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Knowledge Management about Knowledge Management Systems: A Conceptual Cleansing

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ABSTRACT

Knowledge Management and Knowledge Management Systems are slowly but surely capturing the attention of many organisations in a quest for competitive advantage. Like many other computing fads before them, there is no shortage of recipes by their proponents. This paper discusses the emerging discipline of Knowledge Management in computing and explains the concepts underlying Knowledge Management Systems that will lead to a better development and implementation of these systems. The conceptual confusion about data, information, and knowledge, which appears to be finding its way into the Knowledge Management literature, is highlighted. The terms, 'capta' (Checkland & Howell, 1998) and 'constructed data' (Flood, 1999), are used in analysing these concepts to clear some of the confusion surrounding them.

INTRODUCTION

Every few years the IT community comes up with a promised panacea to cure all ills. There was once the push for office automation, artificial intelligence, decision support, groupware, reverse engineering, MIS, B2B, B2C, and now, it is KM - Knowledge Management. These are often brilliant concepts, and while they all find their level of utility, usually more modest than their proponents' claims, they have by and large been misunderstood and misapplied, to the disadvantage of some stakeholders and, ultimately, investors.

Now that Knowledge Management Systems (KMS) are being touted as yet another silver bullet, how can a would-be investor in a KMS realise its anticipated benefits, and how would an implementor know they are on the right path?

As noted by White & Sutton (2001, p.180), "the kinds of rationalist assumptions about knowledge creation and use, which characterise Knowledge Management, are inadequate." They suggest the need for a broader approach to, and definition of knowledge as an essential prerequisite to attempts to harness and exploit it: otherwise the emerging discipline may also be consigned to the ranks of yet another 'management fads'.

This paper looks at some concepts underlying Knowledge Management and suggests some ways of bringing the concepts to bear on Knowledge Management Systems. The paper begins by first highlighting the current state of affairs and then some of the conceptual confusion in the area of Knowledge Management. It then critically analyses some terms which KMS thrives on. The paper then presents a conceptual cleansing that will lead to better KMS.

CURRENT STATE OF AFFAIRS

The Implementation of Knowledge Management Systems has generally focused on the technological capabilities of data representation and access, to the detriment of foundational concepts. As noted by Yen (2001), of the many vital issues in knowledge management, knowledge representation has been studied more thoroughly than others. However, without a foundationally coherent and consistent understanding of data, information, knowledge and, the organisation and management of complexity within the target environment (Boahene and Ditsa, 2001), all the technological sophistication is unlikely to guarantee the realisation of any anticipated benefits.

By far, the literature on KMS has focussed on the categorisation, classification and processing of invariances, assuming some relationship between data, information and knowledge. Hence we have categorisations such as tacit and explicit knowledge, objective and subjective knowledge, certain and uncertain knowledge, and so on. These categorisations however, while interesting, are of little value in providing insights into the conception and development of Knowledge Management Systems. They do not distinguish between data originating from observations of the target environment on one hand, and the 'knowledge-base' needed to make sense of the observations on the other, and as such, any given data may have characteristics of both.

White & Sutton (2001), in their inquiry into knowledge management in clinical practice within the NHS in Britain, make a similar observation when they note that no work was found which analysed types of clinical knowledge in such a way as to define which phenomena fell into which category and what the relative percentages were.

This treatment of KMS follows a systemic account that draws heavily on concepts and insights originating from the works of Hirschheim et al. concerning information systems development methodologies, Checkland's work concerning the nature of information systems, and Flood and Senge's work concerning the organisation and management of systems.

THE CONCEPTUAL CONFUSION

A relationship between data, information and knowledge is widely recognised in the literature. However, the distinction often seems arbitrary. These terms are often used inter-changeably making it difficult to make sense of the emergent relationships that exist between them. This confusion has found its way into the knowledge management literature where a diverse range of application systems lay claim to being Knowledge Management Systems.

Organisation and management constituting the core endeavour, which Knowledge Management Systems seek to support, are underpinned by thinking, which can be categorised in philosophical and sociological terms. From a philosophical perspective, there is positivism and phenomenology at opposite ends of a continuum. The positivist stance refers to a philosophical position characterised by a readiness to concede primacy to the given world as known through experimental evidence. The phenomenological stance on the other hand, refers to the position characterised by a readiness to concede primacy to the mental processes of observers rather than to the external world (Checkland 1981).

From a sociological perspective, there is functionalist and interpretivist views at polar ends of a continuum, yielding 'hard' and 'soft' systems thinking approaches to the organisation and management of phenomena (eg. problem of choice in a dynamic environment). The functionalist view adopts a realist ontology and assumes

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that facts about the world exist and are waiting to be discovered; hence knowledge is perceived as an immutable object that exists in a variety of forms (eg. tacit, explicit) and reside in a variety of locations (eg. individuals, culture, work routines). The interpretivist perspective maintains that reality is socially constructed; hence knowledge is perceived as a process of knowing that is continually emerging, indeterminate and closely linked with practice (Detlor 2001).

These philosophical and sociological viewpoints form the basis of all thinking and practice in the inquiry into a target environment, the selection of relevant data, and the development of information systems that serve systems of purposeful action (eg. managing complexity).

Can both viewpoints be right or is one right and the other wrong? Or more importantly, how can each be leveraged off the other to deepen our understanding and reduce uncertainty in inquiries concerning the development of Knowledge Management Systems? To answer these questions we first need to understand the target environment and the nature of the phenomena (ie. data, information and knowledge) that fuels the creation, access, use and sustenance of Knowledge Management Systems.

The following section presents an analysis of the terms (*data*, *capta*, *information, knowledge and, organisation and management*) on which Knowledge Management Systems thrive.

ANALYSIS OF TERMS IN KNOWLEDGE MANAGEMENT SYSTEMS

Data

Hirschheim et al. (1995, p.14) defines data as "invariances with potential meaning to someone who can interpret them". According to Hirschheim et al., the basis of all communication: technically, biologically or socially are invariances encoded in some medium and transmitted in many forms (*eg.* waves, electrical currents).

The encoded invariances are received through our senses (eg. vision, hearing, smell, touch, taste). It is important to note that, following the receipt of invariances, via a communication medium through our senses, what is expressed as data may be represented as a word, sentence, number, sign or some other form of representation.

Hirschheim et al. distinguish between invariances that occur naturally such as bird markings, and invariances created by humans for some purpose such as letters and graphics. In this paper, we shall concentrate on the invariances created by humans through observations (with our senses) or cognitive capabilities.

Also, through his analysis of Systems Thinking, Checkland (1981) makes an important contribution to the understanding of the nature of data. He distinguishes between two types of data. One that is independently verifiable (that which, positivists and functionalists propose as a reality outside ourselves which actually exists), and one that is perceptive and therefore within oneself (that which phenomenologists and interpretivists propose as the continually negotiated truth).

Consider the following examples of data. If I observe an object (e.g. a dog), which other observers that I am not in collusion with can confirm, or a camera can record the same object as a dog, then I am prepared to say there is an immutable invariance that may be expressed as data (e.g. "This is a dog", or dog) which exist outside of ourselves and is real. This type of invariance seems to be what the functionalists refer to as data.

However, if I observe a dog and describe it as cute or beautiful, or ugly, then while the fact remains that it is a dog (which agrees with the functionalists view of data), it can hardly be argued that 'a beautiful dog' is an immutable invariance, since it is my perception of the dog which may or may not be confirmed by any other observer. This type of invariance seems to be what the interpretivists refer to as data.

Capta

As Checkland and Howell (1998) point out, there could be a multitude of data (or invariances) pertaining to any particular object or phenomenon, but we choose, for one reason or another to focus on a subset which is of interest to us at any time. They make a defining distinction between the multitude of data attributable to an object or phenomenon and the subset we choose to pay attention to. This, they refer to as 'capta'.

Flood (1999) complements this line of reasoning. He uses the term 'data construction' instead of 'data collection' to distinguish between the mass of data that could be attributed to a phenomenon or item of interest and the portion that is considered and chosen to be of interest. He points out rather understatedly that, "data is not waiting out there in volumes to be reaped like corn in an autumn harvest, but it is rather the product of a process of investigation" (p. 145).

For instance, of all the invariances that may be observed about dogs and represented as data, a breeder may choose to pay attention to (ie. 'capta') colour, breed and origin rather than say, size, age or sex, as a result of some interests (eg. breeding exotic dogs) that the breeder may have and the environment (eg. locality, regulations, etc.) within which the inquiry is conducted. It is however possible that at some future time the breeder may choose to pay attention to a different subset of data if the environment or his/her interests change.

This distinction is important as it draws attention to the fact that the selection of a subset of all possible data about an object or phenomenon should not be taken for granted, since it defines boundaries of the target environment. More importantly, it also limits the subsequent insights that may be generated about the object or phenomenon. Therefore, the current assumption that 'data-warehouses' could be the repository of all data about an object or phenomenon in advance, and 'mined' for insights is not very well grounded, because the bounded environment keeps changing.

In summary, data are the starting point in our mental processing. That is, invariances about an object or a phenomenon that could be paid attention to. 'Capta' on the other hand are the result of selecting some for attention.

Information

Having *constructed data (*through the process of investigation) or chosen to pay attention to a subset of the mass of possible data (*capta*) about an object or a phenomenon, we put it into context or attribute meaning to it. Hirschheim et al. (1995) contends that, by themselves, these invariances have no intrinsic meaning. The invariances acquire meaning through social conventions of individuals and communities. The invariances received are transformed through a process of meaning attribution (or interpretation) into information, which then triggers a behaviour. Attribution of meaning to 'capta' is a creative act, and may be argued that no two interpretations are ever quite the same.

For instance, at a dog show, the dog breeder may observe, for argument sake, a red, white and blue striped chihuahua from France and attribute meaning such as, 'cute but not exotic', which triggers a 'don't buy' behaviour. Another may make the same observation, but attribute meaning such as, 'interesting, worth trying' and trigger a 'buy' behaviour.

This complements the observations of Sutton & White (2001) when they point out that, technically, clinical observations can be readily translated into data, and that data can be shared. However, accurate technical performance does not necessarily equate to transfer of knowledge. It rather gives a partly illusory and misleading representation.

In summary, information is created through the attribution of meaning (by individuals) to 'capta'. Information therefore, is a far more personal, variable, esoteric and ephemeral concept, dependent on the receiver's point of interest and 'knowledge-base', which is private and only available to the person. Information however, should not be confused with knowledge.

Knowledge

'Capta', that has been generated as a result of a process of inquiry or observation, the meaning attributed to it and the behaviour that follows can all be transformed into a new 'form' exhibiting different emergent properties. This new 'form', also 'capta', is stored as part of a 'knowledge-base'. It enriches the 'knowledge-base' and may be used for further meaning attribution to new 'capta' on another occasion.

From the previous statements, we assert that there are two types of 'capta': one that is about observations, meaning and behaviour pertaining to a target environment and one that enriches the 'knowledge-base'. The first type of 'capta' referred to as 'observation induced capta' is transformed into the second type of capta referred to as 'transformed capta'. The 'transformed capta' is represented as concepts, methods, beliefs, values and normative principles, forming a filter through which we perceive events and observations thereby enabling us to attribute particular meanings to new 'observation induced capta'. This however, does not preclude the 'garbage-in garbage-out' principle. If the 'knowledge-base' is unreliable, it is unlikely to support the effective attribution of meaning to new 'observation induced capta'.

This concept complements what White & Sutton (2001) noted as a process of knowledge generation and decision making by one of the participants in their study. The participant explains that, "following the initial discussion with the patient, I take the data collected [ie. 'observation induced capta'] and put it in my knowledge base [ie. transformed 'capta'] and conclude a number of things [ie. further meaning attribution to 'observation induced capta'] about the present state of the individual" (p. 179).

Hirschheim et al. (1995, p. 14) cites four types of speech acts (cf. Deitz and Widdershoven, 1992, cited in Hirschheim et al., 1995) following from Habermas' Theory of Cummunicative Action:

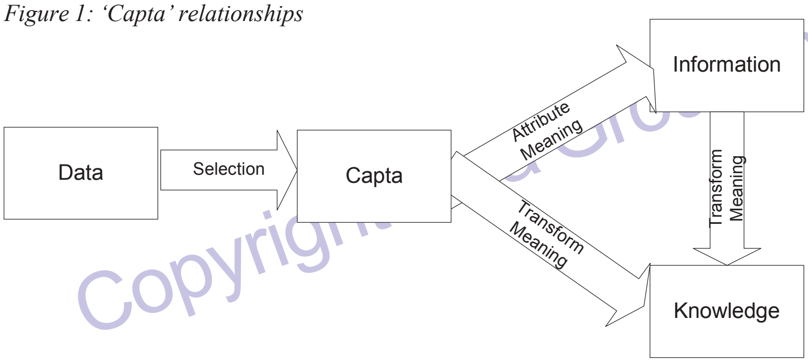
- To express how one feels or thinks (expressiva)'
- To appeal to others to obey accepted social norms (regulativa)
- To get someone to do something (orders, imperativa)
- To get someone to accept something as true (assertions about the external world, also called constantiva)

'Observation induced capta' manifest as, expressiva regulativa and imperativa speech acts, while 'transformed capta', stored as part of a 'knowledge-base' manifest as constantiva speech acts – assertions of truth about the external world.

As a further example, let's go back to the information created by the breeder's observation. In speech acts, the information created is both expressiva and regulativa (ie. 'cute' for expressiva, and 'not exotic' for regulativa) and the behaviour triggered, that is, 'don't buy' is imperativa. But why does the breeder come to this conclusion? Perhaps the breeder comes to this conclusion because of knowing that, his/her clients are only attracted to one colour, pure bred dogs originating from hard to reach countries, or higher profit margins for such dogs. Whatever the reasons (ie. the 'Whys'), this knowledge expresses the breeder's assertions of truth about the external world (ie. constantiva).

In summary, knowledge is a reserve of 'transformed capta', expressed as constativa, that can be applied to new 'observation induced capta'. Knowledge may be personal or collective but definitely more stable than information.

Figure 1: 'Capta' relationships



From the discussion so far, we recognise an emergent relationship between data, capta, information, and knowledge as shown in the following diagram. The question then is, can computers automatically undertake the transformation of 'capta' into knowledge?

Organisation and Management

Little attention has been paid to the nature of a target phenomenon, which is invariably the management and organisational function, which a Knowledge Management system is supposed to serve.

Senge (1990) makes an important contribution here by distinguishing between two kinds of complexity in management situations reflecting the nature of the target phenomena that Knowledge Management Systems aim to support. These are detail complexity and dynamic complexity. Detail complexity refers to situations where there are many variables, however outcomes are predictable. Dynamic complexity refers to situations where cause and effect are subtle and where the outcomes of interventions over time are not obvious. As he points out, mixing many ingredients into a stew involves detail complexity, as does taking inventory in a retail store. But balancing market growth and capacity expansion, or improving quality while reducing total costs and satisfying customers in a sustainable manner are examples of dynamic complexity problems. According to Flood (1999, p. 86), "dynamic behaviour is capable of producing unexpected variety and novelty through spontaneous self-organisation. … a complex of variables interrelates with multiple feedback, which spontaneously creates a new order".

In problems involving detail complexity, cause and effect are closely linked; therefore it is possible to predict outcomes based on 'capta' of a given set of variables. For instance, it is relatively easy to predict the taste of a hamburger given the proportionate mix and the order of introducing the ingredients (a problem of detail complexity). Using 'capta' about the taste of the hamburger, it is a lot more uncertain, if at all reliable, to predict if it would attract customers and therefore increase sales or share of the hamburger market (a problem of dynamic complexity).

Detail and dynamic complexity are the challenges that Knowledge Management Systems, and for that matter all other information systems, aim to help users organise and manage in problem situations.

The next section presents a conceptual cleansing that will lead to a better development and implementation of Knowledge Management Systems.

CONCEPTUAL CLEANSING

We have thus far been laying the foundation from which we hope to clarify the competing claims about knowledge management and the confusing manifestations of Knowledge Management Systems.

Knowledge Management Systems have been popularly defined by different writers from either a structural or functional perspective. From a structural point of view, Morse (2001) defines Knowledge Management Systems as follows. "Knowledge [management] systems take a large, diverse collection of document-based knowledge, provide a physical infrastructure for storing those documents and provide a logical structure for retrieving information" (p. 230). He also provides a functional definition as follows. "Knowledge [management] systems are centralised computer systems that store, structure and provide access to the corporation's document-based knowledge" (p. 230).

We find the structural perspective somewhat deficient, because of the variety of possible compliant components, which do not particularly contribute to either a necessary or sufficient condition for the attainment of an effective knowledge management system. The functional perspective although gets us closer to a unifying definition, it does not surface fundamental assumptions (eg. beliefs and values) made about content which is necessary for the KMS to function adequately.

Knowledge management in any target environment may be viewed as an ongoing 'journey' rather than an end or a destination in itself. Knowledge changes over time since it is a synthesis of the perceptions of a target environment, which is in a constant state of flux. Further, in knowledge-intensive working environments where people deal with dynamic complexity, consensus building, as an approach to decision-making is rarely the norm. However, most conventional KMS implementations assume and model interventions around consensus (as the dominant cultural approach to decision-making) and determinism (a characteristic of detail complexity).

Following from our earlier discussion about the philosophical and sociological perspectives of organisation and management of phenomena (and objects), and its relationship to data, it is apparent that the ontology and epistemology of systems developed to support problem situations will contain an indeterminate mixture of positivist (functionalist) and phenomenologist (interpretivist) stance. This will reflect the relative mix of detail and dynamic complexity requiring management in the problem situation. In practice, each polar end of the continuum is unlikely to capture the relevant nature of the target environment or managing complexity (detailed and dynamic) of problem situations arising within them.

The ontology is concerned with the fundamental units, which are assumed to exist in a target environment. The units may be composed of hard tangible structures with a concrete material base (realism), or composed of malleable, vague phenomena, which are socially constructed through an intellectual or cultural base of values and concepts (nominalism or idealism). The epistemology is concerned with how an investigator inquires into a target environment and sees phenomena (observation 'capta') in them (Hirschheim et al., 1995).

To support the organisation and management of the mix of detail and dynamic complexity in a target environment, we distinguish between three types of information systems, often claimed to be Knowledge Management Systems:

- Information management systems – Require an observation 'capta' base of regulativa and expressiva speech acts. Mainly supporting the recall of meaning-attribution.
- Knowledge-based systems – Require an 'observation induced capta' base of codified meaning consisting of regulativa and imperativa speech acts. Mainly supporting the organisation and management of detail complexity.
- Knowledge management systems – Require a 'transformed capta' base of constantiva speech acts. Mainly supporting the organisation and management of dynamic complexity.

As a consequence of this distinction, we assert that there is only one type of Knowledge Management system. Defined from a content perspective, a Knowledge Management system is an organised collection of concepts, methods, beliefs, values and normative principles (ie. 'knowledge-base') supported by material resources (eg. technology). Our definition is similar to Hirschheim et al's (1995) definition of an Information Systems development methodology. A 'knowledge-base' is used to make sense of invariances (ie. 'observation capta'), not to provide codified meaning, about an object or phenomenon that has been chosen for attention. A 'knowledge-base' is the source of our 'know-why' (Boahene, 1999), used to organise and manage uncertainty in complex problem situations, which is an essential property of knowledge.

As a rule of thumb, Information Management Systems have the capability to provide answers to questions of 'Where', 'Who', 'When', while Knowledge-based Systems provide answers to questions of 'What' and 'How', but Knowledge Management Systems will have the capability to provide answers to questions of 'Why'. Notwithstanding the dizzying array of application systems that claim to support knowledge management, if the system does not articulate a 'knowledge-base' that supports dynamic complexity, then it is not a KMS.

Since dynamic behaviour is characterised by unexpected variety and novelty through spontaneous self-organisation, solutions to issues and problems cannot be known priori. We learn our way into the unknown. The 'knowledge-base' in a knowledge management system ought to provide the frame of reference that will be consistently used to provide insights that support the organisation and management of dynamic complexity in a target environment, that is, new and deeper understandings of problem situations and how to intervene in them.

Table 1: Rule of thumb

System support	Typical capability	Problem Situation
Information Management	Where, Who, When	Detail Complexity
Knowledge-based	What, How	Detail Complexity
Knowledge Management	Why	Dynamic Complexity

Concepts in a 'knowledge-base' are structures used to classify, explain and give order to phenomena or an object in a target environment. Flood (1999) provides an insightful conceptual structure for deepening systemic appreciation of a problem situation. According to Flood, any investigation into a problem situation will use ideas from systems of processes, structure, meaning, and systems of knowledge-power. These different views may be combined to provide a panoramic view, which he terms prismatic thought.

Beliefs are inferences of 'truth' that we hold in esteem and values help us to justify and uphold those beliefs. These beliefs affect our attitude to, and perception of, phenomena and the environment in which it occurs. Truth, however, should not be viewed as unchanging. As Flood's concept of prismatic thought suggests, a target environment is determined by boundary judgement. Boundaries are mental constructs, which determine what is in view (and might be taken into account at the moment), and what is out of view (and thus excluded from consideration). As such, the determination of a target environment (ie. bounded action area) and what is taken to be relevant and worthy of having knowledge about, is influenced by beliefs and values, both of which may change (in space and time) as different complex mixes of variables come into view and others drop out of view. It therefore follows that knowledge also changes as truth is continually renegotiated.

Concepts, beliefs and values can be organised into coherent sets of technical and behavioural rules which guide an approach to investigating problem situations in a target environment. These rules may be expressed as methods and normative principles. These elements of a 'knowledge-base' are what transformed 'capta' is about.

The 'knowledge-base' so constructed with the support of material resources can then be used to make sense of the nature of what is known about a target phenomenon (eg. problem situation and possible insights that can be acquired through different types of inquiry and alternative methods of investigation (ie. observation capta) and thereby intervene more effectively.

CONCLUSION

This paper discussed the emerging discipline of Knowledge Management in computing and explained the concepts underlying Knowledge Management Systems, which we believe, will lead to a better development and implementation of these systems. An attempt has been made to clear some of the conceptual confusion surrounding data, information, and knowledge, which appears to be finding its way into the Knowledge Management literature.

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