sharing is inter-organizational as, for example, in IT outsourcing contexts (Lee *et al.*, 2008). Related but distinct from trust, research has shown how KMS use is influenced by co-workers, especially bottom-up social influence rather than top-down influence (Wang *et al.*, 2013). Furthermore, rather than just assuming that culture will influence all aspects of knowledge sharing, more recent research has indicated that employees' perceptions of particular aspects of their organizational culture (often described as the organizational climate) will influence the type of knowledge sharing that they engage in – using more formal knowledge sharing approaches when the climate is perceived as more competitive and using informal and formal approaches where the climate is perceived as warm and cooperative (Boh and Wong, 2013).

While organizational culture may be important, it has also recently been noted that, given the existence of sub-cultures within organizations, there may be significant differences within an organization in relation to how culture influences knowledge sharing (Ravishankar *et al.*, 2011). Moreover, Anandasivam and Sanjay (2010) reported that while a collaborative culture enhanced performance quality because it encouraged knowledge sharing, it simultaneously reduced efficiency – leading them to conclude that a collaborative knowledge sharing culture has 'mixed benefits'.

One way in which culture can influence knowledge sharing relates to how safe people feel to share failures – it is much easier to share successes. A cross-country study by Esperanza *et al.* (2012) looked at how national culture impacts

this. Their study confirmed that sharing failures was less likely than sharing successes (even when people are allowed to post anonymously) but they also found that participants from a collectivist culture (China and Mexico) were more likely to share information about failures than those from an individualist culture (UK and USA). At the same time, other research has indicated that in collectivist cultures, like China, people tend to prefer to share knowledge informally, with few examples of successful KMS (Davison *et al.*, 2008). A study by Huang *et al.* (2010) considered this in more detail and identified how Chinese employees engage in knowledge sharing (especially tacit) when this helps them to gain face and so feel satisfied; simultaneously, when knowledge sharing was perceived as potentially threatening a loss of face (e.g., by sharing knowledge an employee felt that she/he could be exposed as wrong), employees were less likely to share.

More generally, *guanxi*, the use of networks of mutual interest and benefit, also influenced knowledge sharing among their sample. Young *et al.* (2012) take this one step further and identify how the surveillance characteristics inherent in any KMS may be particularly problematic in a collectivist culture where face-work (maintaining social esteem of self and family) can be threatened by the fact that any contribution a person makes will expose him/her to the public gaze and so potentially to a loss of face. Their case study of teachers in Taiwan showed how in this context users of a KMS found ways to avoid exposing themselves to the panopticon potential, for example, by not contributing much (despite attempts on the part of the designers to create features that could enhance the potential value from any knowledge sharing) and/or interacting in spaces where they could exclude others from seeing any contributions they made. These studies, therefore, indicate that national and organizational cultural differences can be important in explaining the effectiveness of any KMS. Moreover, these studies highlight that while the importance of culture for encouraging knowledge sharing is widely accepted, it may be important to incentivize individuals to contribute to a KMS, even where there is a knowledge sharing culture.

Motivating knowledge sharing processes: rewards and incentives

KMS, especially of the repository type, depend on people actually entering content into the system. This is not trivial because knowledge and power go together (Davenport *et al.*, 1992) so that sharing knowledge may undermine an individual's power; hence accounting for why knowledge hoarding is often (Liu *et al.*, 2010), albeit not always (Kankanhalli *et al.*, 2005), observed in empirical studies. Incentivizing or motivating knowledge sharing has been considered important since the early 1990s (Orlikowski *et al.*, 1995). Thus, how to incentivize this activity has been the subject of research and as with more general motivation research, the results have not always been clear-cut. For example, while some research suggests that financial incentives can positively influence knowledge sharing (Kulkarni *et al.*, 2006), other research shows that such incentives, as extrinsic motivators, can be less effective at encouraging knowledge sharing, as compared with intrinsic motivators (Bock *et al.*, 2005).

Untangling this has led researchers to examine different types of incentive, often through experimental methods. Thus, incentives can be extrinsic, monetary (direct payment but also gift certificates and prizes) and/or intrinsic, non-monetary (e.g., recognition in annual evaluations, certificates) and can be either individual or group-based. Wolfe and Loraas (2008) conducted experimental research to try and examine how well different types of incentives motivated knowledge sharing. They found that both monetary and non-monetary rewards had to be considered sufficient in order to motivate knowledge sharing. This is in line with earlier work by Davenport and Prusak (1998) who provide the example of a professional services firm that was unable to motivate knowledge sharing because they offered only a trivial reward (in this instance a mouse pad), suggesting that 'you get what you pay for'. Following this, Wolfe and Loraas (2008) also suggest that it might be difficult for non-monetary incentives to be deemed sufficient, especially when individuals are being asked to share proprietary knowledge (i.e., knowledge that if hoarded might give them some advantage). However, this may depend on whether knowledge contributors share the same interests as the organization, with all types of reward having little effect when potential contributors do not share the interests of the organization and intrinsic (non-monetary) rewards being sufficient when they do (Kankanhalli *et al.*, 2005). In terms of individual *vs* group incentives, an experimental study by Taylor (2006) found evidence that group-based financial incentives produced more knowledge sharing than either individualized piece-rate or tournament incentives.

Despite the lack of clarity about what particular incentives work best in which context, the general idea that organizations can encourage knowledge sharing by introducing an incentive system is widely accepted. von Krogh (1998), for example, suggests that incentive systems can help to build a culture of care within an organization that promotes knowledge sharing and this is why they can be effective, thus providing a link between culture and incentives. While incentivizing the knowledge sharing process and developing a trusting culture focus mainly on the supply side of KMS – ensuring that content is actually uploaded on the system – other research has looked at the demand side – how to encourage people to actually use the content of a KMS for some purpose.

Fulfilling the purpose of KM: qualifying and legitimating knowledge and ensuring appropriate governance

The quality of the content of a repository type of KMS is obviously fundamental in relation to improving any knowledge process. Nelson *et al.* (2005) identify a number of key dimensions of information quality, including accuracy, completeness, currency and format. They also identify a number of separate dimensions of information systems quality, including accessibility, reliability, response time, flexibility and integration. It would appear logical that these same types of criteria apply to the content and system operation of a KMS. This indicates that for a KMS to fulfil its purpose, its content and operation must be at least 'good enough' (Burton-Jones and Grange, 2013) to meet users' needs. As Durcikova and Gray (2009) indicate, 'To succeed, a repository must contain knowledge that will prove useful for employees looking for answers to their questions and solutions to their problems' (p. 82). Moreover, the repository must not only contain useful knowledge, the knowledge must be easy to find. However, while repository KMS allow people to access knowledge (content uploaded by someone/some group of a solution, best practice, lessons learned etc. in order to share their knowledge with others across space and time) there is very often a glut of such content and it may be difficult for a potential user to sift

through and decide what knowledge is valid (and in what circumstances) and so useful to act upon (Alavi and Leidner, 2001). This may account for the fact that many KMS repositories suffer from a supply-demand problem – there is lots of supply but less demand for what is in the repository (Newell and Edelman, 2008). In addition to these repository problems of quality and overload there is also a problem of keeping content up-to-date, which involves weeding out content as well as adding new.

The recommended solution to these problems from the KM literature is that contributions to a repository undergo some type of validation process (Durcikova and Gray, 2009). These recommendations have been implemented in some organizations, which nominate a small group of experts as the content moderators, tasked with culling old content and evaluating any new content before it is uploaded. However, the time of experts is, by definition, an expensive commodity, so this is often only one job that an expert is expected to do, and often not a priority, with the result that the use of experts does not always lead to the expected outcomes of good quality content (King, 2007). Moreover, while legitimating knowledge may help those searching a KMS, too much control over the content can deter potential contributors (Brown and Duguid, 2000). For example, Durcikova and Gray (2009) identify the importance of validation processes being both transparent *and* developmentally oriented. Thus, it is necessary to find a balance that encourages, but governs and controls supply, so that those using the content can find and be assured of its quality and validity and so be more likely to use it. This balance may differ across different industry contexts (Ciborra and Andreu, 2001).

An alternative to using experts is to rely on users. For example, some KMS have built-in rating schemes (familiar to us through the many examples of such rating systems used in online shopping sites like Amazon or social sharing sites like yelp), which encourage users to rate the quality of the KMS content, allowing others to better decide whether to use the content. The idea here is that seeing others' reviews will enable potential users to sort out good and bad content in the repository. Poston and Speier (2005), using the experimental method, demonstrated how these ratings can influence content search and evaluation processes when using a KMS and that this in turn affects performance positively. However, we also know that such rating systems can be 'gamed' (Resnick *et al.*, 2000) especially when they are based on anonymous reviews (Scott and Orlikowski, 2012), suggesting that they are not a fool-proof way of improving the validity of the content of a KMS.

Another study examining how to ensure the quality in a KMS was undertaken by Bergquist *et al.* (2001). They identified the problem of users being overwhelmed with content on a KMS and not being able to differentiate and use this content and suggested that a solution to this problem was to institute a peer-review system in order to formally legitimate what is stored in a KMS. They studied how effective such a system could be in a pharmaceutical company where changes in regulations require constant adjustments to the development and production process. In this context, the company had introduced a system to evaluate new incoming information and peer-review it before it was circulated, ensuring that this information was converted 'into something that is considered to be reliable and accountable knowledge' (p. 108). Based on their evaluation of this system, these authors conclude that, in relation to the role of IT in managing knowledge, 'attention should be directed towards the interactive processes of communication, negotiation, reviewing and commenting instead of focusing simply on what information should be fed into databases' (p. 110). More specifically, they argued that it is the social, collaborative process of reviewing that legitimizes knowledge and makes it more likely that it will be used across an organization. Essentially they are arguing that a repository KMS will not be effective unless it is supported by a network KMS (see Liu *et al.*, 2010, who also argue for the complementarity of the two approaches) because the social networking is needed to create the context in which the knowledge is legitimated. In this case the legitimation occurred through a peer-review process, but they acknowledge there may be other ways to legitimate knowledge, albeit they imply all will involve some sort of social process.

Unfortunately, the importance of this social process for legitimating content on a KMS is probably the exception rather than the rule, with rating systems being more common than peer-review type processes; even more common is that there is no content evaluation at all available to potential users who must then sort through the glut of information for themselves (if they make use of the repository at all).

More generally these accounts of how to legitimate knowledge to ensure the quality and make it more accessible so that it can serve a useful purpose are linked to the broader theme of KM/KMS governance. This line of research considers the kinds of governance that need to be in place so that the rights and responsibilities of different stakeholders are clearly defined. If these rights and responsibilities are not clearly defined there can be problems in harvesting the expected benefits from a KMS (Zyngier and Burstein, 2012).

Different approaches: managing knowledge and managing knowledge work

This discussion of ways in which organizations can improve the management of knowledge by focusing on contexts, processes and purposes has tended to assume that the same organizational mechanisms will support all aspects of KM – capture/store, distribute/transfer and effectively use/apply knowledge – in all situations. In effect these assumptions are related to the more general idea of absorptive capacity (Cohen and Levinthal, 1990), which identifies a general capability that organizations need to develop to acquire (capture), assimilate (distribute/transfer) and apply (use) knowledge (Roberts *et al.*, 2012). Recent research has suggested that the processes involved in acquiring, assimilating and using knowledge may differ across situations. For example, Carlo *et al.* (2012) studied three different types of IT innovation in software firms and showed that there were distinct knowledge antecedents for each. For example, the diversity of knowledge (i.e., the heterogeneity of a firm's knowledge base) directly impacted the level of service innovation (the creation of new software functionality for a client's tasks); but for base innovations (changes to computing capabilities and related architectures) knowledge diversity had no direct effect, but was rather mediated by sensing routines (the types of scanning and focused search undertaken) and experimentation routines (the ways in which firms attempted to 'try-out' new ideas through trial and error learning). On the other hand, the depth

of a firm's knowledge had a direct positive effective on the extent of base innovation; but a direct negative effect on the level of process innovation (new ways of designing and implementing software). While this study was not about KMS *per se*, it does indicate that different approaches to managing knowledge may have different effects. In this section we consider the different approaches to KM that have been identified in the literature.

We have already briefly introduced the distinction between repository and network KMS. Other accounts make a similar distinction, although they may focus on different aspects of KM (see, e.g., Earl, 2001, who has classified different 'schools' of KM). For example, Swan *et al.* (1999) distinguish between a cognitive and community model of KM. In the cognitive model, knowledge is viewed as an entity that exists in a particular user's brain or in a collective's routines and can be captured, codified, packaged and handed over to someone else to reuse. By contrast, the community model views knowledge as existing in practices and shared through participation in these practices (see Trusson *et al.*, 2013, for an account that depicts a discrepancy between managerial assumptions about the usefulness of a KMS based on a cognitive model and workers' actual knowledge practices, which privilege self-reliance and interpersonal knowledge sharing, i.e., represented by the community model). As another example of a typology, Hansen *et al.* (1999) distinguish between different KM strategies and identify a codification *vs* a personalization strategy. Hansen *et al.* make the point that companies should pursue one or other of these strategies since 'executives who try to excel at both strategies risk failing at both' (p. 7) and so advocate an 80–20 split – focusing 80% of resources on one strategy and the other 20% on the other. This is essentially in line with the idea that firms need to select either a cost leadership or a differentiation strategy (Porter, 1980), with the cost leadership strategy focusing on efficiency and so being consistent with a codification knowledge strategy and a repository KMS and differentiation focusing on innovation and hence consistent with a personalization strategy and a networked KMS.

Not all subsequent research has confirmed that pursuing one or other KM strategy is always best. For example, Liu *et al.* (2010) confirmed that pursuing an either/or approach was better when the potential from knowledge sharing was low, but found that in organizational contexts where the potential from knowledge sharing was high, pursuing a combined personalization and codification knowledge strategy was better than pursuing one or other, despite the trade-offs between these two approaches. Similarly, Lundh-Snis and Sorensen (2001) applied the cognitive/community distinction to analyse innovation in two manufacturing cases and argued for the need to look at the interplay between these two models of KM to understand what was happening in these cases and more generally to examine when and how codification supported by IT can be valuable. Moreover, Ciborra and Andreu (2001) argue that the kinds of KM approaches that are going to help within a single firm are not likely to be successful in a network setting. In the latter context, accidental learning from spill-lovers is more likely to foster success so that attempts to restrict and manage knowledge transfer may prove counter-productive here even while this might help within a single firm (we discuss this point further when we discuss social software below).

These typologies of KM are, then, typically presented as contingency accounts – repositories are better for some types of knowledge sharing and networks for other types. Viewed as a contingency account (more recently also referred to as task-technology fit – see Slaughter and Kirsch, 2006) they indicate whether knowledge can be transferred indirectly through text/IT, that is, repositories (which is assumed to be doable if the knowledge is explicit, the focus is on knowledge reuse and both sides – those who upload and those who use – share similar assumptions and background) or whether knowledge needs to be shared through personal interactions, that is, networks (which is assumed necessary if the knowledge is tacit, the focus is on innovation, and/or new to one of the parties in the exchange).

Another way of viewing these KM typologies is to view them as life-cycle accounts. Viewed as a life-cycle account, it is suggested that both codification (through a repository) and personalization (through networks) are important for different tasks necessary to complete the knowledge creation cycle. The most commonly referenced life-cycle account is Nonaka's (1994) SECI model – which essentially looks at the movement of knowledge between different states (explicit and tacit – see below) that he argues is essential for knowledge creation. In this SECI model, tacit knowledge is converted into explicit knowledge and then back again in order for a knowledge creation cycle to be completed (although see Tsoukas, 1996 and Hislop, 2002 and the discussion of knowledge as possession below for a critique of this notion of conversion).

Nonaka's model and the associated accounts of the most effective ways to transfer different types of knowledge (explicit and tacit through repository or network KMS respectively) have been used in the IS literature (e.g., Irani *et al.*, 2005). However, beyond seeing these different approaches from simply a contingent or life-cycle account, it is also important to recognize that they contain different assumptions about the nature of knowledge. We turn to this next.

An epistemology of practice and an epistemology of possession

Schultze and Leidner (2002) identify different types of knowledge discourse: normative (about the cause-effect of problems and solutions), interpretive (about understanding broad organizational implications), critical (about political struggles and power), and dialogic (about the complexity and lack of shared meaning). They argue that it is the normative view of knowledge that has been most common in the literature. This view treats knowledge as an asset (a resource) and as an object that can be extracted from an individual's mind and stored externally to be used by others, like any other object. A review by Jacks *et al.* (2012) suggests that the literature has moved from an essentially normative approach to more interpretive and critical views of knowledge over the 10-year period between 2000 and 2010, although there is still considerable research that remains wedded to the resource view of knowledge, even if this is only implicit.

Another way of considering the different assumptions about the nature of knowledge was presented by Cook and Brown (1999) who distinguish between an epistemology of possession (that treats knowledge as something individuals and groups have or own, based on prior experience but separable from that experience) and an epistemology of practice (that treats knowing as something people do that is context-dependent, always emerging and socially situated).

Essentially, this distinction differentiates between the idea that people 'have knowledge' and that people 'act knowledgeably', an idea that we introduced earlier.

The possession perspective focuses on structures (e.g., routines that 'carry' knowledge) and cognitions (individual mental functioning with the mind seen as the carrier of knowledge). Knowledge is, thus, a personal property of an individual knower or a collective (Spender, 1996), and mental processes are the mechanism that confers meaning (i.e., knowledge) from data and information, which exist 'out there' (i.e., outside the head) in the world. These mental processes are the product of past experiences, perceptions and theoretical understandings, which create a 'frame of reference' that allows an individual to infer particular things (i.e., to make discriminations based on patterns they see in the data as this relates to theory or experience). Therefore, an individual with prior training in physics can infer meaning from the equation – e = mc squared – that someone without this possessed knowledge will be unable to. This possessed knowledge includes both tacit and explicit knowledge (Polanyi, 1967). Explicit knowledge is that which can be written down or articulated in language or some other symbolic form. Tacit knowledge is knowledge that is impossible or certainly hard to write down and, even if written down, does not express the knowledge adequately. The example that is often used is knowledge of riding a bike. This includes both explicit knowledge (you must sit on the saddle and hold on to the handle bars, which might seem obvious but if you had never seen a bike before you would be unlikely to know that it was something you could sit on and pedal) and tacit knowledge (you must balance to stay upright). The knowledge of balance will always remain tacit – you can be told to shift weight if you are falling to one side, but what this 'shifting weight' actually involves cannot be explicitly shared, although once it is mastered the individual will possess it as tacit knowledge. It is important to remember in Cook and Brown's classification that both explicit and tacit knowledge are possessed knowledge (tacit knowledge is not the practice element), albeit the epistemology of practice is needed, in their view, to generate this possessed knowledge. Importantly, it is also clear that the repository and network types of KMS are both based on facilitating the sharing of possessed knowledge (the repository KMS of explicit knowledge and the network KMS of tacit knowledge). From Polanyi's account it is also clear that tacit knowledge cannot be converted to explicit knowledge (Tsoukas, 1996), although there may be considerable implicit knowledge (articulable knowledge that no one has bothered to try and formalize in words or text) that can be made explicit.

The epistemology of practice, on the other hand, sees knowledge, or better knowing, as intrinsic to localized situations and practices where people perform or enact activities with a variety of others (both human and non-human) such that acting knowledgeably emerges from this practice and cannot be separated from this practice. Knowledge and practice are thus, immanent; knowledge is not something that stands outside of practice but is rather constantly (re)produced as people and their tools work together with certain consequences (intended or otherwise). The collective, or community, within which practice is undertaken, is characterized by a particular set of stories, norms, representations, tools and symbols which together produce the knowledge-related outcomes. These outcomes include the development of shared identities as well as shared beliefs, which underpin being a knowledgeable actor in any particular setting. Moreover, these outcomes are always emergent – never completely predictable (Marabelli and Newell, 2012). From this perspective, it is not possible to 'manage knowledge' *per se*; rather the focus is on managing knowledge work (i.e., the practices).

Cook and Brown (1999) see these two epistemologies not as alternative or opposing views (unlike radical practice theorists like Nicolini, 2011), but rather as complementary, with knowledge (possessed) being a tool of knowing. Possessed and practised knowledge, thus, work together in what they describe as a 'generative dance'. However, practice, from this perspective, has the central role since an individual's possessed knowledge exists only in so far as it was created using social categories derived from practice that gave sense to this knowledge (Latour, 2005). Thus, possessed knowledge is always a product of past practice. Much of the KM/KMS literature discussed above has, more or less implicitly, adopted a knowledge as possession perspective, ignoring the role of practice in generating this knowledge and making this knowledge useful in practice. In this next section, therefore, we consider some of the more recent research that is looking at knowledge from a practice perspective and considering how IT is an actor in knowledge work (not merely a passive container for transmitting knowledge).

The practice view of knowledge is associated with research on particular communities of practice, the focus being on how old-timers share knowledge with novices, not through a direct transfer of knowledge, but rather as novices work alongside experts so that over time they develop the skills, understanding, beliefs and sense of identity associated with the particular practice community. This is referred to as 'legitimate peripheral participation' to denote the idea that newcomers learn through gradual participation in the situation of doing. Communities that have been studied include nurses, flute makers, photocopy technicians, tailors, radiologists, academics etc. and is most associated with the work of Lave and Wenger (1991) and Orr (1996), although today there is considerable IS research that has used the concept of community of practice to study some aspect of IT-enabled practice (see below).

Moreover, recently, it has been recognized that focusing on single communities may be overly restrictive because practice typically involves interactions and negotiations with people from different professions and communities (McPherson and Sauder, 2013). It is also recognized that practice is not simply a social activity but is materially mediated, even when the practices are discursive (Stegliani and Ravasi, 2012). For instance, social actors can interact with each other through objects (either physical or conceptual boundary objects, Star and Griesemer, 1989) or, they can interact directly with objects (e.g., an IT artefact). We turn next to these more recent developments in the IS discipline as it focuses on knowledge work.

Recent developments: IT as an active participant in knowledge work

In reviewing this literature we use the same framework previously introduced (context, processes and purpose) but go beyond existing accounts that emphasize culture, incentivizing individuals and legitimating and qualifying knowledge. This allows us to connect to the old debates but also to surface some new debates related to the context, processes and purpose

associated with managing knowledge work (rather than managing the knowledge itself).

Beyond an enabling social (cultural) context: material agency

As we noted earlier, social structures and cultures have been identified as contextual factors influencing knowledge sharing. While these social structures are clearly important, from the practice perspective of knowledge – that knowing is constituted in and by practice – material as well as human/social agency has emerged as important and has been discussed in the IS literature under a number of conceptual umbrellas, including Bourdieu's practice theory (1977 – e.g., applied in IS by Schultze and Boland, 2000), Actor Network Theory (ANT) (Latour, 2005, e.g., applied in IS by Hanseth and Monteiro, 1997; Mitev and Howcroft, 2011), Mangle of Practice (Pickering, 1995, e.g., applied in IS by Rose and Jones, 2005 and Chae and Poole, 2005) and sociomateriality (Orlikowski and Scott, 2008, e.g., applied in IS by Jones, MISQ forthcoming). These accounts suggest that we need to look beyond the social aspects of an organizing context to examine knowledge work.

From a practice perspective, knowing is a performative accomplishment (i.e., our practice constitutes the social world that we experience), and while it may be based on knowledge possessed by individuals (if one accepts the mutual constitution view of, e.g., Cook and Brown, 1999) it is the act of doing something that constitutes knowledgeability (and generates the possessed knowledge) and doing typically involves a range of actors, human and non-human (as with the doctor practising with her stethoscope). This has brought to the fore the agency of non-human actors, including IT, in knowledge work. An example often used and easy to understand is how a hotel room key can be designed in ways that produce different outcomes – a key with a large fob that is too heavy and large to put in a pocket will mean that guests don't leave and forget to return their room key. The key in this example has agency; it is an actor because it makes things happen. While in this example, the key has a physical presence, materiality can also involve less-tangible objects like concepts (Pickering, 1995). For example, a particular software interface can have agency in the sense of influencing knowledge work, as can a conceptual aspect of a database, like data centralization.

One way of thinking about material agency is using the concept of affordance (Gibson, 1979), which considers how objects constrain and allow human actors to do certain things (i.e., to practice knowledgably); or as Markus and Silver (2008) put it, 'the possibilities for goal-oriented action afforded to specific user groups by technical objects' (p. 622). Some see objects as having pre-defined affordances that are waiting to be identified by human actors (Norman, 1988); others see affordance as open-ended and always 'in the making' depending on the particular interactions between the human and non-human actors (Leonardi, 2011). In some ways this distinction is reminiscent of the distinction between knowledge as a possession and a practice. On the one hand, seeing material objects as having pre-defined affordances focuses on the features and functionalities that an artefact can be said to possess; on the other hand, looking at the emergent affordances of an artefact focuses on its use in practice. As with knowledge, we can potentially consider how knowing in practice is a result of a generative dance between the pre-defined (or better designed) affordances of an artefact and its use in everyday practice, which may at times be very different from how it was designed to be used (e.g., using email as a knowledge repository by sending important documents to oneself) and with any given object having the potential for multiple possible (but nevertheless not without limits) affordances (Volkoff and Strong, 2013).

As an example of the role of materiality in knowledge work, Jung *et al.* (2010) illustrate how modifications to a software interface can influence how much users collaborate, with these modifications influencing the IT artefact's 'motivational affordance' (the degree the system design fulfilled users' motivational needs). This study adopts a possession view of material affordance in that the interface is regarded as static (even if appealing) with the interface affording certain behaviours. On the other hand, Zammuto *et al.* (2007) consider how it is important to understand changing organizational forms (e.g., the move to more networked rather than bureaucratic forms of organizing that better support knowledge work) by considering the affordances of IT in conjunction with the features and practices of the social system in which the IT is being used (i.e., a more practice-based view of affordance). For example, they describe how virtual collaboration is afforded by the particular intertwining of IT and organizational features: Sharepoint® may open up opportunities for distributed knowledge workers to collaborate, but whether this happens may depend, for example, on organizational contextual features such as the amount of interpersonal conflict in the team (Hinds and Mortensen, 2005). Once the affordances of an IT artefact become embedded in particular organizational routines, the IT artefact itself becomes an important guide for human action, a generative mechanism sustaining an organizational routine (Robey *et al.*, 2013), such as a knowledge sharing routine supported by Sharepoint®. At the same time an IT artefact also provides the potential for new routines based on new affordances that emerge as people appropriate artefacts in new (sometimes unintended) ways (Leonardi, 2013, describes this using the metaphor of imbrication). This (practice) view of affordance highlights, in contrast with the previous example of the software interface, the dynamic relationship between human and social agency where human agency does not just adapt to a technology (and thus, come to 'possess' the understanding of how to work with an interface); human agency actively interacts with the technology (the users interact with their peers while they practice a new technology such as Sharepoint® but they also try to change what the technology can do for them, for instance appropriating new affordances).

These accounts of material affordance are based on the idea that it is possible to separate material artefacts and their use in social contexts; an approach Robey *et al.* (2013) describe as socio-technical. In contrast, a more radical, sociomaterial (no-hyphen) ontology views the social and material as inseparable, rejecting 'the notion that the world is composed of individuals and objects with separately attributable properties' (Orlikowski, 2010: 134) and instead seeing the social and technical as 'constitutively entangled in everyday life' (Orlikowski, 2007: 1437). Here we do not have space to go into the implications of these ontological differences (see Special Issue on Sociomateriality in *MISQ*, Cecez-Kecmanovic *et al.*, Forthcoming), rather we want to emphasize the importance of future research that considers the role of the IT-artefact itself in knowledge work. Thus, future research can usefully consider how materiality can afford or constrain knowledge

work, not seeing these outcomes as a product of only social aspects of a context (like the culture in an organization) but examining the different ways in which material agency has performative outcomes, for example, in relation to knowledge acquisition or knowledge translation. Moreover, while this has business implications, it also has broader societal implications, for example in relation to creating effective online education, or from a more negative perspective, encouraging the spread of pornography.

Beyond motivating individual processes: overcoming knowledge boundaries

We saw earlier that literature has focused on how to incentivize individuals to share their knowledge with others. This assumes the main barrier to knowledge sharing is individual motivation. However, this ignores knowledge boundaries that can mean that even when individuals share their knowledge this may not be effective. Thus, the knowledge literature has highlighted that knowledge does not flow smoothly between people and organizational units, especially where they have different backgrounds and experience (Montazemi *et al.*, 2012); knowledge is thus described as being 'sticky' (Szulanski, 1996). Some of the knowledge literature has obscured this because it has focused on knowledge processes within particular communities (i.e., all the literature on communities of practice that refers to the seminal work of Lave and Wenger, 1991).

In some cases this focus on a particular community is invaluable for exploring and explaining a particular phenomenon. For example, Panteli (2012) considered how a community was important for explaining how women wanting to return to the IT industry after a career break were prepared for this transition. However, many knowledge challenges exist in contexts where people from different backgrounds and interests need to practice collaboratively (Pan and Leidner, 2003). Nicolini (2011) refers to such contexts as 'sites of knowing' to capture this aspect of knowledge practice. A site of knowing involves the discursive practices, artefacts and spaces that form a nexus for knowledgeable action in a particular context. For example, in a hospital, there may be a variety of communities of practice (nurses, oncologists, radiologists, even patients with a particular disease) and to understand practice in this setting it is important to look at the inter-relationships between these communities as well as the relationships between people and objects and spaces. The knowing of a paediatrician, for example, is intimately tied up with the tools (including IT tools) that she uses and the relationships she has with a variety of other healthcare professionals (and the patient). It is through and with these relationships that she can act knowledgeably. From a practice view, within this context, or site of knowing, people and objects do not 'carry knowledge' but instead are mediators that actively translate knowledge (Latour, 2005). Given this process of translation, practice (and so knowing) is always emergent – 'pursuing the same thing, necessarily implies doing something different' (Nicolini, 2007: 893–894).

Translation captures the idea that knowledge is (re)produced rather than transferred, so that certain elements will be foregrounded or take on different meaning depending on the mix of actors (human and non-human) that are present.

This brings to the fore that problems associated with knowledge work involve more than simply that knowledge is sticky because of a lack of shared mental framework. For example, Carlile (2002, 2004) highlights that there are syntactic, semantic and *pragmatic* boundaries that can prevent knowledge workers collaborating. Pragmatic boundaries attest to how we are invested in our knowledge so that any change that threatens our knowledge is likely to involve some kind of political contestation. Pozzebon and Pinsonneault (2012) combining a possession/practice view of knowledge with a similar view of power demonstrated how power struggles between consultants and clients emerged in practice, triggered by clients increasing knowledge that led them to question some decisions made by their consultants. This study demonstrates how it can be divergent interests (rather than a lack of common understanding) that can influence success in collaborative knowledge work settings. In another study, Ma and Agarwal (2007) demonstrate how technologies that can help to communicate and verify an individual's identity (in contexts where collaboration involves strangers) positively influence the degree of contribution in an online community, affirming that knowledge sharing is not simply based on functional need and reciprocity but is also influenced by what knowledge sharing means for our identity. Given our investments in our knowledge, we will resist knowledge that undermines what we know and share knowledge when it helps to bolster our self-identity (even when this is a negative self-identity, as in communities focusing on self-harm).

The Ma and Agarwal (2007) study also demonstrates that while human actors – knowledge brokers who can surface and challenge different assumptions among different groups (Pawlowski and Robey, 2004) – can help in overcoming knowledge boundaries, material artefacts can also be important in spanning knowledge boundaries, as attested by the work on the role of boundary objects (Star and Griesemer, 1989; Star, 2010). Boundary objects can be either abstract (a metaphor) or physical (a prototype) and they are important because they have interpretive flexibility (people can make sense of them in different ways) that can help those involved in a collaborative effort to translate knowledge for different communities (Doolin and Mcleod, 2012); yet they are robust enough to maintain a common identity across sites (Star and Griesemer, 1989). In this way, they play a role in helping to promote shared representations, transform knowledge, mobilize action and legitimate knowledge (Bergman *et al.*, 2007). However, as Levina and Vaast (2005) note, a boundary object does not have specific properties that enable this translation; rather it is the ways in which a particular object is used in 'collective-reflection-in-action' by the collaborating parties that is important. In other words, those attempting to work together from different backgrounds must recognize that a particular object (an IT software package for example) can be interpreted differently to the way that they are interpreting the object and that for the collaboration to be successful these differences must be appreciated with a view to negotiating a common understanding and some shared interests.

Gal *et al.* (2008) suggest that boundary objects not only facilitate cross-organizational communication through their help with knowledge translation but also help to establish organizational identities, indicating that boundary objects can have a symbolic role (Swan *et al.*, 2010). Developing this further, Nicolini *et al.* (2012) distinguish between different roles that can be played by objects, including: boundary objects, epistemic objects and infrastructural objects. Boundary objects, as already discussed, help to bridge collaborators from different specialized domains. Epistemic objects (Knorr-Cetina,

1997) are inherently open-ended and unfinished such that they motivate collaborators to work together based on a mutual recognition that they all want to develop more knowledge about the object; they become emotionally invested in working together to solve complex problems (see Ewenstein and Whyte's 2009 discussion of the role of a sketch in motivating collaboration in a design project). Infrastructural objects are those taken-for-granted objects that nevertheless can support (or harm) collaboration, 'scaffolding' everyday activities (Orlikowski, 2007), their role only coming into focus when an object suddenly stops working so that people realize that there was a relationship between them and the objects, albeit taken for granted (Sandberg and Tsoukas, 2011). To-date the IS literature has focused on objects as boundary objects and to a more limited extent infrastructural objects (Gal *et al.*, 2008) suggesting that there is scope for considering the epistemic roles of objects. This is likely to be particularly pertinent in IS, since the continuous creation of new IT means that the objects of development themselves might play a significant role in motivating knowledge work (as, e.g., in open source communities, von Krogh *et al.*, 2012).

Beyond fulfilling the purpose of KM by legitimating knowledge and good governance: social software and open innovation

We saw earlier that research has focused on how to legitimate and improve the quality of knowledge so that it is more accessible to potential users and has identified the importance of validation and governance structures that control the rights and responsibilities of contributors and users of a KMS. However, the more recent developments in social software raise questions about whether and when, this is necessary – after all, there are very few controls on sites like Facebook or Linked-in or Twitter and yet people manage to use these sites very successfully to share and collaborate. More fundamentally, these new types of social software (sometimes referred to as Web 2.0 or enterprise 2.0, McAfee, 2006) bring new opportunities for thinking about who will be involved in an organization's knowledge work.

Research on understanding online collaboration is not new, with a whole community of scholars (CSCW – Computer-Supported Collaborative Work) dedicated to this agenda since the mid-1980s. This community refers to the tools that support collaborative work as 'groupware' and they see the development of such technologies as 'a conceptual shift; a shift in our understanding. The traditional computing paradigm sees the computer as a tool for manipulating and exchanging data. The groupware paradigm, on the other hand, views the computer as a shared space in which people collaborate; a clear shift in the relationship between people and information' (Marca and Bock, 1992: 60). More recently, authors have noted the differences between groupware, that is software focused on facilitating group processes with clearly defined goals; and social software, that is software focused on individuals and their social desires to communicate with others, with no defined purpose, at least upfront; although potentially its use can fulfil goals. Koch (2008) summarizes the difference as 'Web 2.0 [social software] provides new technologies, a focus on usefulness and on the medium aspect of support, while CSCW [groupware] provides insights into groups and the needs of organizations and management' (p. 10). Exemplifying this difference is the contrast between Sharepoint® that can facilitate sharing of documents and exchanging information in a clearly defined and managed structure and Facebook, a generic platform that can be used for many different tasks and in a very flexible way. Social software (as opposed to groupware), by definition, therefore, means that managers need to let go of any notion that they can control the communication and employees have to believe that their contributions are not being monitored, perhaps explaining why there are relatively few examples, to date, of the really effective use of social software in business organizations (Huang *et al.*, 2013).

IS research has focused on how to maximize contributions in these collaborative online forums, especially in contexts where there may be no immediate gain to those involved and despite potential free-riding of some (e.g., Whelan, 2007; Wang and Haggerty, 2009; Davison and Ou, 2013). Research has also focused on collaborations that are inter-organizational and intra-organizational (e.g., Kotlarsky *et al.*, 2007).

More fundamentally, these new social software applications have given rise to new ideas about who can participate in organizational knowledge work. Ideas of open innovation use various types of social software application to engage a variety of organizational stakeholders in the innovation work; work that was previously done entirely in-house, albeit drawing on ideas and resources from beyond the firm's boundaries (Chesbrough and Garman, 2009). Achieving the goals of these new ways of innovating, especially when a firm is collaborating with new partners, often relies on active intermediaries who broker the relationships (Feller *et al.*, 2012), thus not assuming that knowledge itself can be straight-forwardly transferred. Ideas of social capital have underpinned some of this research (e.g., Huysman and Wulf, 2006), although some research has also shown that many aspects of social capital that would predict knowledge sharing in non-virtual environments (like high levels of relational social capital) do not predict sharing in virtual settings (Wasko and Faraj, 2005). For example, research has shown that people participate in these networks not because they expect any immediate return, but rather because this can enhance their professional reputation or more simply because it feels good to participate and help others (Wasko and Faraj, 2005).

Today there are many different types of social media that are used to support collaborative knowledge work, both within the firm and between the firm and its various stakeholders (e.g., Yuan *et al.*, 2013). A specific example is the social reality application (virtual world technology) like Second Life and World of Warcraft, where the self is presented in the virtual body of an avatar – as a cyborg (Schultze and Mason, 2012). As a cyborg, a person experiences that she is present in the virtual world (e.g., in a distant place, or with others, or even inhabiting the body of the avatar). IS research, argues Schultze (2010), needs to consider how this avatar-embodied presence can be manipulated to best meet the purpose for which an organization is using a virtual world. For example, she reports that in some business contexts, policies have been put in place to limit the customizability of avatars (a dress code for avatars) but she questions how effective this will be, where, for example, the purpose of the virtual world immersion is to improve diversity understanding. Moreover, she suggests that virtual worlds may be a particularly useful domain in which to consider a sociomaterial or relational ontology – considering how the virtual-real duality is enacted or performed in practice, rather than assuming that there is a fixed divide

between a person and her avatar (the very concept of cyborg meaning the boundary between a person and her avatar is no longer clear cut). The potential of such social software in relation to knowledge work was demonstrated by Mueller *et al.* (2010) in their case study on a virtual world used in IBM. Using a knowledge-as-practice perspective they identified that virtual worlds can be 'applied for dynamic, practice-based and experience-rich knowledge generation far above the pure collection of knowledge in databases' (p. 491).

Much of the literature reviewed has focused on how to increase contributions in online social software platforms (Faraj *et al.*, 2011). However, Smith *et al.* (2012) argue that while this focus on encouraging participation is perhaps not surprising since research has shown that most (over 90%) of 'participants' in online forums are lurkers (visiting but not posting), they also note that we should not forget that at times reducing the barriers to connecting knowledge workers can have a dark side. For example, they conducted a study to demonstrate how in networks of professional practice, confidential company information can be inappropriately disclosed (Smith *et al.*, 2012; see also, Trkman and Desouza, 2012). This suggests the importance of 'vigilant interactions' in collaborations (allowing collaboration to proceed without harm), especially when these are inter-organizational (Jarvenpaa and Majchrzak, 2010). This attention to vigilant interactions will go beyond considering online forums as merely people participating in conversations; rather, Jarvenpaa and Majchrzak (2010) argue that we will need to attend to action-reaction sequences that emerge over time as participants decide, for example, what to post on a wiki and how to respond to someone else's comments often in situations of trust asymmetry (where one interactor is more dependent on another than vice-versa) and where some may be interacting deceptively. Moreover, and in line with the practice view focus, Majchrzak and Malhotra (2013) consider ways in which the social software tools can be designed to shape and optimize open innovation, for example, by encouraging participants to comment on (and so develop) each others' posted ideas rather than simply submitting their own ideas. There are, thus, many opportunities for IS researchers in relation to understanding how new social software applications are being used in business organizations; including the unintended as well as the intended consequences of such applications will be particularly important.

New approaches to managing knowledge and knowledge work: crowd and sensor approaches

Having considered the literature on managing knowledge as well as the literature on managing knowledge work, in this final section we turn to new developments that suggest some fundamental shifts are taking place in terms of how organizations are viewing and using knowledge and knowledge work. Specifically, we can see firstly a shift taking place in relation to the boundaries for managing knowledge and knowledge work: here we see how organizations are moving from seeing knowledge as a valuable resource that is used by knowledge workers and that needs to be managed effectively internally but protected from the outside, to seeing how 'the wisdom of the *crowd*' can be exploited for firm benefit. Secondly, we can see a shift taking place in who is assumed to do the knowing. In this case, we can see movement from treating knowing as an exclusively human accomplishment, albeit materially mediated, to seeing knowledge work as something that can be automated from *sensor* data to produce discriminations based on connections. We describe these movements as involving shifts to a new 'crowd' approach and a new 'sensor' approach. In the crowd approach the assumption is that if we don't know the answer, someone out there will; so we can use IT platforms to get answers from many people. In the sensor approach the assumption is that the data itself (data collected by the social software applications that we are using plus all the other technologies that we use that now have tracking sensors built in) can reveal the answers, even if we don't understand why.

Turning first to the crowd approach, as Von Krogh (2012) argues, while social software 'carries great promise for knowledge management', it also 'raises fundamental questions about the very essence and value of firm knowledge, the possibility of knowledge protection, firm boundaries, and the sources of competitive advantage' (p. 154). Rather than knowledge being a precious resource to be used by knowledge workers within the organization to create value, but protected from the outside to achieve competitive advantage, social software and the associated ideas of open innovation and crowd-sourcing potentially turn this traditional mantra on its head. For example, competitions on social software platforms can be used to encourage 'the crowd' to suggest solutions to different types of organizational problem (Boudreau and Lakhani, 2009) or wikis can be used to encourage collaborative writing on 'what is known about….' (as in Wikipedia). But how to utilize social software for open innovation needs careful consideration, for example, in terms of how and what knowledge to protect and what to share with others outside the firm boundary in order to reap the potential of the 'wisdom of the crowd' without losing a firm's trade secrets; and how to reward the crowd for its input into value-generation and maintain their motivation when they are essentially volunteers. We can also consider how the crowd can become the bully when social software is used by vulnerable groups, like children, who may too easily follow others into posting hateful comments to someone. IS research that considers such issues, positive and negative, associated with crowd-sourcing through social software, is going to be very important moving forward.

While the crowd approach may be new in that it involves stakeholders beyond an organizational boundary, in many ways it can be viewed as simply an extension of the repository and network approaches: people are still required to explicitly engage in knowledge sharing and we can focus either on managing the knowledge or managing the knowledge work. The sensor approach, on the other hand, is fundamentally different because it is based on implicit rather than explicit sharing. The idea behind the sensor approach is that it may not be simply the ways in which these new types of social media encourage knowledge sharing/creation in their own right that is important for business (and for us to study). Rather, the data trail from use of social software that contains tracking devices (as well as all our other devices which increasingly now have tracking software in them) provides new opportunities for creating useful knowledge for organizations. In other words, what is valuable is the data that is accumulated by having sensors everywhere (in our phones, our cars, our homes, our workplaces). This may not be considered under the umbrella of KM (which is why the term KM may begin to fade); rather the

current umbrella term is 'big data'. Nevertheless, it is extremely relevant to our understanding of how knowledge and knowledge work will be viewed in the future.

According to the advocates of big data (Mayer-Schonberger and Cukier, 2013), the old idea was that knowledge work was about understanding causes that could explain why things happen the way they do (whether in science, business, or society). This understanding, as we have already discussed, was the basis for being able to make discriminations in practice. Today, by contrast, they argue that, with the 'datification' of everything, it may not always be about looking for causal explanations but instead allowing the connections to be identified through analysing big data sets in combination and often for purposes other than what the original data was collected for – a phenomenon described as data exhaust (Mayer-Schonberger and Cukier, 2013) – and taking action based on these connections even if the reasons for the connections are not known (McAfee and Brynjolfsson, 2012). For example, Google claims that it is better able to predict flu epidemics than the Center for Disease Control (CDC), based purely on website clicks.[2] This puts a very different emphasis on what constitutes knowledge work. An example provided by Mayer-Schonberger and Cukier (2013) is of Mayor Bloomberg hiring Flowers and Flowers hiring five rookies to use data available in New York to improve the city. These rookies, without understanding why, were able to use various data sets to predict houses that were likely to be fire hazards. They did this using, for example, construction data – this predicted which houses had been revamped so that many more people were living in them than was safe from a fire perspective; through this data analysis, inspectors were able to much more effectively target and find the unsafe houses. In this way, the theoretical frames and experiential understanding of knowledge workers (the fire inspectors) were usurped by the data analysts (the rookies) who could identify patterns in big data sets.

These developments are important for the IS community because IT affords the data collection (it is through digitization that we are left with a memory trace – as was acknowledged by Zuboff back in 1988 but which has not until recently really led to major business and social changes but which now, with the datafication of everything, has massive potential); IT provides the means through which the data is analysed (big data analysis requires super computers and network computers); and often IT is the means through which insights gained from this analysis are used to create new value (e.g., marketing campaigns using social software based on big data analysis that allows more specific targeting of advertisements – as when you receive ads from a car dealership about special offers on particular models after you have googled car auctions). There are many questions that emerge from this sensor approach, not least of which is when discriminations based on connections in the data actually can be as, if not more, effective than discriminations based on human experts (McAfee and Brynjolfsson, 2012).

In examining this issue, we should note that the algorithms that are produced to analyse the 'big data' are always based on rules that are black-and-white; yet what is 'right' to do in a particular situation often involves value judgements because many situations where knowledge workers are involved include discriminations and so decisions that are not black-and-white (e.g., whether and when to intervene in a family where children might be at risk; whether to enter a potentially lucrative market in a new country where human rights abuses are high; whether a hospital should invest in a new specialist baby-care unit or a geriatric unit). This suggests the need for research to identify the knowledge work that might be 'outsourced' to the algorithm and the knowledge work that might continue to require human judgement. More generally, there are many implications of this new sensor era that are worthy of IS scholars' attention. These include implications that are political (e.g., how will the privacy and security of citizens be protected), economic (e.g., what is the impact on different professions, including IS professionals), social (e.g., how do big data decisions affect different social groups and create new forms of bias) and legal (e.g., who owns the data).

As summarized in Table 1, arguably the crowd and sensor approaches raise more fundamental social and personal questions than did the repository and network approaches; questions which the IS community will need to grapple with if research in this area is going to be relevant to business and/or society.

Table 1 Comparison of different approaches to managing knowledge

Approaches to managing knowledge	*Repository*	*Network*	*Crowd*	*Sensor*
IT support	Databases and search engines	Peer-to-peer virtual networks	Platforms that enable as many voices as possible to contribute	Tracking devices in technologies
Outcomes	Reuse of explicit knowledge for efficiency	Sharing of tacit knowledge for improved innovation within organization	Wisdom of crowd to support fast open innovation	Datification that can reveal patterns that can be used for decision-making, regardless of understanding why
Issues	Creating culture of trust; incentives for sharing; quality of knowledge	Pragmatic boundaries; power asymmetries	Protection of firm IP; rewarding participants who are not employees; novelty of ideas	Political, economic, social and legal issues

Conclusions

Perhaps the terms KM and KMS are on the wane. Nevertheless, the idea that knowledge work – the making of decisions based on discriminations whether founded on knowledge possessed by an individual, emergence from ongoing practices, the wisdom of the crowd or the connections observed in a data-set – is fundamental to business and society is beyond doubt. This is the case even in an era where organizations may no longer be making decisions based on traditional views that suggest the organization (or at least its employees) must understand cause-and-effect as a basis for making discriminations that allow them to make informed (i.e., knowledgeable) decisions. Instead, organizations may be moving to a crowd approach (the answer is out there and organizations simply need to tap this) and/or a sensor approach (trends in the data can alert organizations to what is happening irrespective of why) as ways to explore and exploit knowledge for business value.

Yet, we should also not forget that following like sheep (which is essentially what both the crowd and sensor approaches can mean) can lead us to unseen precipices and may not help where we are trying to develop radically new approaches to business or trying to solve major societal problems. Moreover, there are a myriad of privacy, security and more general ethical issues that are unleashed as social software is used to encourage us to communicate explicitly on everything we do and as data is collected implicitly on all our movements.

These issues are important research topics for us as an IS community, whether we are interested in finding ways to increase business value or we are concerned with broader social issues of equality and democracy. Therefore, tracking your elementary child's movements using their mobile GPS data or reading their online conversations may seem like good ways of making sure they are safe, yet how this will affect young people's sense of personal responsibility remains to be seen. Similarly, while using technology to control your teenage son's car-driving, using a monitoring device that shows speeds being done in comparison with speed limits, may seem like a good way of preventing accidents (given that young people are more likely to be in accidents and that monitoring them and restricting their insurance options if they do not drive safely can reduce accidents), but we should also be thinking of the consequences of this for self-restraint when the monitoring is removed for some reason. And in the work context, tracking employees (using, for example, Hitachi's newly developed ID badge that contains sensors which track not just where a person is physically, but also who they are interacting with and the intensity of the conversation) may seem like a good way to improve organizational effectiveness (e.g., to identify how 'wasted time' can be eliminated), but the unintended consequences (e.g., in terms of motivation and job satisfaction) may prove to outweigh the potential benefits, never-mind the ethical issues associated with such constant monitoring.

Thinking about these big issues with the advent of the crowd and sensor approaches to knowledge and knowledge work provides a rich research agenda for IS scholars. Undertaking such research requires that we engage with broad debates about the consequences of technology in business and society, at the same time as we study how technologies are actually involved in everyday knowledge work practices in organizations. Moreover, these issues also raise questions about what it is appropriate for organizations to know. Such questions have in the past been confined to contexts where organizations obtain knowledge illegally, for example, when an airline illegally hacks another airline's computer system in order to obtain confidential information; or where an organization engages in illegal phone tapping of executives in another company. However, with the advent of the crowd and sensor eras, research and debate about whether, which and for what purpose organizations have the right to know about – my health, my financial situation, my driving ability, my location at any time of the day, my shopping and eating habits, my friendship network, and many other minutiae of my daily life – becomes a research agenda that can be tackled from both a normative (what is good/bad for the individual, the organization, the society) and a practical (what are the intended/unintended outcomes) perspective.

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Notes

1 We do not equate knowledge with what is stored in the human brain but here use the term to emphasize how the view of workers as 'a pair of hands' was changing.
2 Although this accuracy has not been consistently confirmed.

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