Knowledge Management Concepts and Models

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1 Introduction

As the previous chapter has explained, knowledge management (KM) has formed from, and been influenced by, several other disciplines. One of the challenges from the earliest days has therefore been to find ways of uniting the disparate theoretical bases of these disciplines, or at least reconciling them sufficiently to be able to build on solid foundations. This has not been easy, and progress has been slow, but KM is in good company on this. Physicists are still edging closer to a Unified Field Theory after 100 years or so, while the countries of the world are split roughly two to one over which side of the road to drive on, and only one country has changed side in the past generation.

The analogy with driving can help us set an attainable goal for KM. There is unlikely ever to be an agreement to all driving on the same side, but it makes sense that everyone drives on the same side throughout one country and that it is well-known that in (say) Japan one drives on the left, while in (say) Canada one drives on the right. So, let us put aside ideas of a single theory of KM, and instead set our sights on the more realistic goal of achieving an agreed terminology or ontology for KM. Indeed, it could be argued that a single KM model might be undesirable, as unless it can be as fundamental as for example the chemists' periodic table, then it might "fossilise" the field and act as a barrier to further progress.

The use of the word "ontology" illustrates the challenge nicely. We have just used it in its information science sense: a taxonomy, classification or categorization of meanings in a field. However, in philosophy, ontology refers to the study of the nature of reality. Taxonomy forms only one small part of that study. So, as information science and philosophy have both influenced KM, we have plenty of

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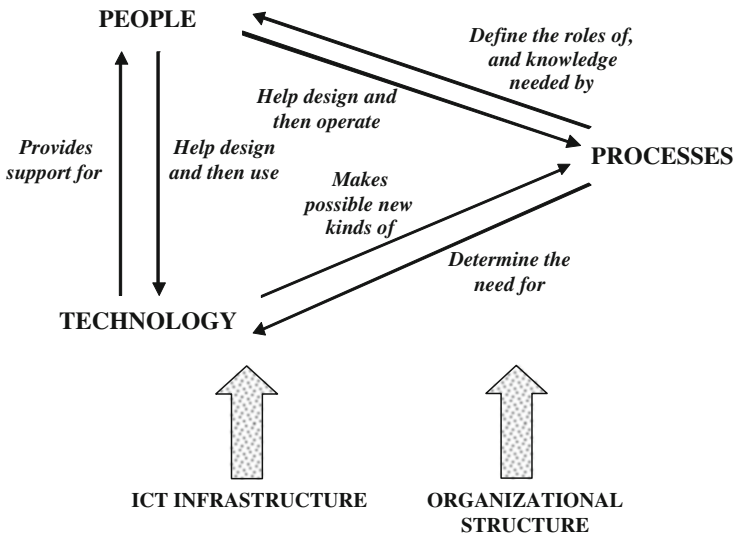

Fig. 1 People, processes, technology and structure (Modified from Edwards 2009)

work to do! The most successful ontology (on the information science definition) for KM so far has been the Formal Knowledge Management Ontology (FKMO) of Holsapple and Joshi (2004). The FKMO includes over 100 definitions and axioms relevant to KM, set out in natural language (English). Garbacz et al. (2012) present further work on a KM ontology and review ontologies in related domains.

An examination of the field of KM will rapidly reveal that the road KM drives on also has rather more than two sides to choose between. Heisig (2009) analysed no fewer than 160 KM frameworks, and that number can only have increased since then. There is, for example, no general agreement about the precise meanings of, or relationship between, the terms knowledge sharing and knowledge transfer, even though knowledge sharing is the most-researched topic in KM (see for example Ribière and Walter (2013)). Nor is there agreement over the definition of a knowledge management system (KMS), as we shall see in a later section.

In order to provide some structure to this chapter despite this level of disagreement, we will start from a model originally developed for knowledge management systems. This regards a KMS as comprised of the interaction between three elements – people, process and technology – as shown in Fig. 1. The Figure also shows how these KMSs, whether formal or informal, are further supported by – quite literally, built on top of – the organization: its structure (both "departmental" and the way in which it recruits, supports and develops its human resources) and its technological infrastructure.

Adding the elements of the Figure to the central concept of knowledge itself therefore yields the five aspects of KM that will be covered in this chapter:

- Content aspects
- Process aspects, including knowledge life-cycle models

- People aspects
- Structural and strategic aspects
- Technological aspects

There is no specific order in which these must be considered in any KM initiative. Our order here is chosen as much for ease of linking the sections as any other reason.

Before we move on, we do need to consider one over-arching question, although our approach to answering it may disappoint some readers. That question is: what is knowledge? Once more, there is no generally agreed answer: Mingers (2008), for example, offers 13 different senses of meaning for the phrase "I know". So, rather than fill this whole book discussing the question, instead we will not work with a single specific definition. As Alavi and Leidner (2001, p. 109) put it, "such an understanding of knowledge was neither a determinant factor in building the knowledge-based theory of the firm nor in triggering researcher and practitioner interest in managing organizational knowledge". The context of KM in this chapter will be the idea of managing organizational knowledge, though many of the concepts and models also apply to KM at different levels, ranging from individuals through SME clusters to cities and nations, and perhaps even to the whole world. Some shades of the different schools of definition will however need to be covered in the next section.

2 Knowledge Content Aspects

We begin with a reasonable measure of agreement: all knowledge must be "about" something, and at least one human has to have been involved somewhere in the process of creating that knowledge, even if only in deciding to accept the validity of the output from a business intelligence system. But that's as far as we can get. The most fundamental debate about knowledge content is whether knowledge can exist – or at least be meaningfully discussed – independently of a human knower. The literature presents support for answers of both "yes" and "no" to this question, and for several compromise positions in-between.

A pure "yes" answer leads to consideration of knowledge as an object, and thus KM becomes mainly a question of managing things – managing those objects.

A pure "no" answer means that KM, if that phrase may be used at all in this context, becomes a challenge of people management – managing the knowers.

Naturally the compromise positions mean KM involves managing both knowledge objects and people, and as this is the more general view, it will be the one we assume in the remainder of this chapter.

2.1 Tacit and Explicit Knowledge

There are many other distinctions between types of knowledge. The one most frequently seen in the KM field is that of the distinction between tacit knowledge and explicit knowledge. This was originally proposed by Polanyi (1966), and summed up in his memorable phrase "we can know more than we can tell" (p. 4). Interestingly, Polanyi actually refers to tacit *knowing*. "Explicit or codified knowledge refers to knowledge that is transmittable in formal, systematic language. On the other hand, tacit knowledge has a personal quality, which makes it hard to formalize and communicate" (Nonaka 1994, p. 16). The tacit-explicit distinction was popularised in the context of KM by Nonaka and Takeuchi (1995) as part of their SECI model (see later in this section). As such, this distinction is also perhaps one of the most widely misunderstood concepts in KM, as many authors have taken it to mean that any particular "piece of knowledge" can be categorized as either tacit or explicit. However, the majority view accords with Polanyi's proposal, which was that all "pieces" of knowledge have both tacit and explicit components. Perhaps this is best thought of as a tacit "core" with an explicit layer surrounding it. The relative size of the tacit core will be greater for some pieces of knowledge than others. For example, there is much less tacit knowledge involved in processing an application for life insurance than in riding a bicycle. The latter is entirely tacit except for "sit on the saddle, hold the handlebars and put your feet on the pedals (but not yet!)". The knowledge involved in building a brick wall would fall somewhere between these two examples. Alternatively, authors such as McInerney (2002) see there being a continuum of knowledge types running from fully tacit at one end to completely explicit at the other.

2.2 How Does Knowledge Arise?

An alternative way of thinking about knowledge is to consider the process by which it arises. One common approach, originating in computer science, is based on the idea of data leading to information which in turn leads to knowledge. There are several slightly different views of this relationship, but they can be summarised as follows.

Data consist of unprocessed facts and observations. Data are transformed into information by adding context; selecting and processing the data to be relevant to a specific person or issue (and usually both, since the relevance of the issue is determined by one or more people). Knowledge then consists of more structured information, information with meaning, transferable from one issue to another.

This is often pictured as a pyramid-shaped hierarchy with data at the bottom and knowledge at the top, but several authors have proposed modifications to this. Tuomi (1999) inverts the hierarchy, arguing that even deciding that something is data requires knowledge – again bringing in the central role of the human knower. Checkland and Holwell (1998) propose a similar idea in the form of *capta*, which they define as that sub-set of the vast mass of data to which we choose to pay

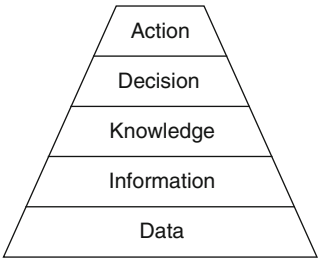

Fig. 2 Wilson's processing hierarchy (Based on Wilson 1996, p. 34)

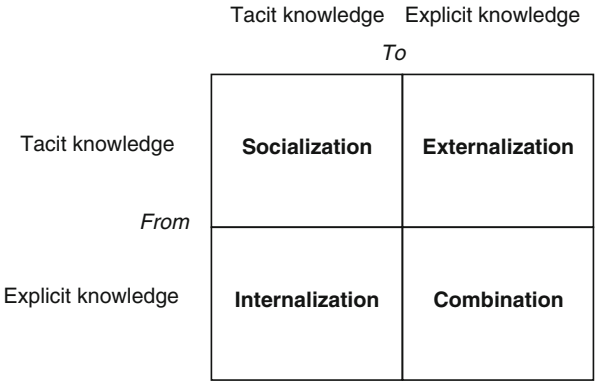

Fig. 3 SECI model – modes of knowledge creation (Based on Nonaka 1994)

attention. Thus capta sit on top of data in the pyramid, information and knowledge being based on the capta. Wilson (1996) takes the hierarchy in a different direction, as shown in Fig. 2, by incorporating the purposes for which the knowledge is to be used – which he would have termed "processed".

2.3 The SECI Model

An alternative view of where knowledge comes from, which is probably the one most commonly cited by those who are not from a computer science background, will also form a convenient bridge into the next section. This view is what is now known as the SECI model (Socialization – Externalization – Combination – Internalization) of knowledge creation (Nonaka and Takeuchi 1995), first proposed as the "knowledge spiral" by Nonaka (1991, 1994). It combines two ideas: conversion of knowledge between tacit and explicit, as shown in Fig. 3, and a spiral progression upwards (or outwards) from the level of the individual to that of the organization. The four modes of creation are defined as follows (Nonaka and Toyama 2003, p. 5):

Socialization – sharing and creating tacit knowledge through direct experience;
Externalization – articulating tacit knowledge through dialogue and reflection;
Combination – systemizing and applying explicit knowledge and information;
Internalization – learning and acquiring new tacit knowledge in practice

3 KM Process Aspects

Process can have several meanings in KM. These include the idea of knowledge as a social process; the view of KM itself as a process; the processes that knowledge goes through in an organization (of which the SECI model is one example); and the processes of the organization examined from a knowledge viewpoint, which was their meaning in Fig. 1.

Knowledge as a social process takes the association of knowledge with a human knower further, so that knowledge is seen as belonging not just to a knower but to a community of knowers, who serve to validate it in some sense. Whilst this is one of the less-disputed elements of KM theory, the benefits and limitations of this view are well illustrated in history by Galileo Galilei's long struggle to convince others that the earth orbits the sun, rather than the sun orbiting the earth.

3.1 KM Maturity Models

From a KM point of view, the most strategic use of the term process concerns an organization-wide view of KM as a process, in the form of KM maturity models. We have proposed one of these models ourselves (Edwards et al. 2005a) as follows:

Stage 0	Unaware of the need for knowledge management
Stage 1	Aware of the need for knowledge management but not actively doing it. Little appreciation of what is involved in actively carrying out knowledge management as distinct from information management
Stage 2	Doing knowledge management but not strategically across the whole organization (at best "islands of knowledge" not "joined up knowledge management")
Stage 3	Doing knowledge management strategically and reviewing it

Siemens AG devised a knowledge management maturity model (KMMM) based on the CMM (Capability Maturity Model) well-known from software engineering and first published by Paulk et al. (1993). The Siemens KMMM identifies five maturity levels: initial, repeatable, defined, managed and optimizing (Ehms and Langen 2002). Infosys Technologies similarly devised a five-stage knowledge management maturity (KMM) model, with the five stages being default, reactive, aware, convinced, and sharing (Mehta et al. 2007). Other KM maturity models have been proposed, but none has yet achieved the status that the CMM enjoys in software engineering.

3.2 Absorptive Capacity

Equally strategic, although it can also be applied to smaller units than the whole organization, is the concept of absorptive capacity, originally proposed by Cohen and Levinthal (1990). This describes the ability of individuals, units or organizations to learn, defined as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (p. 128). According to Cohen and Levinthal "the ability to evaluate and utilize outside knowledge is largely a function of the level of prior related knowledge" (also p. 128). The most strategic aspect of organization-wide absorptive capacity is the subsequent contention by Grant (1996), as part of his knowledge-based theory of the firm, that profits are created primarily through realised absorptive capacity. Grant's work remains perhaps the strongest foundation for the strategic importance of KM.

3.3 Activities and Processes in KM

Turning our attention to the activities and processes that are involved in KM brings us face-to-face with the full scope of the 160 frameworks mentioned earlier. The majority of them – 117 according to the analysis by Heisig (2009) – include some kind of list of activities or processes. Some lists have been produced by concentrating on the knowledge and what is happening to it, others by concentrating on what someone is doing with it, and still others explicitly on knowledge *management*. Naturally these three overlap, sometimes even within the same list.

Starting from the knowledge perspective, we offer the view of Wiig, the person who gave KM its name. Wiig (1993) identifies four sets of activities, each focussed on the knowledge itself:

- Creation and sourcing
- Compilation and transformation
- Dissemination
- Application and value realization

By contrast, Alavi and Leidner (2001, p. 115) approach more from the "what someone is doing" viewpoint, and propose what they describe as 'four sets of socially enacted "knowledge processes"':

- Creation/construction
- Storage/retrieval
- Transfer
- Application

For our third list, we offer that of van der Spek and Spijkervet (1995) as one which appears to focus more specifically on *managing* the knowledge. Their list runs:

- Creating knowledge
- Securing knowledge
- Distributing knowledge
- Retrieving knowledge

There are many other descriptions of the knowledge management process, from viewpoints similar to those above or different again. A summary of several of the earlier ones may be found in Beckman (1999). More recently, Heisig grouped all the activities in the 117 frameworks he analysed into the six most common categories (Heisig 2009, p. 9). These are:

- Share knowledge
- Create knowledge
- Use knowledge
- Store knowledge
- Identify knowledge
- Acquire knowledge

Note that these are in descending order of the number of times they appeared in other frameworks, not in any chronological sequence. When the processes are presented in chronological order, it is referred to as a knowledge "life cycle". There are, inevitably, many of these, too. Naturally we prefer to present our own, as shown in Fig. 4. This is not simply bias, but because the model in Fig. 4 does not include knowledge sharing/transfer as an activity in itself. We believe this difference in focus is important, since we do not regard knowledge sharing, at least in an organizational context, as an end in itself, but as a means to some wider purpose. That purpose must be addressed in two stages: first, the business process or

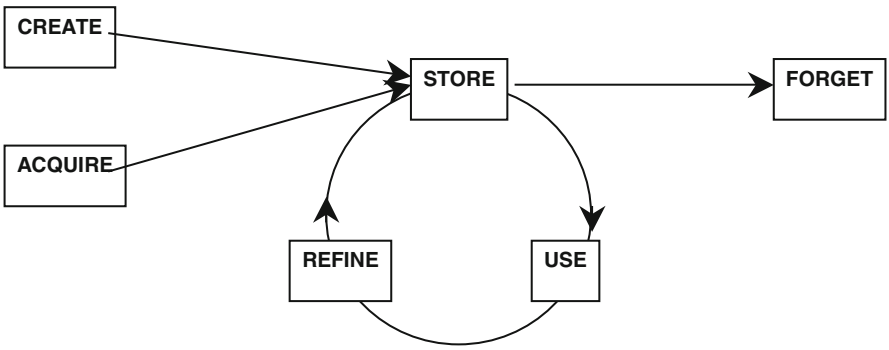

Fig. 4 Knowledge life cycle (Modified from Edwards 2001)

processes to which the knowledge is relevant; and only then the knowledge-related activity.

Earlier we mentioned confusion over the use of the terms knowledge sharing and knowledge transfer. On the one hand, many authors use the terms knowledge sharing and knowledge transfer interchangeably (Klein 2008). However, on the other hand, there is a widely-accepted school of thought that distinguishes between the two along the lines of the definition from King (2006):

> transfer implies focus, a clear objective, and unidirectionality, while knowledge may be shared in unintended ways multiple-directionally without a specific objective. (p. 493)

Berends (2005), for example, observes that "knowledge sharing and knowledge transfer cannot be treated as equals. Knowledge sharing encompasses more than only the transfer of descriptions containing justified factual information. . . .many knowledge sharing episodes contribute to the creation of knowledge, by formulating a problem, suggesting a potential solution, contributing to the justification of solutions or stimulating someone to reflect on something" (p. 104).

Just to confuse matters further, Szulanski (2000), one of our key sources for the next section of this chapter, used the term knowledge transfer, but he clearly means the wider process we are calling knowledge sharing:

> Knowledge transfer is seen as a process in which an organization recreates and maintains a complex, causally ambiguous set of routines in a new setting. (p. 10)

Others also use knowledge transfer for the wider activity, such as Levine and Prietula (2012), who refer to the "transfer (or exchange) of knowledge" but from their discussion evidently are addressing what we call knowledge sharing, and indeed Alavi and Leidner (2001) in their list of knowledge processes mentioned above.

As if this were not sufficient confusion, new versions of KM process models continue to appear. For example, Jimenez-Jimenez and Sanz-Valle (2013) present a model of the KM process comprising knowledge acquisition, distribution, interpretation and memory, which they attribute to Huber (1991). Now, Huber was working before the term KM had come into widespread use, so it is not surprising that at the time he actually described these activities as relating to organizational learning, not KM. However, Jimenez-Jimenez and Sanz-Valle (2013) have made significant changes to the names of the constructs: originally they were knowledge acquisition, information distribution, information interpretation, and organizational memory. Changing "information" to "knowledge" is a non-trivial difference!

4 KM People Aspects

Mention of organizational learning forms a natural link into the "KM people" section, since there are still a small minority – from a pure "knower" viewpoint – who would say that only individuals can learn, not organizations. We will assume in the rest of this chapter that organizations can learn, but also that the process is a complex one.

4.1 Communities of Practice

A common theme amongst most of the "people" aspects of KM is the relevance of the networks to which people belong, whether formal or informal, whether entirely within the organization or partly outside it. The key people-related concept for KM is that of the Community of Practice (CoP) identified by Lave and Wenger (1991) and Brown and Duguid (1991), and investigated in more detail by Wenger (1998) and many others since – see for example Coakes and Clarke (2006). The concept of the CoP arose from consideration of learning through practice, extending the idea of the apprenticeship. The early work on CoPs tended to go for longer characterizations rather than short "definitions", but Wenger and Snyder (2000) offer the following (p. 139) "groups of people informally bound together by shared expertise and passion for a joint enterprise". The principal difference from an apprenticeship model is that while a CoP has fully participating members, it does not have the role of master that the apprenticeship model does. Thus, even when formal, the CoP is more fluid. This means that whilst CoPs may be nurtured or assisted by the formal organization, they cannot be mandated, because *passion* cannot be mandated. Even in a formal group, the informal binding is a crucial element.

The theory around CoPs is extremely useful for explaining how newcomers to a craft or profession gain expertise, but less effective at explaining how the experts continue to learn, or how knowledge arises from interactions of groups of people with different expertise. A very important contribution to the latter, and especially to radical advances in knowledge creation, is that we learn more from our weak ties (Granovetter 1973). This is because people in our networks with whom we have stronger ties tend to think in more similar ways to ourselves, and the "creative spark" is less likely to occur there than in a more diverse group. There has to be some sharing, however – a group with ties so weak or expertise so diverse that they cannot understand each other is unlikely to survive, let alone deliver results. This is supported by research on team formation, which similarly finds that teams with medium variation/diversity are the most effective (Brodbeck et al. 2011).

4.2 Sticky Knowledge

A concept related to that of absorptive capacity, but specifically bringing in the individuals involved, is that of sticky knowledge, identified by Szulanski (1996). Szulanski researched the transfer of knowledge, specifically best practices, within an organization, and defined stickiness very simply as the "difficulty of transferring knowledge within the organization" (Szulanski 1996, p. 29). This was partly derived from von Hippel's (1994) concept of sticky information, although that specifically concentrated on the cost of transferring the information. In two studies (Szulanski 1996, 2000), Szulanski tested the effect of various attributes of the practices/knowledge, source, recipient and context on knowledge stickiness, and concluded that the two most significant predictors were "Causal Ambiguity" (essentially the extent to which the knowledge is tacit) and "Recipient lacks

Absorptive Capacity" (as discussed earlier). Note that, as we have seen, the original concept of the latter was for the firm rather than an individual.

4.3 Narrative/Story-Telling

Another important people aspect, albeit one that can hardly be claimed as unique to KM since its roots lie back in pre-history, is the relevance of narrative or story-telling as a way of sharing knowledge. The study of Xerox photocopier technicians by Orr (1996) is generally seen as an early seminal example of the use of story-telling for KM, and the further analysis by Cox (2007) shows how Orr's narrative subsequently took on a life – and a narrative – of its own within the literature. Narrative remains a very active field of KM-related research, especially as a potential bridge between individual and organizational learning. For example, Kwong and Lee (2009) describe how narratives were used to elicit knowledge from engineers about reliability management in an airline, while Garud et al. (2011) examine how narratives enable learning from unusual experiences. Gorry and Westbrook (2012) demonstrate how the narratives need not come from within the organization at all – customers may well have stories of value to the organization, but often these are at best able to be shared with other customers, not members of the organization itself. Burnett et al. (2013) take the idea further still, examining the deliberate construction of organizational "learning narratives". By its nature most published articles on this topic are reports of single case studies, which can make it more difficult to learn implementable lessons from them.

4.4 Cognitive Maps

A visual representation of "pieces of knowledge" and their connections can encourage people to understand and discuss them in a more structured way than narratives. Cognitive maps are designed to show links between concepts, and can be used either with individuals or with groups, or indeed first at the individual level and then combined to give group maps. Kwong and Lee (2009), as cited in the previous section, use cognitive maps to represent the knowledge elicited from the engineers. We have used them extensively ourselves to investigate KM and especially KM strategy in organizations (Edwards et al. 2005b; Shaw and Edwards 2005, 2006; Shaw et al. 2006). Figure 5 is an example of a cognitive map from one of our studies.

4.5 Social Network Analysis

The last important concept in this section is that of social network analysis. Again this pre-dates KM, this time by many decades, from its roots in anthropological research. As with cognitive maps, it is a mapping-based technique, with the

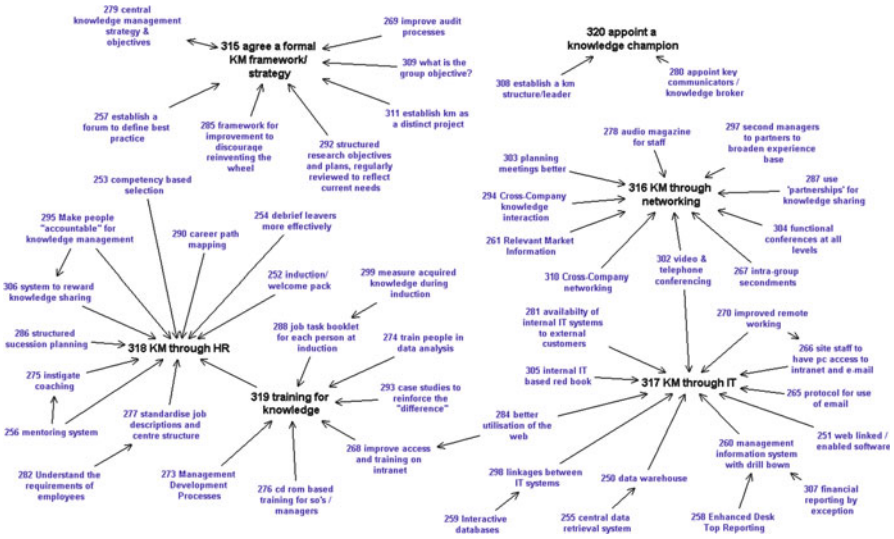

Fig. 5 A cognitive map relating to KM strategy (From Edwards et al. 2005b)

elements this time being individuals, groups or even organizations. Social network analysis covers the study of who connects to whom, and several techniques for the analysis of social network structures in terms of concepts such as the position and density of nodes have been developed. The analysis may also include more qualitative aspects such as an assessment of the strength of ties. The nodes used in the analysis may be at the level of individuals, groups or companies. Examples of the use of social network analysis in the KM field include those of Alavi and Kane (2008), Smith and McKeen (2007), Liebowitz (2005). Mention of structures takes us nicely into the next section.

5 KM Structural and Strategic Aspects

Two significant dichotomies are at the heart of much of the work in KM related to KM strategy and consequently KM structure. One concerns the intention of managing the knowledge ("what are we doing with the knowledge?"), the other the approach taken – the KM strategy itself ("how do we make it happen?").

5.1 Exploration Versus Exploitation

The principal choice regarding what to do with the knowledge is between exploration and exploitation: "the exploration of new possibilities and the exploitation of old certainties" (March 1991, p. 71). In other words, what should the balance of effort be between creating/acquiring new knowledge and using the knowledge that

the organization already has? This balancing between the future and the present is a central element of any business strategy and one that many organizations get wrong.

Linking back to the previous section, a social network analysis at the organization level by Gilsing et al. (2008) suggested that network density of a firm actually has an inverse U-shaped relation with exploration activities of the organization. At first, as the number of connections increases, exploration becomes more successful. However, once a certain threshold is reached, success tails off: a very dense network may lead to undesired spillovers, redundant knowledge and excessive loyalty to current partners.

5.2 KM Strategy: Personalization and Codification

Almost independent of the exploration/exploitation choice is that of the KM strategy to achieve the exploring and/or exploiting. The essential work on KM strategies is by Hansen et al. (1999), which identified the two fundamental KM strategies as codification and personalization. The personalization strategy takes the "knower" viewpoint that the organization's knowledge resides mainly in the heads of its people (and thus is tacit), and the main purpose of KM systems is to help people locate and communicate with each other. The codification strategy takes the viewpoint that the most relevant knowledge for the organization can be made explicit, codified and stored in computer format, so that it may be widely shared. Even though this was mainly based on an analysis of just one industry sector – management consulting – plus just one pair of examples from each of two other sectors, most subsequent work on KM strategy takes this dichotomy as a foundation.

More arguable was the further suggestion by Hansen et al. (1999) that organizations should concentrate on one of the two strategies with at least an 80–20 split, however one might measure 80 % of a strategy. Many have challenged this, with one of the most recent even drawing on data from the same management consulting sector (Powell and Ambrosini 2012).

5.3 Alignment with Business Strategy

One aspect of KM strategy on which there is general agreement is that KM strategy needs to be aligned with business strategy, and we are not going to argue with that. However, it is intriguing to observe that the Hansen et al. (1999) paper does not specifically refer to any of the literature on business strategy at all. Not that there is any single agreed view in that literature either! Hansen et al. identify the two competitive business strategies of standardization and customization as fitting with codification and personalization KM strategies respectively, and thus it is clear that they take a market-driven view of business strategy. Nevertheless, these two business strategies do not exactly match the best-known exposition of market-

driven business strategy, that of Porter (1980). The market-driven view of strategy asserts that the main drivers for strategic choice are external to the organization. One of the main alternative views of business strategy is the resource-based view (RBV), which believes the main drivers for strategic choice are internal ones, such as an organization's core competences. The resource-based view was proposed by Grant (1991) and developed into the knowledge-based theory which we have already mentioned. It is not unusual in the KM literature to find articles on KM strategy which claim to build on both Porter's and Grant's work without realising that their theoretical bases are not compatible; for obvious reasons we will not cite any of them here.

Whichever KM strategy is adopted, an important element of monitoring that strategy is to be able to measure its effectiveness. Accountants and others have been grappling with the issue of trying to measure knowledge, or the effectiveness of its management, for the past 20 years. A pioneer in this field was Sveiby (1997). His work and that of others (Edvinsson and Sullivan 1996; Roos and Von Krogh 1996) has led to the field now known as intellectual capital research. Not surprisingly this has progressed better in relation to the view of knowledge as an object and strategies of codification, which can lend themselves to quantification, than in relation to attempts to "measure" the knowledge in people's heads, which at best need to be qualitative. A good summary of the current state of knowledge measurement may be found in Bolisani and Oltramari (2012).

5.4 Somewhere to Share Knowledge

Turning to a more abstract aspect of KM structure, which is definitely not easy to measure, we find the concept of *ba* – originally proposed by Nonaka and Konno (1998). *Ba* is a Japanese word meaning something approximating "place" or "space", which it has been claimed has no direct equivalent in English. Snowden (2000) sees similarities between *ba* and the Welsh word *cynefin*, although he states that the latter has a historical dimension that the former does not. *Cynefin* also is claimed to have no English equivalent, although to this chapter's author, as a Londoner, both seem to be very close to the London slang term "manor". In KM, *ba* is where knowledge may be created or shared. Although different types of *ba* have been identified, some physical and some virtual, we have found that the concept of *ba* as "a way of organizing. . .rather than a form of organization" (Nonaka and Toyama 2003, p. 7) is the most useful way to think of it.

Finally, to link this section to the next, we return to types of KM strategy. Earl (2001) extended the codification/personalization dichotomy to identify seven different strategies, or "schools", for KM, concentrating on the nature of the IT support required. He named them as: systems, cartographic, engineering/process (these three being the "technocratic" schools), commercial (the "economic" school), organizational, spatial, and strategic (these three being the "behavioural" schools).

6 KM Technological Aspects

Here we mention two aspects: the use of technology to support KM in general (knowledge management systems), and one of the most useful applications in helping to structure and process knowledge (ontologies).

6.1 Knowledge Management Systems

As we hinted in the Introduction to this chapter, although it may come as a surprise to some, there is even a fundamental difference in definitions in the apparently clear-cut world of technology, namely – what is a KMS? There are two common answers to this question, which we shall term as "narrow" and "wide" views. The narrow view is concerned solely with the technological artefacts: for example, Alavi and Leidner (2001) define a KMS as "a class of information systems applied to managing organizational knowledge" (p. 114). The wide view is the one that we have already implied in Fig. 1 – that technology is only one part of a KMS, along with people and systems or processes, and indeed that a KMS would not necessarily have to use information technology at all. We have described one example of a shopfloor KMS in manufacturing (Edwards 2009) where the only IT used was word processing software to produce laminated sheets of "best practice" instructions.

It will be clear that the wide view of KMS can incorporate the elements and issues of the narrow view within it, but not the other way round. Thus a concentration on the narrow view can lead not just to consideration of knowledge as an object, but to considering only the object, and not what anyone does with it. This has long been a well-known recipe for KMS failure (see, for one of many examples, McDermott (1999)) but organizations continue to make this mistake even now, as recent conversations with this chapter's author at an industry conference confirmed. The relationship between the technology and its effective use is a subtle one. The realization that untargeted "push" systems (where everything is made available to everyone and people have to filter it to find what they need) are not effective even for information management, never mind KM, came several years ago (Damodaran and Olphert 2000). However, the knowledge-based systems field, one often neglected by those in the KM field (Edwards 2003; Hendriks and Vriens 1999; Liebowitz 1998), provides the complementary finding that 100 % "pull" systems (providing only what is specifically demanded) do not work either, because those who most need help in a particular situation may be the least likely to seek it (Edwards et al. 2000).

6.2 Ontologies

Ontologies (with the information science meaning of the term) are the result of addressing the meaning of terminology in KM from the "knowledge as an object" viewpoint. Gruber (1995) defines an (applied) ontology as a formal specification of

shared conceptualisation. An ontology thus comprises more formalized and structured relationships between concepts than those seen in cognitive maps, thus enforcing greater rigour and permitting much more by way of automated processing of these knowledge objects. The kind of disagreement on the meaning of fundamental terms that we have already discussed arguably makes ontologies potentially even more useful in KM, since automated processing is an effective way to highlight inconsistencies and gaps. Thus the construction of an ontology can be a central element in understanding the codified knowledge in a domain. Ontologies may be constructed by working with domain experts (Rao et al. 2009; Almeida and Barbosa 2009), or increasingly by automated means (Guo et al. 2009). Gavrilova et al. (2013) give a comprehensive review of how to develop ontologies.

As mentioned earlier, the FKMO (Holsapple and Joshi 2004) is the best-known ontology for KM itself. However, Garbacz et al. (2012) point out an obstacle here: KM ontologies often refer to fundamental concepts ("primitives") from outside KM which are not well-defined either, such as the meaning of "an organization".

Conclusion

In this chapter, we have looked at what we believe to be the most important KM concepts and models. Inevitably this can only be a small subset of all those that have been produced.

The fundamental split in the field that was identified more than a decade ago as the difference between what many called first and second generation KM is still visible. Swan et al. (1999) label the distinction as between cognitive and community perspectives; Cook and Brown (1999) as between an epistemology of possession and an epistemology of practice. First generation KM was seen as emphasizing knowledge as an object, codification approaches and support for KM that was heavily based on IT. Second generation KM by contrast stressed the importance of the role of the knower, personalization approaches and supporting contact between people.

Rather than pursue a pointless quest for third generation KM, the most useful research over the past decade has taken the best from both of the earlier generations, and added to it. As we have seen in this chapter, KM is not solely about technology, or solely about people: in fact it has five interlocking aspects, covering content, process, people, structure and strategy, and technology.

The main challenge for KM researchers is therefore to develop models that incorporate enough of this complexity to be effective, while remaining simple enough that people who are not KM experts can use them. The nature of KM in practice means that this use has to be conceived in terms of support for a process of "doing KM" rather than as some kind of "solution to KM problems". Many of the necessary elements in the form of specific models and technological support are already present, as outlined above. Perhaps what is most needed is a better way of including the dynamic and ongoing nature of KM in organizations, as a continuing activity where the options depend on the path that KM in that organization has already followed.

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