Notions of Knowledge Management Systems: A Gap Analysis

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Abstract: Knowledge management, now a distinct domain of research and practice, has roots in many disciplines. As a result, a wide variety of philosophies, theories, and definitions of knowledge management are used in the literature, and in practice. This has led to many models and methodologies being used in developing knowledge management systems, but without sufficient cross-pollination of ideas from the various influences and adopted philosophies. We argue that this has led to significant gaps in the understanding of what is needed for knowledge management systems and to divergent and inadequate models and methodologies. These problems are hindering both research and practice. Fieldwork in knowledge management systems development for organisations has been supplemented by an in-depth analysis of the literature, which has revealed particular gaps in knowledge management systems research. The notions that should underpin knowledge management systems development are confused and incomplete. This paper summarises the most salient of these and challenges several of the published notions of knowledge, knowledge management, and models of knowledge management. In particular we challenge the apparently accepted dichotomies and propose how different facets can be considered within a matrix of KM models.

Keywords: Knowledge, knowledge management, knowledge management systems, knowledge management systems development

1. Introduction

Knowledge Management (KM) owes much to disciplines such as philosophy, psychology, social sciences, management sciences, economics and computing. Indeed, researchers rely on the variety disciplines to advance concepts and models for KM, while practitioners use them to progress methods for developing Knowledge Management Systems (KMS). However, neither researchers nor practitioners seem to look beyond their influences to others relevant to KM and KMS, and indeed often full proposed by fellow KM scholars. As a result, a wide variety of ideas – philosophies, theories, concepts, models etc. – are used to conceptualise KM (Earl, 2001; Kakabadse et al., 2003). The unnecessarily self-limiting language of discourse has led to a wide range of what we view as impoverished models and methods in what should be a broad, rich discipline. Our work on how to improve the development of KMS in organisations has exposed significant gaps due to the narrow perspective of many contributors. We start from the conviction that Information System Development (ISD) is fundamentally the wrong point for starting Knowledge Management System Development (KMSD) in organisations. We believe rooting KMSD in ISD is damaging, because ISD focuses on consensual or imposed, single meanings whereas we argue KMSD needs to support individualistic, multiple interpretations. Partly, the use of ISD concepts and methodologies for KMSD is due to history. Partly, it is to do with the divergent and inadequate models and methodologies in the literature (Gebert et al., 2003; Herder et al., 2003; Moffett et al., 2003). By examining what is needed for KMSD we will show that ISD methodologies are not adequate for KMSD; they do not address or reflect the nature and locus of knowledge in KMS (Hahn and Subramani, 2000). At very least KMSD requires the identification of what constitutes the 'knowledge' to be managed, why it needs to be managed, and how it is to be managed. The paper is organised according to the dependencies among areas contributing to the question of how to develop knowledge management systems. Hence, we begin to examine notions needed for KMSD by starting with a critical analysis of KM models (and theories that underpin them). KM models depend on reasonable, practical ideas of the practice of KM, variously described in the literature as frameworks and lifecycles. These are discussed next. These depend on the notion of knowledge itself, clearly a crucial aspect of KMS and their development. So, the paper continues by exposing the issues to do with knowledge, information and data. We conclude with a summary of the gaps that must be filled to be methodological about KMSD and recommend areas that might fill those gaps.

2. Models of knowledge management

A multitude of KM models with a wide range of approaches are apparent in the literature and praxis. Recently, there have been different attempts to classify them. Whereas some scholars (e.g. Earl, 2001; Kakabadse et al., 2003) provide a classification of KM models into different schools and approaches according to their 'orientation', others (e.g. Gebert et al., 2003, Herder et al., 2003) perceive different dichotomies in KM models. We will focus on dichotomies in

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criticising KM models because they expose limitations vis-à-vis KMSD.

2.1 Dichotomies in KM models

Two main dichotomies prevail in the literature:

- Analysis dichotomy: scholars (e.g. Gebert *et al.*, 2003) classify KM models based on the modeller's approach to analysing knowledge;
- Working dichotomy: scholars (e.g. Herder *et al.*, 2003) classify KM models based on the modeller's approach to working with knowledge.

2.1.1 Analysis dichotomy

Based on the modeller's approach to for analysing knowledge Gebert *et al.* (2003) argue that almost all KM models can be traced back to two basic types of models:

- Epistemological models – focus on the nature of knowledge independent of its context;
- Ontological models – focus on the relationship between knowledge and its environment or context independent of its nature.

Thus, epistemological modellers perceive knowledge as an entity with defined (or at least definable) characteristics, overlooking interconnections among knowledge entities and with their environment. The main differentiating characteristic of knowledge, from the epistemological perspective, is the difficulty of its articulation: knowledge that can be easily articulated is labelled explicit knowledge, while knowledge that is difficult to articulate, and therefore difficult to communicate to others, is labelled *tacit* knowledge (Polanyi, 1966). Famously, Nonaka and Takeuchi (1995) address this differentiation in their SECI model, which focuses on the arrangement and regeneration of knowledge through continuous conversions between explicit and tacit knowledge. In contrast, ontological modellers perceive knowledge in terms of its relationships with its environment regardless of its inherent characteristics. They view knowledge as taxonomy of interconnected entities that exist in a bounded environment, overlooking the nature of these knowledge elements. The main differentiating feature of knowledge, from the ontological perspective, is the relationships that link them.

2.1.2 Working dichotomy

On the other hand, based on the modeller's approach for working with knowledge Gloet and Berrell (2003), Herder *et al.* (2003) and Moffett *et al.* (2003) perceive different binary KM models:

- Analytical models;
- *Actor* models.

Analytical models focus on the codification of knowledge for IT systems. Herder *et al.* (2003) argue that these models emphasise the importance of explicit knowledge and the technological infrastructure to share it such as an intranet. Conversely, actor models are people- and (business) process- oriented. Herder *et al.* (2003) argue that these emphasise the importance of tacit knowledge and the social infrastructure required to share it, for example, through communities of practice.

2.2 KMS modelling matrix

We propose that KMS models be considered to generally fall into one of the four domains according to the focus and locus of knowledge. These are depicted in the matrix of Figure 1.

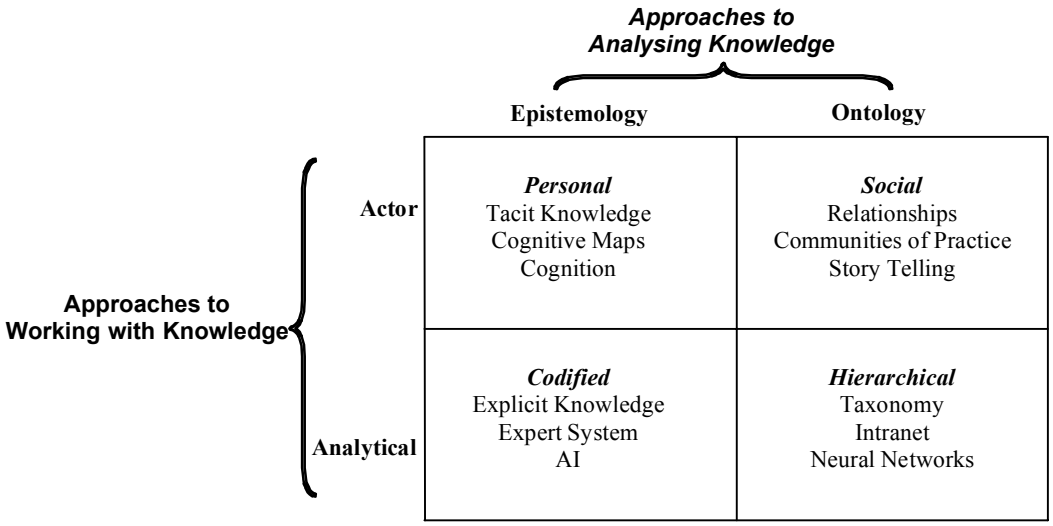

Figure 1: KMS Modelling Matrix

- Personal KMS models (Epistemology-Actor) focus on knowledge of the individual, in particular tacit knowledge. In this domain modellers attempt at representing KMS as cognitive maps of each individual's knowledge – who knows what? There is no particular technology that is used for this domain, but it is rather based on cognition;
- Social KMS models (Ontology-Actor), e.g. Wenger (1998), focus on knowledge of the group as a society, in particular knowledge flow and relationships. In this domain modellers merely refer to communities of practice as the representation of KMS. IT has limited use in this domain and the main technique used for KM is story telling;
- Codified KMS models (Epistemology-Analytical) e.g. Nonaka and Takeuchi (1995), focus on knowledge of the individual, in particular explicit knowledge or knowledge that could be codified. In this domain modellers attempt at representing KMS as expert systems. IT has a wide usage in this domain especially artificial intelligence;
- Taxonomy KMS models (Ontology-Analytical) e.g. Wiig (1997), focus on knowledge of the group as a hierarchy, in particular knowledge taxonomies. In this domain modellers refer to Intranets as an adequate representation of KMS. IT has a wide usage in this domain such as with neural networks.

2.3 Implications of KM models for KMSD

In terms of value to organisations, adopting either a solely epistemological or a solely ontological approach to KM models is insufficient and cannot be used for management decision-making. Hence considering them mutually exclusive hinders KMSD. The business value of undiluted epistemological models is limited in a business context Gebert et al. (2003), especially in situations that require the evaluation of knowledge as a business resource. Here, all epistemological models have the common weakness of only contributing to an assessment of value through internal qualities, which are independent of the context of use. The business value of ontological models alone is also limited, especially on the operational level, because they disregard inherent characteristics of knowledge. For example, budgetary decisions on identifying, disseminating, and using knowledge depend on whether its manifestation is mainly tacit or mainly explicit. For KMS, and hence for their development, it is essential to have KM models that incorporate both the nature and relationships (the process and the practice) of knowledge in organisations. Gebert et al. (2003) suggest a balanced, hybrid paradigm, with the potential of considerable synergy. A fully balanced model is yet to be created with only few attempts of balancing both in the literature. Nonaka and Konno (1998) have tried to integrate an ontological dimension to the epistemological approach in their spiral-like model, and Demarest (1997) tried to analyse different types of knowledge in his process-oriented model.

Adopting either solely an analytical approach or an actor approach in KM models is also insufficient in terms of value to organisations. Again, choosing just one or the other would diminish a KMS and so has no part in a KMSD. Analytical models overlook the role of tacit knowledge and cultural aspects in KM. Technology alone will not lead to a KM culture (Davenport and Prusak, 1998). Similarly, the value of actor models alone is limited because they do not acknowledge the full potential of technology and systematic processes to managing knowledge. An unbalanced approach to implementing KM in organisations hinders its success. Moffett *et al.*, (2003) assert that tensions are often found between knowledge-orientated applications and the progress of organisational change in implementing KM programmes. Therefore, more systematic empirical research addressing the relationship between cultural and technological aspects of KM is required. We conclude that focusing on epistemology or ontology in KM models limits the value to organisations. Similarly, emphasising either analytical or actor aspects in KM models hinders the success of organisational KMS. Understanding and addressing these issues either practically or theoretically is currently being held back by a paucity of systematic empirical research, addressing the relationship between the organisational, human and technological aspects of KM. Current KM models lack a holistic representation of KMS in organisations. Malhotra (2005) argues that the gap is widening between technology inputs, knowledge processes, and business performance. This is leading to failures of KM technology implementations. Accordingly, a balanced approach is needed for KMSD to deliver a balanced KM model. It is essential to be able to encompass organisational, human, and technological aspects by including:

- People (actor),
- Tools (analytical), and
- Processes (actor and analytical).

This leads us to investigate what KM means in the context of KMS and how KMSD should address it.

3. KM framework s and lifecycles

Knowledge has been implicitly managed, as long as work has been performed. Recent publications point at a continual relationship among economic, industrial, social, and cultural transformations and evolution in managing knowledge (Wiig, 1997;

Drucker, 2002) Knowledge is now the cause rather than the effect of such transformations, particularly when it is systematically organised to be purposeful. Since many argue that the more developed world is evolving into a knowledge-based economy (e.g. Beijerse, 1999; Drucker 2002; Wiig 1997), the new application of knowledge today is to knowledge itself, i.e. meta-knowledge (Laszlo and Laszlo, 2002). Hence the essence of KM is to manage knowledge about knowledge. This section summarises attempts to clearly define KM and frameworks and lifecycles for KM by analysing what the most cited scholars have said. Ultimately we are concerned with KMSD so we need to be clear about what KM itself is.

3.1 Abstractions of knowledge management

We start by examining a variety of what have been variously called 'frameworks' and 'lifecycles', also known as 'processes' (without necessarily being provided with differentiating definitions). We take these to be generalisations without explicit mechanisms for instantiation or phasing.

Nonaka and Takeuchi (1995) focus on informal and tacit knowledge in their KM lifecycle. Rather than 'knowledge management' they identify the main processes in a KM lifecycle as knowledge creation, dissemination, and embodiment. Moreover, they emphasise knowledge *exploration* for creating new knowledge, over *exploitation* of existing knowledge. On the other hand Wiig (1997) focuses on procedural and explicit knowledge more than informal and tacit knowledge in his definition:

> *KM is to understand, focus on, and manage systematic, explicit, and deliberate knowledge building, renewal, and application – that is, manage effective knowledge processes.*

Wiig identifies main processes in a KM lifecycle as knowledge building, renewal, and application and stresses a more methodical approach to KM by associating processes with the terms systematic, explicit, and deliberate knowledge. These indicate that knowledge can be articulated and that it has a specific purpose and, presumably, value. Also, it gives an indication that he views managing knowledge to be guided by procedures and techniques.

Davenport and Prusak (1998) provide a pragmatic approach to describing processes in a KM lifecycle. Despite the lack of an explicit definition of KM, they describe the main processes knowledge generation, codification and coordination, and transfer. Beijerse (1999) has a more analytical approach to KM lifecycles. For example, he breaks down the term 'knowledge management' and analyses different definitions of each component to derive his own resulting in the following:

> *Knowledge management is achieving organisational goals through the strategy-driven motivation and facilitation of (knowledge-) workers to develop, enhance and use their capability to interpret data and information (by using available sources of information, experience, skills, culture, character, personality, feelings, etc.) through a process of giving meaning to these data and information.*

Beijerse identifies main processes in a KM lifecycle as knowledge developing, enhancing and using. In line with Nonaka and Takeuchi (1995), he emphasises the role tacit knowledge, viewing it as the added value to these processes. Note the explicit responsibility given to workers to interpret and hence give individual meaning to knowledge. Ignoring this crucial facet of KM has left a huge gap for KMSD. Instead, of an explicit definition of KM, Bhatt (2000) selects processes from the KM lifecycles from others: knowledge creation (from Nonaka, 1991), knowledge adoption (from Adler et al., 1999) knowledge distribution (from Prahalad and Hamel, 1990), and knowledge review and revision (from Crossan et al., 1999). However, Bhatt describes his own KM lifecycle in the following definition, which stresses procedural KM by emphasising processes like Wiig (1997):

> *The knowledge management process can be categorised into knowledge creation, knowledge validation, knowledge presentation, knowledge distribution, and knowledge application activities.*

We conclude that KM definitions, both explicit ones and those implicit in frameworks and lifecycles, in the literature do not describe a coherent account of what is knowledge management, because they are mainly prescriptive. Rubenstein-Montano *et al.* (2000) argue that the majority of KM definitions and frameworks merely provide "direction on the types of procedures without providing specific details". Hence, we argue that more descriptive KM frameworks are required to provide insight into what knowledge to manage, why, and how. Many scholars posit that the key flaw of KM is the focus on KM activities without addressing why knowledge should be managed (Malhotra, 2005). We propose that the 'why?' can should be provided by an organisation's strategy.

3.2 Implications of notions of KM for KMSD

A richer interpretation of what KM is required to guide KMSD for organisations. We need to define what knowledge to manage, why, and how. Furthermore, it is important for business value to be able to guide KMSD towards what an organisation intends for its business. We propose a working definition of KM, that relates to business value and

which incorporates most of the processes in KM lifecycles described earlier as the set of processes of (i) creation and acquisition, (ii) representation and dissemination, and (iii) validation, utilisation and renewal of purposeful knowledge:

- that is needed by knowledge workers and aligned with an organisation's business goals and strategies;
- that addresses a problem or an opportunity for the organisation;
- that is provided to the right person, at the right place and time

This preliminary definition provides a general direction for developing KM theory, to allow us to consider what knowledge means for KMSD, as we discuss next.

4. Knowledge in knowledge management systems

Deficiencies in the models of KM lead inexorably to the question of what 'knowledge' is for KMSD. Frankly, the literature is distracted by what we assert is an irrelevant discussion of the meanings of and relationships among 'knowledge', 'information' and 'data'. Knowledge, in the context of KMS, needs to be represented in a way not previously addressed in other systems such as Management and Executive Information Systems (Alavi and Leidner, 1999). Yet, arguments still continue regarding the nature of knowledge how it is formed and held and its relationship to notions of information and data.

4.1 Knowledge, information and data

The literature frequently discusses de facto differences between knowledge and information, and information and data. Whereas the terms are perceived to represent concepts that are significantly different in nature, there is a lack of clear distinction. In fact, the three terms are often used interchangeably in both research and practice (Alavi and Leidner, 1999; Stenmark, 2002; Vouros, 2003). Often the relationship among these concepts is taken to be linear and mutually exclusive: something is added to data to make it information, and something is added to information to make it knowledge. However, there is nothing that indicates such linearity or justifies such separation (Holsapple, 2005). Whereas transformations are perceived to happen from data to information to knowledge, the literature fails to explain these transformations. One widely accepted view in the literature is that data, information, and knowledge are radically different (Lang, 2001; Yahya and Goh, 2002). However, this assumption has come under criticism recently, especially with a lack of definitions that clearly distinguish the terms one from another (Stenmark, 2002). The following questions are frequently addressed:

- What is knowledge in comparison with information and data?
- What is the relationship among knowledge, information and data?
- What transformations occur among knowledge, information and data?

The terms are often defined in relation to each other. Data is usually defined distinctively as 'facts':

- Raw facts (Bhatt, 2001; Pe'rez et al., 2002; Beveren, 2002; BSI, 2003), or
- Discrete facts (Davenport and Prusak, 1998; Herder et al., 2003).

However, information is usually defined in relation to data:

- Processed data (Bollinger and Smith 2001),
- Organised data (Bhatt, 2001; Pe´rez et al., 2002),
- Collected data (BSI, 2003), or
- Messages (Davenport and Prusak, 1998; Nonaka and Takeuchi, 1995).

Similarly, knowledge is usually defined in terms of information:

- Meaningful information (Bhatt, 2001; Herder et al., 2003; Pe´rez et al., 2002), or
- Commitments and beliefs created from messages (Nonaka and Takeuchi, 1995).

A widely accepted assumption in the literature is the unidirectional nature of transformations from data to information to knowledge, and not in the other direction. This asymmetrical situation has come under criticism recently as being incorrect, since knowledge is required for the creation of information and data, just as the creation of knowledge often requires information or data (see Beveren, 2002; Stenmark, 2002). The above definitions and rule would allow the deduction that knowledge might be 'meaningful, processed discrete facts.' However, we should not infer what data is needed to represent messages that embody a belief. How does this help KMSD? Alavi and Leidner (1999) state the view that "knowledge is not a radically different concept than information". They assert that the key distinguishing factor between knowledge and information is "not found in the content, structure, accuracy, or utility of the supposed information or knowledge", but "rather, knowledge is information possessed in the mind of an individual". Holsapple (2005) takes the view that the terms should not be casually equated, but echoes Alavi and Leidner, stating that while knowledge is not equated to information, there is no barrier built between them. Information is data represented in a different format due to an action performed on it: processing, organising, collecting, etc. Similarly, knowledge is information represented

in a different format due to an action on it: producing meaning, commitments or beliefs. Likewise, data is information or knowledge represented in different format: unprocessed, discrete, or abstracted. We argue that the entire discourse on knowledge, information and data is ill-founded, irrelevant and distracting. They are labels for essentially the same thing. If they have any usefulness it is to indirectly signal different contexts or values, e.g. 'knowledge' is what an individual will claim to have, and be of value, whereas 'information' is from somebody else, and therefore its value has not yet been assessed by an individual.

4.2 Implications of notions of knowledge for KMSD

All disciplines that update the meaning of their vocabulary suffer from the persistence of old meanings or ideas. We believe that the evolution of the terms 'knowledge', 'information' and 'data' are a case in point and argue that the confused perspectives we have discussed lead to position. However, the literature has shown some tentative moves in the direction we propose. Alavi and Leidner (1999) see knowledge as "personalised or subjective information related to facts, procedures, concepts, interpretations, ideas, observations and judgments (which may or may not be unique, useful, accurate, or structurable)". For us this introduces the personal assessment of the value of 'knowledge' to an organisation, which means that whatever a KMS might store cannot have a fixed meaning for all users of that 'knowledge'. The value or purpose of knowledge is a crucial aspect that must be represented in a KMS. Despite the argument of the importance of knowledge to organisations (Drucker, 2002; Koskinen, 2003), it is vital to direct KMSD towards knowledge of value, so as to develop and implement an effective KMS.
However, directing KMSD towards knowledge of value does not mean limiting access to pre-specified entities. KMSD should maintain a balance between directing development towards knowledge of value, and allowing enough flexibility for natural emergence and interaction among interpretations of knowledge.

5. Discussion and conclusion

In this paper we addressed a need for development methods for KMS through a critical analysis of the literature of knowledge management. This analysis showed a lack of credible knowledge management models for KMS, inconsistencies and obfuscating variations regarding KM definitions, and confusion about what is knowledge itself.
In our review of KM models, we concluded that focusing on epistemology alone or ontology alone limits the value to organisations. A KM approach based only on epistemological ideas will lack the representation of relationships that would expose clear business value. Such looseness would suit few modern organisations. A KM model based only on ontological notions would be so process-focussed that only a single, inflexible worldview could be supported. Such rigidity has proved unsuccessful in many organisations. Similarly, emphasising either analytical or actor aspects in KM models hinders the success of KMS in organisations. Understanding of these issues in KM models, both practically and theoretically, is currently hindered by a paucity of systematic empirical research that addresses the relationship between the organisational, human and technological aspects of KM. Therefore, KMSD should embody both epistemological and ontological aspects of knowledge, and encompass organisational, human, and technological aspects in KM. We presented a matrix of non-mutually exclusive facets of KM models that need to be considered in the development of any KMS. Having encountered many issues in models of KM we reviewed notions of KM processes, lifecycles and frameworks. These showed insufficient accounts of what KM actually is – and even whether knowledge could really be 'managed'. Our analysis leads us to argue that a richer notion of KM is required to provide insight into (a) what knowledge to manage, (b) why to manage knowledge, and (c) how to manage knowledge. We have proposed a suitably descriptive definition of KM, which addresses these and also incorporates all of the KM processes posited by a range of scholars. We found the discussions comparing knowledge with information and data sterile and unhelpful – obscuring the important ideas that there need to be multiple interpretations of knowledge and flexibility to extend, blend and change interpretations. Through our analysis, we have shown divergence in KM philosophies, definitions, theories, and models has left gaps that is hindering KMSD in organisations. While some might argue the suitability of such variation, we argue the requirement for a common basis for KMSD. A common basis is required to:

- Facilitate communication between practitioners, especially with different perspectives and roles;
- Enable interoperability of different KMS of different departments within an organisation or between different organisations.

Ultimately we need to be clear about what, in terms of IT, is an 'information system' as opposed to a 'knowledge management system'. In the context of our work an 'information system' is one in which static relationships between entities (in the accepted database sense) dominate the system's architecture and design. Typically an information system could be developed according an accepted approach, such as embodied by Zachmann (1987). Crucially, there will be a single meaning ascribed to

all entities in an information system and to the relationships between them. By contrast, a 'knowledge management system' is not dominated by static relationships but needs to support the ad hoc, dynamic creation of and changing relationships among entities – the type that no *a priori* analysis would reveal. A KMS should accommodate the dynamic and inherently unpredictable nature of knowledge. Crucially, a KMS must support multiple meanings for stored entities and must support interactions between interpretations, not just stored entities.

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