Reconceptualizing Knowledge Management:

Knowledge, Social Energy, and Emergent Leadership

in Social Complex Adaptive Systems

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"For every complex problem, there is a solution that is simple, neat, and wrong."

H.L. Mencken, popularized update from "The Divine Afflatus"
in New York Evening Mail (16 November 1917)

Abstract

The field of knowledge management struggles among apparent paradoxical standpoints. Beyond the facts that knowledge remains poorly defined, and is also not easily 'managed', theories of knowledge management propose opposing views traditionally ranging from an information science perspective to a more social orientation. There is also an epistemic gap between the concepts of knowledge and knowledge management. Although this is primarily experienced at the practitioners' level, it is essentially due to a theoretical disintegration at the academic level between the micro and macro levels of knowledge management and a myriad of non-integrated frameworks. There is currently no integrated theory of knowledge management.

This thesis employs a *radical socio-cultural constructivist* epistemology, adopting complexity theory as a lens to provide the first step towards an integration of the field of knowledge management. Using a disjunctive logic and a holistic approach, this thesis makes several significant contributions:

- This research presents a Delphi study utilizing a panel of experts to explore existing consensus and dissension within the field of knowledge management.

- This research introduces the E2E Model, a new complexity-based conceptualization of the cognitive system of knowledge which revisits the position of the traditional constructs of data, information, knowledge, and wisdom within an interlinked feedback system of increasing levels of understanding, allowing multidirectional interstate transitions, bound between two states of being: existence and enlightenment (hence "E2E").

- This research introduces the LIFE Model (Leadership Invigorating Flows of Energies) which provides a comprehensive description of the organizational Knowledge Processing System. It highlights the role of emergent leadership and flows of social energies as forces invigorating the Knowledge Processing System, and describes how knowledge is created, assimilated, and diffused dynamically within an organization through the Knowledge Processing.

- This research also presents a first application of the LIFE model with the case analysis of Wikipedia illustrating why this organization can be considered as a

social complex adaptive system and how the LIFE model facilitates its analysis. This analysis demonstrates how continuous flows of positive and negative feedback among users and the processes of the Knowledge Processing Cycle lead to the emergence of a complex feedback system that nurtures the self-organization of the Wikipedia community and its outputs.

Together, the E2E Model and the LIFE Model provide a sound foundation for a reconceptualization of knowledge management. They open the path to the creation of an integrative theory of knowledge management, of which a first stepping stone is presented in this thesis.

Acknowledgments

First and foremost, I would like to thank my two supervisors Rob Lawson and André Everett for their tremendous job in supporting me in my academic work and development. They have always found ways to help me improve my academic skills, and I would not be half the academic I am today without them. They have also supported me, even in the most difficult times, and for this I will always be grateful to them. I was extremely lucky to have both of them during these few years, and I wish all PhD student could have such great supervisors.

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A special 'thank you' to my family for being so supportive along all these years. It has been a great challenge for them and for me to be so far away from each other, and I am grateful they have always been there for me along this difficult path.

Last but not least, I dedicate this thesis to my Dad who unfortunately was taken away from us before he could witness the end of this journey.

Preface

It has always been my goal to produce a short thesis. There are a few reasons underlying this choice. First, I believe every academic work should be concise. If you can say the same thing in half the amount of words, then not doing so is pure laziness. Second, I hate to read long text which repeats the same thing over and over again; it is just a waste of time for the reader. Looking at the limited time everyone has in his/her hands, it is simply unacceptable. Third, I believe in quality, not quantity. I have therefore tried my best to make this thesis as concise as possible, and I hope this will be appreciated.

Consequently, this thesis only features the discussion of concepts that seemed necessary to understand the critical issues at the core of my argumentation. I have voluntarily omitted several discussions of secondary issues related to my work. I have tried to be upfront about these omissions in the text and it is hoped that these possible injustices for other academic works are neither crucial nor injurious. If it is, then I am deeply sorry as it was not my intention.

The reader might find a few puns in this thesis, and wonder what they are doing in such a serious piece of work (i.e., a doctoral thesis). I believe that even a serious work such as this one should not take itself too seriously. For the sake of conciseness, I have restrained myself to a maximum, but some slippages may still remain, yet, I won't apologize for them.

Finally, I have not used any 'cook book' on how to write a thesis. While I do not think I have reinvented the wheel either, I have produced a structure and content that fit the purpose of my academic journey. I hope this thesis will surprise my readers by its approach and essence, and that its contribution to academia will shine through the midst of the too many words composing it.

Notice of Publication of Related Work

Some of the research described in this thesis has undergone peer review and has been published in, or at the date of this printing is being considered for publication in, academic journals, books, and conferences. This notice serves to indicate that certain parts of the material presented here have already been described by the author in the literature, and some parts are therefore subject to copyright by either publishers or the author outside this volume. Coauthors are in all instances the researcher's thesis supervisors.

"What Do We Know About Knowledge?" By Jean-Baptiste P.L. Faucher, André M. Everett, and Rob Lawson. In Alex Koohang, Keith Harman, and Johannes Britz, eds., Knowledge Management: Theoretical Foundations. Santa Rosa, California: Informing Science Press, 2008, pp. 41-78. ISBN 978 1 932886 061.

"Reconstituting Knowledge Management." Journal of Knowledge Management, 12:3, 2008, pp. 3-16. By Jean-Baptiste P.L. Faucher, André M. Everett, and Rob Lawson.

"Modeling the Knowledge Processing System through the Lens of Complexity Theory: Social Energies, Leadership, and the LIFE Model." 3rd International Conference on IT Applications and Management, The Korea Database Society, Seoul, Korea, 30 October 2009. By André M. Everett, Jean-Baptiste P.L. Faucher, & Rob Lawson. Proceedings, pp. 111-123.

"Knowledge Intrapreneurship in a Complex Adaptive Organization: The Case of Wikipedia." 11th McGill International Entrepreneurship Conference, Dunedin, New Zealand, 6-8 December 2008. By Jean-Baptiste P.L. Faucher, André M. Everett, and Rob Lawson. Proceedings published on USB drive, pp. 546-567.

"Applying a Modified Delphi Approach to Determine the Current State of the Concept of Knowledge." 39th Annual Meeting of the Decision Sciences Institute, Baltimore, Maryland, 22-25 November 2008. By Jean-Baptiste P.L. Faucher, André M. Everett, and Rob Lawson. Proceedings published on CD only, ISBN 0-9667118-0-7, pp. 4801-4806.

"Applying Complexity Theory to the Foundation of Knowledge Management: Recasting the DIKW Pyramid as the E2E Model." International Conference on

IT Applications and Management of the Korea Database Society, Seoul, Korea, 31 October 2008. By André M. Everett, Jean-Baptiste Faucher, & Rob Lawson. Proceedings, pp. 171-184.

"A Complex Adaptive Organization Under the Lens of the LIFE Model: The Case of Wikipedia." 4th Organization Studies Summer Workshop: 'Embracing Complexity: Advancing Ecological Understanding in Organization Studies,' Pissouri, Cyprus, 5-8 June 2008. By Jean-Baptiste P.L. Faucher, André M. Everett, and Rob Lawson. One-page summary in book of abstracts; full papers online only (24 pages).

"Examining Successful Complex Adaptive Organizations via the LIFE Model: The Case of Wikipedia." 38th Annual Meeting of the Decision Sciences Institute, Phoenix, Arizona, 17-20 November 2007. By Jean-Baptiste Faucher, André M. Everett, and Rob Lawson. Proceedings published on CD only, no ISBN, pp. 3181-3186.

"A Proposed New Knowledge Management Framework with an Intended Validation Approach: The E2E Model." 6th International Conference on Information and Management Sciences, Lhasa, Tibet, China, 1-6 July 2007. By Jean-Baptiste P. L. Faucher, André M. Everett, and Rob Lawson. Proceedings, ISSN 1539-2023, pp. 349-355.

"Extending the Knowledge Management Paradigm: The E2E Model, From Existence to Enlightenment." Pan-Pacific Conference XXIV, Dunedin/Queenstown, New Zealand, 2-4 June 2007. By Jean-Baptiste P.L. Faucher, André M. Everett, and Rob Lawson. Proceedings on paper and CD, ISBN 1-931649-23-5, pp. 42-44.

"Towards a New Understanding of the Knowledge Processing Feedback System: Introducing the LIFE Model." 37th Annual Meeting of the Decision Sciences Institute, San Antonio, Texas, 18-21 November 2006. By Jean-Baptiste Faucher, André M. Everett, and Rob Lawson. Proceedings published on CD only, ISBN 0-9667118-0-7, pp. 29411-29416.

"The LIFE Model: Towards a New Understanding of the Knowledge Processing Feedback System." International Conference on Business Knowledge Management, Macao, China, 26-27 October 2006. By Jean-Baptiste P.L. Faucher, André M. Everett, and Rob Lawson. Proceedings, pp. 155-168.

"Reconstituting Knowledge Management." International Conference on Business Knowledge Management, Macao, China, 26-27 October 2006. By Jean-Baptiste P.L. Faucher, André M. Everett, and Rob Lawson. Proceedings, pp. 36-50.

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"If man is not to do more harm than good in his efforts to improve the social order, he will have to learn that in this, as in all other fields where essential complexity of an organized kind prevails, he cannot acquire the full knowledge which would make mastery of the events possible."

Friedrich A. von Hayek. (1989). The Pretense of Knowledge, p. 7.

"In truth, it is not that the practitioner seeks obstacles and impediments, but that he must be ever vigilant, for the way is full of dangerous and unforeseen events. He should prepare himself for all eventualities so that when faced with actual obstacles, he can remain calm and unruffled."

Von Hien Study group (2003). The Seeker's Glossary of Buddhism, p. 774.

Chapter 1. Setting the Scene

This thesis examines the concepts of knowledge and knowledge processing in human organizations. It is primarily grounded in the knowledge management field, although linkages to philosophy, science, and general management will be exploited.

The concept of knowledge has been actively discussed since at least the time of the ancient Greeks. Socrates, in Theaetetus by Plato (369 BC), conceptualized knowledge as a true belief with an account – commonly identified as the concept of justified true belief – but then indicated this definition remained inadequate. Many attempts have been made by scholars to redefine or explain the concept of knowledge, however, the field of knowledge management has not yet settled on one.

Beyond the fact that knowledge remains poorly defined, it is also not easily 'managed'. Theories of knowledge management propose opposing views traditionally ranging from an information science perspective to a more social orientation. Consequently, the field of knowledge management struggles among apparent paradoxical standpoints; knowledge tends to be as seen either an object or a process. Reductionism leads to a disjunctive logic of 'either/or' while system thinking provides a conjunctive logic allowing an understanding of knowledge as an object and a process at the same time.

Furthermore, there is an epistemic gap between the concepts of knowledge and knowledge management. Although this is primarily experienced at the practitioners' level, this is essentially due to a theoretical disintegration at the academic level between the micro and macro levels of knowledge management. There is currently no integrated theory of knowledge management.

It is the intention of this thesis to address and discuss all the above issues, and provide a useful framework leading to an integrative theory of knowledge management.

This chapter includes six sections.

- Section 1 outlines the literature underlying this thesis. Three main areas of literature are presented: the concept of knowledge, knowledge processing systems, and complex adaptive systems.

- Section 2 provides conclusions from the different literature reviews. It shows how the three main areas of literature will be linked and together supply the

background for this study. Gaps in the literature are highlighted and briefly discussed.

- Section 3 describes the research objectives and contributions of this thesis. It explains how gaps found in the literature will be addressed and what intended outcomes they will bring about.

- Section 4 presents the philosophical position of the researcher. It discusses briefly the approach undertook by the researcher. It outlines the ontology underlying the research, followed by a description of the epistemology used in this thesis.

- Section 5 describes the methodology employed in this thesis.

- Section 6 introduces the outline of the thesis and provides an overview of each chapter.

1.1. Relevant Literature Underlying this Thesis

The following section introduces the most relevant areas of literature to this research, ones that provide an appropriate context for the development of a better understanding of knowledge processing systems in organizations. The three main areas of literature are:

(i) The concept of knowledge

(ii) Knowledge processing systems

(iii) Complex adaptive systems

While other areas of literature (e.g. leadership) will be incorporated as required throughout this study, these three are the most important areas of focus. The third area of literature (i.e., complex adaptive systems) serves as a theoretical lens for this study, whereas the two other areas of literature are at the core of the research outcomes.

(i) The concept of knowledge

The historical development of the concept of knowledge helps to understand how a reductionist perspective entered the debate between philosophers in the West and took an important role in the development of the theory of knowledge. It also shows how the latest philosophical and scientific developments provoked an evolution of the concept of

knowledge symbolizing the convergence of views from the East and the West towards a holistic view of knowledge.

The current literature on knowledge management is replete with distinctions among knowledge, information, data, and wisdom (Nonaka and Takeuchi, 1995; Matthews, 1998; Awad and Ghaziri, 2004, Wiig, 2004; Hicks *et al*., 2006). It is also common to see distinctions drawn between different kinds of knowledge, such as tacit and explicit (Nonaka and Takeuchi, 1995), actionable and passive (Wiig, 2004), or knowledge and meta-knowledge (McElroy, 2003; Wiig, 2004). Similarly, data are considered as broader than facts, which are typically treated as a form of proven or verified data. Most of the authors define knowledge, fewer define information, fewer still define data, and almost none define wisdom.

One area of agreement is that there is a hierarchy among the concepts of data, information, knowledge, and wisdom. The knowledge hierarchy is usually seen as a pyramid ascending from data to wisdom. One area of potential controversy regarding the definitions and nature of the various knowledge related constructs relates to the distinction between tacit and explicit aspects. However, no overall consensus exists in the field of knowledge management about the concept of knowledge.

(ii) Knowledge processing systems

Western management has traditionally viewed organizations as highly structured and passive information processing machines, gathering information from their environments, employing it in order to resolve existing problems (Nonaka et al., 2001). This is a view of the organization that ignores the underlying dynamism of knowledge creation processes. Instead, an organization should be seen as a venue (Nonaka et al., 2001) or a field (Bourdieu, 1977) that facilitates interactions among the members of the organization. Guided by the rules specific to the given field, the role of an organization's members is to identify and analyze problems, in essence to apply existing knowledge of patterns of movement in an ever-changing, complex environment. This process results in the development and application of new knowledge.

The knowledge management literature abounds in models of knowledge transformations or conversions (see Chapter 4); however, little is said about the distinction between knowledge management and knowledge processing. As argued by McElroy (2003), knowledge management is not so much about managing knowledge but about managing

knowledge processes. Therefore, the focus of knowledge management should be on studying the knowledge processing system (KPS), defined as the system of social processes through which knowledge is created, diffused, and utilized within a human organization. In order to understand an organization's knowledge management capabilities, it is therefore more important to appreciate the dynamics of its KPS than to ascertain the depths and/or scope of its existing knowledge base.

(iii) Complex adaptive systems

Complex systems have been recognized and studied in biology, physics, and economics, and are increasingly used to describe firms and their environments. Complex adaptive systems are defined as open systems with large variability and diversity of elements or agents, with dynamic interactions among them that create non-linear feedback systems (Bak, 1996; Byrne, 1998; Cilliers, 1998; Phelan, 1995; Stacey, 1992). These are related to learning activities and are necessary for many features of complex adaptive systems, such as self-organization and unpredictability. Furthermore, being non-linear, complex systems show a synergy among their parts, resulting in the whole being more than the sum of the components; a holistic approach is therefore crucial to understand the patterns of behavior that emerge from the system.

Complex behavior is the tendency of a system to evolve through spontaneous and autonomous processes into a critical state, in which a small disturbance may have a great impact on the whole system (Bak, 1996). This is referred to as self-organization (Byrne, 1998; McElroy, 2003; Phelan, 1995; Stacey, 1992). It is the process of attraction (obtaining inputs) and repulsion (expelling waste) in which the internal organization of a system increases in complexity without being guided by an outside source. A constant flow of energy is necessary to maintain the self-organization of a complex system and to ensure its survival. Without energy, the system would gradually fall into a static state in which it is unable to adapt to its environment, eventually leading to the system's demise.

In the social world, most social systems are essentially complex. Hence, they import energy to sustain their evolution. A distinguishing characteristic of social complex adaptive systems is the presence, indeed necessity, of flows of social energies to maintain the existence of the system. Survival of an organization requires sufficient inputs of social energy to sustain its normal activities as well as to create new ones. Thus, social energy can be described at the same time as an individual and an

organizational resource, as well as an enabler of emergent properties of the organizational system. Assuming that human organizations are complex adaptive systems implies that flows of energies sustain self-organization processes.

1.2. What Will Be Learned from the Literature Review?

The review of the existing knowledge management literature will show the potential to improve understanding of the concept of knowledge. It is proposed here that the emergence of complexity theory indicates that the knowledge management field has reached a critical point and this provides the opportunity for new metaphors to convey the concept of knowledge, allowing better representation of its holistic and complex nature. Indeed, most existing models do not show the holistic and complex meaning of the concept of knowledge. This lack of integrated understanding holds back knowledge management and hinders understanding of the cognitive system. Insights from complexity theory will facilitate attainment of the next stage of knowledge management evolution (McElroy, 2000; Firestone and McElroy, 2003).

Complexity theory emphasizes the importance of non-linear relationships within a system. Therefore, it is not so much knowledge of the elements of a system that is important but more comprehension of how they interact to form feedback systems. Complexity theory suggests that innovation and creativity occur when systems operate at the ''edge of chaos,'' where they show emergent behaviors that enhance their ability to adapt to a particular situation of their environment (Bak, 1996; Capra, 1996; Stacey, 1996). Hence, complexity theory provides a framework to understand how knowledge forms at the level of individuals and then influences knowledge processing at the collective level of the organization (McElroy, 2000).

The review of the literature will also demonstrate that a better understanding of the concept of knowledge processing system is needed. Existing models do not feature a systemic meaning of knowledge management and ignore the role played by flows of energies in the knowledge processing system. Although it is a core concept of systems theory, the concept of input and output of energy within a system has been practically ignored by the management literature (Midgley, 2008). This deficiency is one of the key findings of this literature review; it is holding back the field of knowledge management as it only allows for incomplete models of processes occurring in the knowledge

processing system. This area of knowledge management hence requires more careful theoretical attention and new models that remedy that situation.

1.3. Research Objectives and Contributions

Initially, the intention of the researcher was to propose a new model of knowledge processing based on complexity theory, and assessing this model through multiple case studies. It became rapidly obvious that to build such a model, another model was required, one that would describe a systemic concept of knowledge coherent with the initial purpose of the researcher (and constitutes a sub-system of the knowledge processing system). The last two sections have highlighted the principal issues inherent to the current field of knowledge management concerning the concept of knowledge. Subsequently, such a model of the concept of knowledge could not be found in the literature at the commencement of this thesis and had to be created. What was originally a matter of creating and assessing one model, led to the need to create a new one, but more importantly, to the question of why such a model did not already exist. As a result, the researcher changed the primary focus of his research and tried to assess the current state of the field of knowledge management instead. This helped to understand some of the reasons that made the field of knowledge management so disintegrated. Consequently, the reconceptualization became more central to the thesis, and the multiple case studies were replaced by one case example to illustrate the possible use of the new model of knowledge processing.

Therefore, the major objective of this thesis is to propose a reconstitution of knowledge management through the use of concepts drawn from complexity theory. This re-conceptualization will help academics and practitioners to approach knowledge management from a holistic angle, allowing for a better understanding of the key issues and possible ways to address them in the future. In essence, the purpose of this thesis is to build the theoretical foundations for an integrated theory of knowledge management.

The specific objectives are as follows:

- To discuss the limitations of the traditional views of the concept of knowledge and knowledge processing systems;

- To assess and discuss the current state of the field of knowledge management regarding these models;

- To introduce a different paradigm addressing these limitations;

- To build new models of the concepts of knowledge and of the knowledge processing system.

Two further objectives of this thesis are:

- To identify and discuss the academic and managerial implications arising from of this thesis;

- To suggest directions for future research.

1.4. Philosophical Positioning

This thesis is centered on the concepts of knowledge and knowledge processing, hence it seems important to clarify a precise philosophical position for this research. The philosophy of science has long discussed questions about knowledge, its origins and nature, but it is a common mistake in the knowledge management field to overlook ontological and epistemological positioning (Allix, 2003). However, when trying to choose one philosophical position, researchers are often confronted by the fact that many philosophies share some common arguments or propositions. Although it has often been argued that philosophies were opposing each other as if they were on a linear continuum (Leong, 1985), it seems more appropriate to say that all philosophies are interrelated.

That is why it is not rare to find researchers stating that they are empirical realist, or radical structuralist, in order to specify their philosophical position. Hence, it is common to see researchers trying to differentiate themselves within the same philosophy. For example, logical positivists tried to create a new branch of positivism. Sometimes, researchers also tried to build on their opposition to a particular school of thought, such as the post-structuralists who denied structuralism. More frequently, philosophies would develop and different branches would arise as clarifications of a position such as radical constructivist compared to a social or cultural constructivist. What is intended in this section is to present a coherent philosophical positioning, one that will enable the reader to understand the different choices made in this thesis regarding research design and methodologies.

The following section describes the ontological position of the researcher. The second section describes the epistemological position adopted in this thesis.

1.4.1. Ontology

Agnostic existentialism is the ontological position underlying this thesis. The researcher makes no claim to know, or not know, if there is a greater power in play, and simply recognizes that the greatest truth is the one that one chooses to act upon. As an agnostic, little value is given to the search for knowledge of the existence of God and ultimate truth, and this is therefore left to others.

It has been said that existentialism was a product of bourgeois society in a state of dissolution which gave birth to a pessimistic stream of post-modern theory (Best and Kellner, 1997). However, this neither implies that all existentialists are pessimistic, nor that existentialism is a post-modern position. Existentialism is a philosophical movement which suggests that human existence has a set of underlying themes and characteristics, such as the absurd, awareness of death, consciousness of existing, alienation, anxiety, dread, and freedom (Crowell, 2004). It is a perspective on life pursuing the question of the meaning of existence. This quest is of the highest importance and underlies many aspects of this thesis.

As suggested by Jean-Paul Sartre (1956), existence is prior to essence. Humans are thrown into existence (Heidegger, 1962), and have no choice in coming into existence. Any belief in an *essence*, such as a soul, rationality or a psychological type, is a choice left to each of us to make rather than something pre-existing that is imposed on us (Sartre, 1956). Existentialism emphasizes the ideas of freedom and autonomy of individuals, which is a basis of self-organization and emergence of social patterns.

The ontological position described above underlies this thesis, and emerge into the models presented in chapter 6.

1.4.2. Epistemology

Absolute certainty about knowledge is impossible, or, at least, all knowledge claims can in principle be mistaken. This position is called *fallibilist*, as opposed to *foundationalist* and *skepticist*. Accordingly, scientific knowledge is considered fallible, and genuine scientific knowledge may be built upon foundations that are themselves fallible. As suggested by Suppe (1997), all knowledge claims in science are tentative, subject to revision on the basis of new evidence. This epistemological position provides ground for trial by error, and emphasizes the possibility of null results in research.

This thesis follows a *pragmatic coherentist* theory of justification. It is *pragmatic* because truth is considered relative and contextual; hence the best truth is the one that contributes the most to understanding of existence over the long run. As Box (1979, p.202) said: "All models are wrong but some are useful". Real truths can not be found; therefore, it seems important to look for useful ones. *Coherence theory* suggests that a proposition is true to the extent it is *coherent* with another statement or system of statements (Hunt, 2003), however, it is more suitable to consider 'justification' rather than 'truth' as truths do not really exist (Bonjour, 1985).

Coherentism helps to solve the problem of the *regress argument*, a classical problem in epistemology linked to *linear* thinking. This argument comes from the idea that a proposition P requires a justification (as it is not possible to have an ultimate truth), but as that justification is another proposition P', then P' needs a justification as well. An infinite regression of proposition follows, for which one can see three endings. First, the series is infinite (without circularity). Second, it ends with a proposition without justification (and, therefore, the series is deductively wrong). Third, the series end with a previous proposition and forms a loop. This last situation is the only one possible for coherentists, but seems absurd in the sense that it forms a circular justification (Bonjour, 1985), and therefore can only be understood as a naive description of coherentism. Indeed, *coherentism* denies the validity of the regress argument, rejecting the idea that justification can only take the form of a linear chain. The regress argument is the result of linear thinking and should be repudiated.

According to *coherentism*, the justification of a proposition is a holistic process depending on a system of statements. Therefore, a proposition is justified not because it relies on another proposition, but because it coheres with some system of proposition in which it forms a part of a viable whole. This type of thinking is inherently *non-linear*, and partly explains why complexity theory is used as a theoretical lens in this thesis. Indeed, each part of the system of propositions has no justification on its own; coherence emerges from the system of proposition as whole.

Furthermore, this research follows a *radical socio-cultural constructivist* epistemological approach. Knowledge is *constructed* because it does not reflect any external objective reality but the one the knower experiences (von Glasersfeld, 1990), a view also found in Vico's '*verum factum*' principle in 1710 (von Glasersfeld, 1984). Perception is not passive, it is the result of action (Piaget, 1969). The conception of

reality is interactive because observer and observed are mutually dependent (von Glasersfeld, 1995). As von Foerster (1981) suggested, objectivity is the delusion that observations can be made without an observer. Hence, knowledge is reliant on human conventions, perceptions, and social experience (Oulasvirta, Tamminen, and Höök, 2005). Knowledge and reality are constructed through on-going and dynamic social relationships and interactions (Berger and Luckmann, 1966), meaning that knowledge and reality are products of their cultural context (as illustrated as early as 1912 by Durkheim's seminal sociological work). Knowledge is a social construct chosen by humans rather than imposed on them by some higher force, a view that is also consistent with existentialism. Furthermore, *constructivism,* as opposed to *realism,* is a practical philosophy that promotes working out solutions to practical problems (Korsgaard, 2003).

The epistemological position of this thesis is *radical* (as termed by von Glasersfeld) because the knowledge creation process is adaptive and regulates itself (von Glasersfeld, 1995). Knowledge is considered as the outcome of a self-organized cognitive process of the human brain, and may be shared within social networks. A living creature abstracts regularities and rules from experience (Kelly, 1955). This assimilation process implies disregarding certain differences while searching for patterns (von Glasersfeld, 1990).

In the context of this thesis, it is considered that being a *radical socio-cultural constructivist* implies being *fallibilist*, *pragmatic*, and *coherentist* (as interpreted from the works of von Glasersfeld and Piaget and illustrated above). Hence, this thesis espouses a *radical socio-cultural constructivist* approach, which can be summarized as follows (adapted from von Glasersfeld, 1990):

1. Knowledge is not passively received either through the senses or by way of communication. Knowledge is actively built up as a construct by the cognizing subject.

2. The functioning of cognition is self-organizing, tending towards fit or viability (i.e., coherence).

3. Cognition serves the subject's organization of the experiential world, not the discovery of an objective ontological reality.

4. Coherence of a system of propositions emerges from the system of propositions itself. This is a non linear and self-regulating process.

In the previous sections, gaps in the literature have been identified. In their fundamental nature, they constitute a challenge for the creation of an integrated theory of knowledge management. The above epistemology will be the underlying tool to construct solutions and models addressing these issues.

1.5. Methodology

Following the preceding philosophical positioning, three methodological tools have been employed in this thesis. All of these respect the theoretical lens underlying this thesis that is complexity theory.

To compare the different models of the concept of knowledge and knowledge processing, a systemic typological tool has been produced. This framework is based on insights from complexity theory. It provides a framework to compare the main models of knowledge management found in the literature.

To assess the current state of the field of knowledge management, a three round Delphi has been conducted. This flexible research process presents feedback systems and utilized a panel of experts to analyze the possible emergence or existence of a consensus, and to identify key issues in knowledge management.

Finally, to provide an example of the implementation of the conceptual model presented in Chapter 6, a case study of the free online encyclopedia Wikipedia is provided. This case study depicts the knowledge processing system found in Wikipedia at both administrative and editorial levels.

1.6. Thesis Outline

This thesis consists of eight chapters; however, readers should be warned that this thesis does not follow a traditional structure. Due to the non-linear nature of this research, chapters have been organized to develop a journey into the world of complexity and knowledge management. In order not to break the flow or the logic behind this work, not all concepts used are fully explained in what is traditionally called the literature review (Chapters 2, 3, and 4); some new concepts, including some key ones, are introduced and discussed where the researcher thought it more appropriate. Some concepts are repeated in different parts of the research; this is not in contradiction with the intent of conciseness pervading this thesis, but rather an editorial choice to reinforce

the importance of these concepts, or sometimes because this allows for a better flow. Hence, the structure as it stands might at times provoke the reader to wonder, on purpose, to finally find answers when they are most needed. Figure 1.1 is there to guide the readers and provides a flow chart of the different chapters, their main components, and how they interact.

In many respects, the thesis follows the models it introduces in Chapter 6 in which many feedback loops are portrayed. As explained earlier, coherence of a larger claim shines though the entanglement of many smaller ones. Therefore, reading this work is like a journey of discovery with many tipping points, unfolding new discoveries and surprises. Enjoy the ride!

Here is a brief overview of the eight chapters and how they relate to each others. The reader should use Figure 1.1 in the background:

- Chapter 1: *Setting the Scene* (see page 1).

- Chapter 2: *Using Complexity Theory as a Theoretical Lens* (see page 34): This chapter presents the theoretical foundation of this thesis. Although it does not deal with knowledge per se, it provides a theoretical lens that is used in this thesis to understand knowledge and knowledge processing. Hence, this chapter offers an account of complexity theory, and a description of complex adaptive systems (CAS). It also discusses relevant extensions of the theory to social systems and highlights the main implications. It concludes with an outline of the concept of social energy and a discussion of its importance in social CAS, a concept used in Chapters 3 and 4 and prominent in Chapters 6 and 7.

- Chapter 3: *What Do We Know About Knowledge?* (see page 48): As shown in Figure 1.1, this chapter is an important stepping stone for Chapter 4. It first discusses the historical origins and development of the concept of knowledge. Next, it describes the resulting taxonomy of knowledge-related terms and their role in the traditional knowledge hierarchy, as well as the distinction among key terms of the knowledge management literature. Finally, it presents several models of the concept of knowledge to highlight recent developments in the field. These literature review components also provide background for the Delphi study of Chapter 5 and a foundation for the need for and construction of the E2E Model introduced in Chapter 6.

Figure 1.1: Thesis Outline
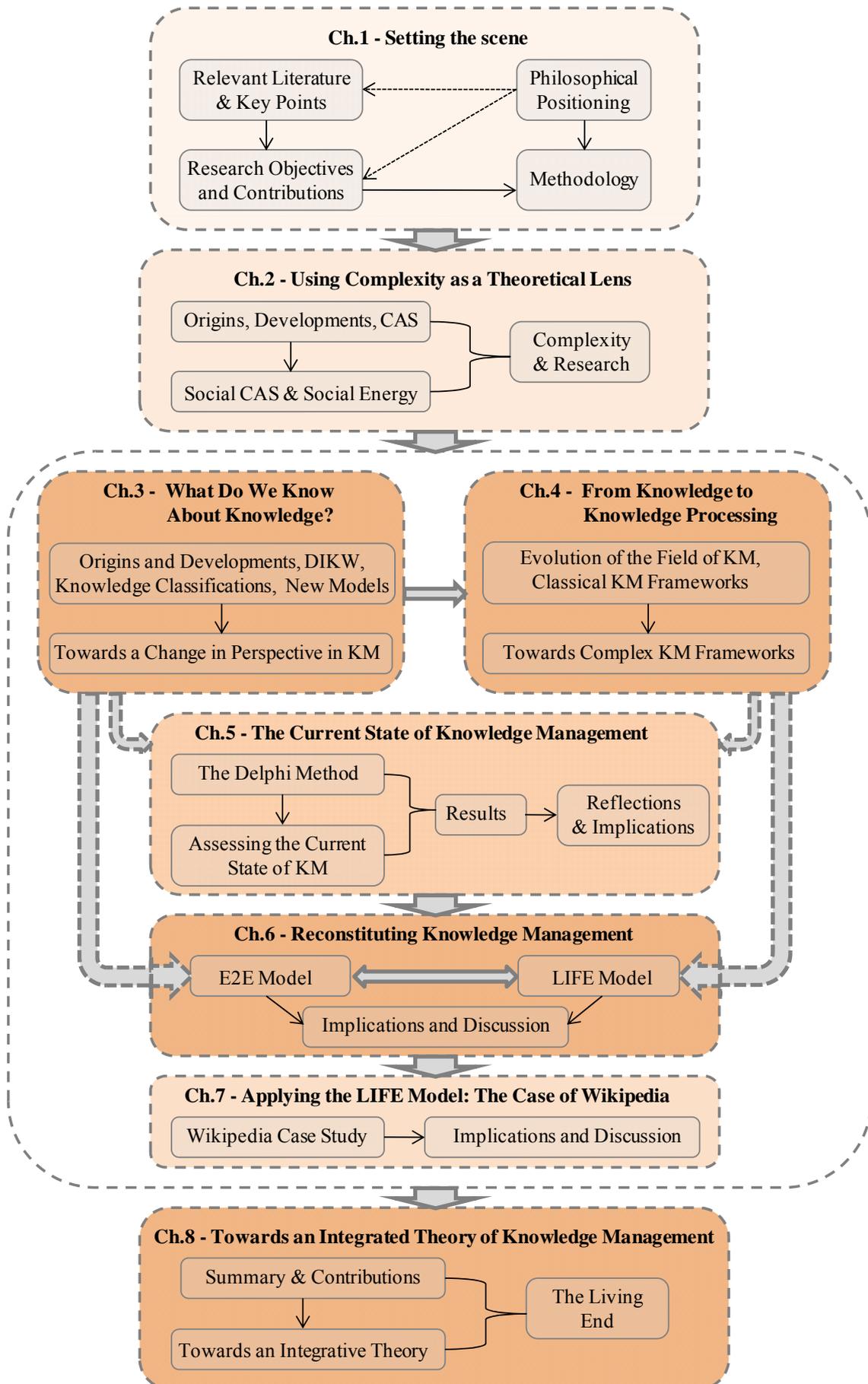
- Chapter 4: *From Knowledge to Knowledge Processing* (see page 80): This chapter builds on Chapter 3, presenting a review of the knowledge management literature leading to knowledge processing and illustrating current changes the field is undergoing. The most common models of knowledge management are presented and their limitations discussed using a systemic comparative typological tool. The chapter concludes with theoretical implications and provides the final ground for Chapter 5, while also serving as a foundation for the LIFE Model introduced in Chapter 6.

- Chapter 5: *The Current State of Knowledge Management* (see page 99): This chapter completes and confirms the literature review work started in Chapters 3 and 4 by describing the implementation of a Delphi study aimed at examining the current state of KM and the constructs in use in the field. The chapter starts with a justification of the methodology chosen, followed by a description of the Delphi method. The questions and corresponding feedback from the Delphi study are then presented and discussed. Finally, a concluding section proposes limitations and implications for the field of knowledge management. Hence, this chapter serves as a final confirmation of the need for the models introduced in Chapter 6.

- Chapter 6: *Reconstituting Knowledge Management* (see page 148): This chapter draws on previous chapters to produce the main contributions of this thesis. It presents two new models outlining the foundations of an integrative theory of knowledge management. The first model, called the Existence to Enlightenment (E2E) model, draws on complexity to construct a systemic concept of knowledge, while the second model, called the Leadership Invigorating Flows of Energies (LIFE) model, depicts the complexity-based view of the knowledge processing system incorporating the role of vital flows of social energies.

- Chapter 7:*Applying the LIFE Model: The Case of Wikipedia* (see page 172): This chapter demonstrates the potential utility of, and serves as an initial justification for, the models introduced in Chapter 6 through a case study of Wikipedia (the free online encyclopedia), providing an example of a social complex adaptive organization. A brief overview of Wikipedia followed by a detailed analysis illustrates how the LIFE model can be used to understand the knowledge cycle that takes place within Wikipedia. Wikipedia's LIFE are

identified and examined. Several implications are discussed before suggesting areas for further research, leading to the final conclusions presented in Chapter 8.

- Chapter 8: *Towards an Integrated Theory of Knowledge Management* (see page 194): This chapter provides the ending to the readers' journey while opening onto new territories yet to be researched and discovered. It summarizes this thesis and provides reflections and implications for academics and practitioners in knowledge management. The chapter concludes with a discussion of the contributions made by this thesis and future avenues of research to further progress towards an integrated theory of knowledge management.

Chapter 2. Using Complexity Theory as a Theoretical Lens

This chapter introduces the key aspects of complexity theory, which is applied in this thesis as a theoretical lens. The aim of this chapter is not to debate the validity of complexity theory, but to show the implications of assuming that the economic system and the business world are complex and evolve in terms of complex adaptive systems (Byrne, 1998; Cilliers, 1998; Stacey, 1992).

Dent (1999) described complexity theory as an emerging approach to research, study, and perspective that took in consideration the philosophical assumptions of holism, indeterminism, and recursive causality, as opposed to the classical (scientific management) view which assumes linear causality and encourages reductionist approaches to management. These classical assumptions emphasizing control, order, and predictability, have now been seriously challenged (Keene, 2000). These principles which originated in Newtonian physics and Darwinian evolution (Parker and Stacey, 1994) now need to be upgraded with those of complexity theory (Stacey, 1995).

This chapter includes six sections.

- Section 1 provides a brief overview of the historical origins and development of complexity theory.

- Section 2 discusses the distinction among simple, complicated, and complex, completing the contextualization initiated in Section 1.

- Section 3 outlines the characteristics of complex adaptive systems, a construct that will remain central to the following chapters of this thesis.

- Section 4 introduces the concept of social energy and illustrates its importance for social complex adaptive systems.

- Section 5 discusses the implications of complexity theory for research methods, and presents the underlying principles that will be used throughout this thesis.

- Section 6 is a summary of this chapter, and provides a starting point for subsequent chapters.

2.1. The Origins and Development of Complexity Theory

Complexity theory takes its roots from chaos theory and system theory. Chaos theory has its origins more than a century ago in the work of the French physicist Henri Poincaré, while system theory originated even earlier from the work of another French physicist, Nicolas Carnot, who studied thermodynamics at the beginning of the nineteenth century. However, it is only with the work of von Bertalanffy (1950, 1968) that system theory really took off, allowing for complexity theory to flourish a few decades later. The emergence of complexity theory lies in the development of several streams of research, mainly in physics, thermodynamics, and biology. A pivotal stream of research for complexity theory was the work of Nobel prize-winning Belgian physicist Prigogine in the field of non-equilibrium thermodynamics (Prigogine and Stengers, 1984). Prigogine demonstrated that living systems were capable of surviving and growing despite the laws of entropy, as a result of self-organizing mechanisms and emergent properties, characteristic of dissipative structures evolving far from equilibrium (this is discussed in more details in the following sections).

Although complexity theory arose from work conducted in biological and physical systems science (see Gleick, 1987; Waldrop, 1992; Kauffman, 1992, 1995; Gell-Mann, 1994), it slowly found its way into management theories, predominantly in organization theory (Smith and Humphries, 2004; see also Stacey, 1995; Tsoukas, 1996). Such a transition remains fairly new, and even if complexity theory has attracted a growing number of supporters, it long remained clouded by numerous misunderstandings (Stacey, 1996). The place of complexity theory in the future of management theories is still quite controversial, and will be discussed further in Chapter 5, which will provide some evidence of its usefulness and potential role in building an integrated theory of knowledge management. As suggested by Smith (2004), echoing Cohen (1999), complexity theory found popularity amongst managers as a consequence of environmental change. The growing pace of economic change and the necessity for constant innovation have pushed managers into a search for new theoretical approaches to face uncertainties. Confronted with unintended consequences, counterintuitive outcomes, and the impossibility of mapping the future, managers and management scholars turned to theories such as chaos and complexity (Tetenbaum, 1998).

Complexity theory is often associated with, if not mistaken for, chaos theory. Although these theories share several key concepts, they are two very different approaches. As

defined by Waldrop (1992, p. 293), complexity is a state of "chaos of behaviors in which the components of the system never quite lock into place, yet never quite dissolve into turbulence either." The emergence of complexity theory shows that there is a domain between deterministic order and randomness which is complex (Cilliers, 1998). When one analyses a complex system, sensitivity to initial conditions, for example, is not an issue as important as in chaos theory, in which it prevails. As stated by Colander (2000), the study of complexity is the opposite of the study of chaos, as chaos remains deterministic. Complexity is rather about how a huge number of extremely complex and dynamic sets of relationships can generate some simple behavioral patterns, whereas chaotic behavior, in the sense of deterministic chaos, is the result of a relatively small number of non-linear interactions (Cilliers, 1998). In fact, as argued by Prigogine (2002), complexity is non-deterministic, and gives no means whatsoever to predict the future, even for Laplace's demon (which was capable at any given moment of knowing with exact certitude the position and velocity of every mass that constitutes the universe, and therefore was able to infer its past and future evolution (Prigogine and Stengers (1984)).

There is no such thing as *the* theory of complexity. Some scholars view it as a science (e.g. the Santa Fe Institute), some call it simply 'complexity,' while others define it as a different way of thinking (e.g. Richardson and Cilliers, 2001). Thus, no real consensus resulting in a singular definition of complexity theory exists. Horgan (1995) reported 31 different definitions of complexity. However, this does not mean that a general consensus regarding what complexity study is about does not exist (refer to the following sections). Furthermore, unifying all definitions should not be the goal. As Richardson suggests (2008, p.18): "Fragmentation is inevitable, but what we must learn to do better is work with this fragmentation rather than force a 'commensurable unification' upon it." However, too much diversity is probably not warranted, as it would evidently hurt the development of the field of complexity studies.

It has been argued that there are three main schools of thought in complexity studies (Richardson and Cilliers, 2001; Richardson, 2008). The first school follows a reductionist approach to complexity and attempts to uncover the general principles of complex systems through the use of the fundamental field equations of physics. This community draws heavily on the use of computer simulation in the form of bottom-up agent-based modeling (Richardson, 2008). The second school follows a soft approach, using metaphors to convey insights from natural science to complexity studies. While

the first group is sometimes accused of trying the impossible (verification and validation of numerical models of natural systems is believed to be impossible; see Oreskes et al., 1994), the second group is often blamed for trying to use complexity to justify an 'anything goes' relativism (Richardson, 2008), or for simply using pseudo-science (Phelan, 2001). These two schools of thought are indeed the extremes of what is found in complexity studies, and one could argue that they have been made so in order to justify a third school of thought (Richardson and Cilliers, 2001). Coherent with the idea of fuzzy logic, the scholars of complexity studies do not belong to three discrete groups.

The sharp distinction between the two extreme approaches to complexity theory helps to convey the idea that there is a middle way. The middle way suggested here is similar to what Richardson and Cilliers (2001) called the third school of thought in complexity studies, i.e., complexity thinking (also referred to as the critical pluralist school by Richardson in 2008). Complexity thinking asserts a particular attitude towards models of complexity, rather than privileging one class of model over all others (Richardson, 2008). This stresses the value of critical reflection in grounding models, representations, and perspectives in an evolving reality. As suggested by Richardson and Cilliers (2001), if we consider organizations as CAS, a fundamental change in our thinking is required; it has to be acknowledged that all understanding is limited and provisional. This also relates to the notions of fallibilism and the epistemology underlying this thesis (see Chapter 1 Section 4).

However, in order to pursue this line of argumentation, complexity theory needs to be defined in more detail, and some of its key concepts have to be introduced. The next section starts this by distinguishing the simple from the complex.

2.2. From the Simple to the Complex

As introduced by Morin (1974, p. 555), "Complexity is a concept of which the first definition can only be negative: complexity is what is not simple." It is crucial to understand the distinction among the concepts of simplicity, complicatedness, and complexity as they will be used in this thesis. Hence, to explain what complexity theory stands for, this section starts by defining its opposite: simplicity.

Simplicity is the realm of independence, linearity, reductionism, and predictability. A simple construct is one that can be conceived clearly and individually, reduced into indivisible elementary units, and isolated from its environment (Morin, 1974). The whole can therefore be regarded as the sum of its parts, and prediction can be made as to the evolution of that construct. Because the parts of a simple construct share only linear relationships, a given cause always has the same effect. Consequently, a given action has a given outcome. In other words, a simple causality path can be traced in a deterministic manner (Morin, 1974).

However, constructs are not always perceived as simple at first. They can appear ambiguous and uncertain. For example, airplanes and computers are fairly difficult to understand in detail, and their behavior is harder to predict than that of a light bulb or a windmill, but it is still possible to calculate. If a construct composed of a large number of components can be described completely in terms of its individual constituents, this construct is merely complicated. Complicated constructs can be understood using reductionist simplifications that break them down into isolated pieces, which, once understood separately, can be collated back together into the whole. As suggested by Le Moigne (1999), simplification of complicated constructs is a sufficient method to explain them.

As opposed to simplicity, complexity deals with constructs called 'open systems' that have interdependent parts, non-linear organization, and unpredictable behaviors. In a complex system, the interactions among constituents of the system, and the interactions between the system and its environment, are of such a nature that neither can the system as a whole be fully understood simply by analyzing its components (Cilliers, 1998), nor can its behavior be predicted. A given cause or action can have many different effects or outcomes. Complex systems show a synergy among their parts and are therefore more than the sum of their parts. This last statement is also true for all systems, defined by von Bertalanffy (1968, p. 38) as "sets of elements standing in interactions", which can be closed or open depending on their relationship with their environment. The distinction here is that not all systems are unpredictable; some may be deterministic.

The distinction between simple and complex can be very delicate to identify. Many objects appear simple but become a lot more complicated (and may eventually turn out to be complex) when examined more closely (for example, a leaf). In the same way,

some objects can appear quite complex, but can eventually be described simply (for example, an internal combustion engine).

The following section provides an account of how complex adaptive systems (CAS) are defined in the context of this thesis. The term 'adaptive' is used here to convey the idea of change and the capacity to learn from experience, as introduced by scholars including Holland, Gell-Mann, and others at the Santa-Fe Institute.

2.3. Characteristics of Complex Adaptive Systems

Complex adaptive systems have been recognized and studied in biology, physics, and economics, and are increasingly used to describe firms and their environments. CAS are defined as open systems with large variability and diversity of elements or agents, with dynamic interactions among them that create non-linear feedback systems (Bak, 1996; Byrne, 1998; Cilliers, 1998; Phelan, 1995; Stacey, 1992). Such feedback systems are related to learning activities and underlie key properties of complex adaptive systems, such as self-organization and unpredictability.

Although they are sometimes confounded in the literature, CAS and complex systems are not the same thing; CAS are a special type of complex system. For example, complex systems such as galaxies or stars are non-adaptive. As suggested by Foster (2005), systems that absorb information from their environment and accumulate knowledge to improve or sustain their action are complex adaptive systems. Le Moigne (1990) provides an account, borrowing from Piaget, of the adaptive capabilities of CAS that distinguishes two kinds of adaptive processes: accommodation and assimilation. Accommodation is the process whereby the system modifies its communication network (relationships among elements that serve to exchange or pass information within the system) without changing its composition. It is a defensive mechanism that is associated with negative feedback, using the array of behaviors that the system has in stock at the time of the adaptation. Assimilation, on the other hand, is an offensive process linked to positive feedback that involves modifying the composition of the communication network. New representations are created, and new behaviors emerge as a result, extending the array of behaviors accessible to the system. CAS adapt and learn by combining accommodation and assimilation processes according to their teleological design, in other words, their purpose of action (Le Moigne, 1990).

As suggested by Capra (2006), CAS are living networks that can create their own boundaries and have the capacity to produce, repair, and maintain themselves. CAS also have the tendency to create new CAS (e.g. cells, human beings), which may or may not be part of themselves; CAS are often systems composed of lower-level CAS (see Le Moigne, 1990; Gell-Mann, 1994; Capra, 2006). It is therefore difficult to define the exact border of CAS, as the scope of an open system is usually determined by the purpose of the description of the system (Byrne, 1998). Because complexity results from interactions among the components of a system, it is not located in a specific and identifiable site in the system (Cilliers, 1998); complexity is manifested at the system level itself, emerging from the whole. There is neither something at a level below (a source) nor at a level above (a meta description) that can help to capture the essence of complexity. Being non-linear, CAS show a synergy among their parts, resulting in the whole being more than the sum of its parts; a holistic approach is therefore necessary to understand the patterns of behavior that emerge from the system. Although CAS are open systems, many demonstrate some closure relative to flows of energy and information in order to protect themselves from their environment. This implies the existence of filters and barriers to compensate for the openness of the system, rendering analysis even more difficult.

Complexity occurs far from equilibrium at the "edge of chaos" (Stacey, 1992), also called the critical point (Bak, 1996). This position defines the area between predictable periodic behavior and unpredictable random behavior (Bak, 1996; Byrne, 1998; Stacey, 1992). Complexity emerges as a result of interaction among the elements according to the information they have locally (Byrne, 1998). Complex behavior is the tendency of a system to evolve through spontaneous and autonomous processes into a critical state, in which a small disturbance may have a great impact on the whole system (Bak, 1996). This is referred to as self-organizing criticality (Bak, 1996), and more commonly as self-organization (Byrne, 1998; McElroy, 2003; Phelan, 1995; Stacey, 1992). As suggested by Bak (1996) and Buchanan (2000), self-organization is a fairly slow process, implying that the history of the system is an important consideration. Starting from equilibrium, a succession of slow changes in the system will eventually lead to a critical state (or "tipping point" (Gladwell, 2000)), from which just one small change has the potential to launch a larger transformation of the whole system. Furthermore, Bak (1996) suggested that forcing a system away from a critical state would be a waste, as it would automatically revert to a similar critical state. Therefore, attempting to

override the system's tendency towards a critical point works counter to its efficiency. This latter point is crucial when examining social CAS; indeed, contravening self-organization implies waste in time and resources for an organization.

Self-organization is the process of attraction (obtaining inputs) and repulsion (expelling waste) in which the internal organization of a system increases in complexity without being guided by an outside source. [From a physics perspective, Schrödinger (1944) noted that living systems feed on negative entropy flows. Prigogine (1980) postulated that CAS, which are thermodynamically open, can exchange matter and energy with their environment in order to produce negative entropy (i.e., the export of entropy or import of free energy). Such systems are called dissipative structures and operate far from thermodynamic equilibrium, exchanging energy and matter with their environment in order to self-organize.] An on-going flow of energy is necessary to maintain the self-organization of CAS and to ensure their survival. Without energy, the system would gradually fall into a static state in which it is unable to adapt to its environment, eventually leading to the system's demise. In CAS, energy flows can be identified as part of the interactions among the elements and between the elements and their environment. While conventionally-defined factors of production (such as capital and labor) are usually viewed as the inputs to organizational systems, they are insufficient when working with CAS. They may earmark sources of energy, as do coal and oil in the natural world, but they do not describe the energy itself.

In the social world, most transformations of energy are irreversible and most social systems are essentially complex. Hence, they import energy to sustain their evolution and fight entropy. A distinguishing characteristic of social CAS is the presence, indeed necessity, of flows of social energies to maintain the existence of the system. The next section introduces the concept of social energy and illustrates its importance for social CAS.

2.4. Social CAS and the Importance of Social Energy

A review of the literature shows that the term "social energy" is not commonly used in social science or business. Although the idea of social energy[1] goes back almost a century in the work of sociologists such as Durkheim (1912) and Pareto (1916/1935),

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[1] It has been pointed out to the author of this thesis that support for this concept could be found in the work of Rupert Sheldrake. However, in order to avoid controversy in this already thought-provoking thesis, it has been decided to exclude his rather esoteric perspective.

the sole definition located in academic literature is presented by Ammon (2003, p. 292); citing her own work from twenty years earlier, she states that social energy is "emotional warmth and support of the own development of the identity." However, by focusing intently on the psychology of the individual, this definition is unsuitable for the purposes of this paper, as it does not address the intended organizational perspective. Several authors mention the term "social energy" in the title of their article (Hirschman, 1983; Werlin, 2004) or in their abstracts (Dhesi, 2000; Lawrence, Mauws, Dick & Kleysen, 2005), but none actually define or discuss what social energy is. Could it be that everyone assumes its meaning? That possibility alone warrants returning to the roots of the term to extract a suitable definition.

According to the Oxford English Dictionary (2008), the meaning of energy in physics is "the power of 'doing work' possessed at any instant by a body or system of bodies," a definition that clearly addresses the "potential" nature of energy. Another definition not linked by the dictionary to any specific field but more appropriate for a social/organizational context, is "Power not necessarily manifested in action; ability or capacity to produce an effect." Social energy differs from physical energy (e.g. mechanical, chemical, and electrical energy) that comes from food and other energy supplies used by humans to operate in their environment. Social energy is the collective manifestation of mental energy, here defined as the motivations, emotions, and cognition (drawing on work in psychology by Lazarus, 1991a, 1991b; Markus & Kitayama, 1991), that arouses an individual to act toward a desired goal. Mental energy can remain at the individual level without further interactions with the organization, although in many instances it will flow into the social level and become social energy. Hence, social energy equates with human network mental energy, with social energy defined as the ability or capacity [the potential] to engender, sustain, diminish, redirect, or terminate an effect [an action or outcome] within a human organization. The ideas of ability and capacity capture the notion of power in the physical definition while work is reflected in the different types of actions that are relevant to the organizational context. In the model presented in Chapter 6, this energy is drawn into the Knowledge Processing System from organizational social networks.

In the physical world, energy is released through interactions (usually between the element storing the energy, and the element(s) that will store it once transformed). Indeed, the process of transformation of energy requires the interaction between elements of the system at work. For example, the water of a retention lake has to

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interact with the turbine of the dam in order to release the gravitational potential energy stored in the water molecules and transform it into electrical energy. In the same fashion, social energy is released through social interactions. Examples range from informal discussions to formal meetings, and from emails to telephone conversations; strikes can be viewed as the occurrence of the release of large amounts of social energy; documents can also store social energy as suggested by the work of Greenblatt (1988), and Hawes (2005). The important point here is that social energy is something every organization has in different forms and varying quantities, and that it can be channeled. Every social system has emergent patterns that need to be understood in order to avoid fighting the system in counterproductive ways. Even if social energy is the outcome of self-organizing social processes, and hence is hard to 'manage,' it can still be understood or handled in efficient ways.

Survival of an organization (avoidance of entropy, management of entropy production, or recovery from it) requires sufficient inputs of social energy to sustain its normal activities as well as to create new ones. Thus, social energy can be described at the same time as an individual and an organizational resource, as well as an enabler of emergent properties of the organizational system. As interactions occur among elements of the organization, flows of social energies are created, altered, and destroyed in day-to-day activities. These flows are important elements of organizational evolution; they intervene across all organizational levels (individual, group, inter-group) by creating vital positive and negative feedback systems within organizational processes. Negative feedback leads to consequences that counterbalance or compensate the original deviation (Parker & Stacey, 1994). In contrast, positive feedback leads to consequences that reinforce or amplify the original deviation. Assuming that human organizations are social CAS implies that flows of social energies sustain self-organization processes.

The next section goes back to the line of reasoning initiated in Section 1 and discusses the implications of using complexity theory while doing research in management.

2.5. Complexity and Research

The three preceding sections have highlighted distinguishing characteristics of CAS that explain why research into CAS needs to be approached differently than for simple or complicated constructs. Indeed, there is no possible simplification that can be employed to reduce the complexity of the systems studied (in this case, social systems). As argued

in Section 2.1, this thesis follows a 'middle path', one that focuses on what we cannot explain and that is concerned with limits and how to address those limits when attempting to understand the world (Richardson, 2008).

This thesis concurs with Le Moigne's (1990) postulation that modeling is necessary to understand complex systems. Yet, according to Cilliers (2005), there is no simpler representation of a complex system than the system itself, due to its incompressibility (i.e., its irreducibility). Consequently, any representation or model of a complex system will inherently be incomplete (or incorrect). However, just because a complex system is incompressible does not mean that there are no useful representations of it. As argued by Richardson (2008, p.16), "incompressibility is not an excuse for not bothering." He also suggests that knowing something that is wrong is better than knowing nothing at all, but even better is to know how or why it is wrong in the first place. Extending this perspective, the pinnacle would be to know why it is wrong, be able to explain why, and know how to remedy it. Hence, incompressibility of complex systems implies that we need to approach their analysis from different angles in order to extract the essence of their complexity.

As discussed in previous sections, complex adaptive systems evolve far from equilibrium, in a state of perpetual change, between chaos and order. This highlights another challenge arising when modeling CAS: change. How can change be illustrated in a model, while showing its evolution, in a static format (i.e., the traditional two-dimensional medium of academic reporting)? Drawing an analogy to quantum theory, Heisenberg's uncertainty principle states that it is not possible to measure with equal precision both the position and the momentum of a quantum element (1930). It is similarly impossible to create an accurate model of CAS. Hence, when creating such a model, there are concessions to make between its intended purpose, its precision, and its meaningfulness.

This problem can be better understood (and solved) using fuzzy logic. As stated by Zadeh (1973, p. 28): "as the complexity of a system increases, our ability to make precise and yet significant statements about its behavior diminishes until a threshold is reached beyond which precision and significance (or relevance) become almost mutually exclusive characteristics." Once that threshold has been reached, fuzzy statements become the only bearers of meaning and relevance (Dimitrov, 2003). Therefore, considering the incompressibility of CAS, precision of the model is

superfluous, which justifies the need for meaningful models. Good models are like good maps, leaving out unnecessary details (Miller and Page, 2007). They also need to have the right scale, meaning the right level of description.

As claimed by Le Moigne (1990), modeling complex systems is first and foremost modeling a system of actions. The starting point is not 'What is the system made of?' but 'What is the system doing?'. In other words, the modeler needs to focus on the purpose of the system rather than its constituents. Le Moigne (1990) synthesized all aspects of CAS discussed in this chapter, including the claim that CAS are defined by their action (or system of actions) that takes place in an active environment (or system of active environments) in which they operate and transform themselves purposefully. This leads to the conclusion that a model of a CAS needs to take into account four major issues: the different active environments surrounding the system, the functions of the system, the transformations occurring within the system through time, and the purpose of the system. Modeling complex systems therefore requires adopting a different approach, a complex thinking approach that integrates these four issues. This involves the use of a conjunctive logic as opposed to the classical disjunctive (or Aristotelian) logic employed in analyzing simple constructs (Le Moigne, 1990).

Disjunctive logic is based on three axioms. First is the identity axiom, which states that what is, is (A is A). Second is the non-contradiction axiom, which postulates that nothing can be and not be at the same time (B cannot be A and Ā, where Ā denotes "not A"). Third is the excluded middle axiom, which states that everything has to be or not be (B is either A or Ā). Le Moigne (1990) also refers to this kind of logic as the 'either/or logic'. This logic is problematic when considering complex systems because it assumes that the operator can neither be the operating system, nor can it be the product of its operation, which is often the case with CAS. Therefore, a different kind of logic is needed. Le Moigne (1990) suggests that instead of a disjunctive logic, studying complex systems requires a systemic logic which he calls 'conjunctive logic'.

Conjunctive logic is based on three axioms. First is the axiom of synchronicity (also called teleological operationality axiom): Processes within a system are not random and show some form of pattern (synergy). Second is the axiom of diachronicity (or teleological irreversibility axiom): Processes within a system constitute transformations through time. Third is the axiom of recursivity (or included middle axiom): Processes

within a system are inseparable from their product, which may be their operator (they are autonomous).

In order to model CAS, it is crucial to employ the most appropriate terminology, as a first step toward complexity thinking. Although they have proved to be highly successful in a variety of phenomena, the analytical principles of classical science first enunciated by Galileo and Descartes cannot be used when dealing with complex systems (von Bertalanffy, 1968). There is a need to exploit concepts rooted in a systemic approach that are more suitable to study and create meaningful models of CAS. Table 2.1 provides examples of such a transition from analytical concepts to systemic ones. This thesis shall utilize the latter concepts rather than the classical ones.

Table 2.1: Correspondence between Analytical and Systemic Concepts while Modeling

Analytic modeling	Systemic modeling
Object	Process
Elementary unit	Active unit
Group (of elements)	System (of elements)
Analysis	Conception
Disjunction	Conjunction
Structure	Organization
Optimization	Satisficing (adequacy)
Control	Intelligence
Efficiency	Effectiveness
Prediction	Explanation
Evidence	Relevance
Causal explanation	Teleological understanding

*: Translated from the French and adapted from Le Moigne, 1990

The purpose of this section was not to provide a detailed method to execute this thesis, but to present the tools to achieve this. More detailed methodologies are presented in the next chapters, all referring to the concepts discussed in this chapter. As Le Moigne (1990) suggested, the most important task of modeling is not to solve the problem at hand, but to explicate the relevant problem to solve. Once this is done, the understanding obtained leads to the solution (see Chapter 6 for further discussion of the role of the concept of 'understanding'). Although the linear format of an academic thesis does not allow for systemically coherent presentation, the intellectual process

underlying this thesis follows the ones illustrated by the two models presented in Chapter 6. The researcher, his cognitive process, his research purpose, and his research products are all interconnected and followed the synchronic, diachronic, and recursive paths of complexity thinking.

2.6. Summary

This chapter has provided a brief historical description of the origins and developments of complexity theory, describing how this emerging theory tries to move away from the classical assumptions of scientific management. Key relevant concepts of simple, complicated, and complex, as well as the characteristics of complex adaptive systems were discussed, setting the theoretical basis for the analysis that will be conducted in the following chapters. Furthermore, the concept of social energy was introduced and its importance was discussed in regards to the study of social complex adaptive systems. This concept will be pivotal for the following chapters in which social systems will be discussed and analyzed in the context of knowledge management. Finally, the different methodological implications of using complexity theory as a theoretical lens to study social systems were reviewed. Several conclusions have been reached on this issue, such as the need for a systemic approach to model CAS in order to extract and convey insightful understanding from them. This can be done by favoring the meaningfulness of such models as opposed to their precision which is not viable. Furthermore, it has been demonstrated that this required using a conjunctive logic associated with systemic concepts as opposed to the traditional disjunctive logic associated with analytical concepts. All these considerations when modeling complex systems will serve as the basis for developing the research tools exploited in the next chapters.

The next chapter brings us to the starting point of the reconceptualization proposed through this thesis and presents the concept of knowledge and its past and current developments. This will provide a context and starting point for the following chapters.

Chapter 3. What Do We Know About Knowledge?

The beginning of the journey toward an integrative theory of knowledge management lies in examining the concept of knowledge itself. An appreciation of the historical development of the concept of knowledge underlies understanding of how a reductionist perspective entered the debate between philosophers in the West and took an important role in the development of the theory of knowledge. It also shows how the latest philosophical and scientific developments provoked an evolution of the concept of knowledge symbolizing the convergence of views from the East and the West towards a holistic view of knowledge.

This chapter includes five sections.

- Section 1 discusses some historical origins and development of the concept of knowledge. This section is not intended to be exhaustive, and is only proposed as a contextualization exercise. Hence, many great philosophers have been left out or only superficially mentioned (e.g. Locke, Berkeley, Bentham, etc.). The section only briefly discusses the prominent and most relevant philosophers helping to build the argumentation on reductionism.

- Section 2 describes the resulting classical taxonomy of knowledge-related terms and their role in the traditional knowledge hierarchy.

- Section 3 outlines the different types of knowledge taxonomies illustrating the distinction among key terms of the knowledge management literature.

- Section 4 presents some recent models of the concept of knowledge. They highlight new perspectives appearing in the field of knowledge management.

- Section 5 is a summary of this chapter, and provides the basis for the next chapter on knowledge processing.

3.1. Origins and Developments

The search for knowledge has always been a focal point in the evolution of mankind. As the earliest civilizations appeared in Mesopotamia, Egypt, India and China, they were heavily influenced by their environment (e.g. climate). In order to improve their situation, humans learned to adapt to their environment, diminishing the impact of the environment on their civilization. Through the centuries, humans have acquired and

constructed new knowledge that permitted them to understand and adjust to the world they inhabited, as well as transforming it to suit their needs. As suggested by Scaruffi (2003), knowledge has helped humans to become the "subject" of change, as opposed to being the "object" of change.

3.1.1. The Foundation of Knowledge: The First Taxonomies

Philosophy has had a great impact on the evolution of how we conceptualize knowledge. In both Greece and India, religions and superstitions allowed space for philosophers and scientists to conjecture about the nature of the universe. Greek philosophers built what is now seen in the West as the foundation of philosophy. Although others, such as Thales (the unity of matter), Heraclitus (the concept of eternal change), Pythagoras (and the Sophists), and Socrates (method of inquiry), have had profound influence, the two most influential Greek philosophers for Western thought remain Plato and Aristotle. While similar in some respects, their works show significant differences, as described below.

Plato, the most famous pupil of Socrates, believed that knowledge gained through the senses was confused and impure, as the world humans can sense is only an imperfect copy of the real essence of things (the Forms). Plato posited that the Forms existed independently, on their own (Van Doren, 1991). Therefore, Plato's work approximates that of the idealists and rationalists, who will be discussed in the following sections. It is interesting to note that all the major work of Plato is in the form of dialogues between Socrates and other philosophers, employing a dialectic form of logic later refined by Hegel (Van Doren, 1991). The use of Plato's ideas in knowledge management is developed later in this chapter.

Aristotle, one of Plato's students, was fundamentally opposed to his views on the value of the senses to obtain knowledge. Indeed, he emphasized the importance of the senses in order to gain knowledge. For Aristotle, Forms and Matter had to come together for anything to be created (Van Doren, 1991). Aristotle set the foundation of the scientific method, and therefore could be considered as the first empiricist. He invented the science of deductive logic, as well as the idea of the division of science into fields separated according to their subject matters and their methods (Van Doren, 1991).

Plato and Aristotle shaped the thought of scientists and philosophers for centuries to come in the West. Their influence parallels that of Eastern philosophers such as Laozi

(Lao Tsu, concept of Tao/Dao) and Kongzi (Confucius, the font of Confucianism) in China and their contemporaries in India (Siddhartha Gautama, the founder of Buddhism, and Mahavira, the founder of Jainism), who maintained a deep and well-documented, but indirect (Jullien, 2000), discussion of the concept of knowledge. Buddhism asserts that reality is neither predetermined, nor random, as nothing exists on its own – the concept of dependent origination (anatta). Buddhism also supports the idea that the fundamental reality consists of material and immaterial bodies that affect each other, which is similar to the stance held by Aristotle. Consequently, Buddhism, in its holistic approach, opposes the notion of causation, a view that will be discussed in the section 3.1.6 on Systems Thinking, Chaos, and Complexity.

Buddhism denies the existence of the self (Levine, 2003), only events exist, whereas Chinese philosophers such as Confucius defended the cultivation of the self and elevation of the ordinary individual into the ideal person though holistic socialization processes (Scaruffi, 2003). This idea will be seen as of prime importance in the next section. In the same period, Lao Tsu championed another holistic approach: the way (Tao/Dao). He argued that individuals must follow the flow of nature, as going against it is futile and self-destructive. This notion is at the core of complexity theory, which will be dealt with in section 3.1.6 on Systems Thinking, Chaos, and Complexity.

3.1.2. Reductionism and the Renaissance of the Knowledge Debate

After the fall of the Roman Empire, the Western world endured the period known as 'the Dark Ages,' so called because there are relatively few surviving histories and seemingly little attention was paid to the creation of new science or new theory. It is only with the subsequent Renaissance that the philosophy of knowledge progressed, focusing on the extraction of the 'self' from its religious fetters (Scaruffi, 2003). This concept was highlighted by Descartes in 1637 in Le Discours de la Méthode, in which he stated 'I think therefore I am,' illustrating a reductionist, dualistic view of the self between the mind and the body (i.e., the machine). Following his work, influential philosophers including Locke (continuity of the self) and Hume (the self as a bundle of perceptions) addressed the development of the concept of the self. The Renaissance featured a scientific revolution and major advances in knowledge, with the work of Copernicus, Galileo, and Descartes. The latter two challenged the status quo of the church and pushed towards a new authority, that of science, launching what Van Doren (1991) calls the Galilelean-Cartesian revolution.

The Renaissance gave birth to a significant development in the philosophy of knowledge: the scientific method, a process for uncovering new knowledge. The scientific method of enquiry is the main tool of the Empiricists, whose most famous advocate was Bacon (followed by Newton). In opposition to Aristotle's method of scientific reasoning of deductive logic, Bacon asserted that a better method was to use inductive logic (Van Doren, 1991) – a controversy that has dogged the scientific method throughout its history. Hume, also an empiricist, raised an inherent problem with induction in *An Enquiry Concerning Human Understanding* in 1777, showing how empiricists were using inductive logic to justify inductive logic itself, creating a circular argument of infinite regression.

For empiricists, science is derived from the facts (observable, empirical, and measurable pieces of evidence) which constitute a firm and reliable foundation for scientific knowledge (Chalmers, 1999). Knowledge could be built only by adding bits and pieces to existing knowledge. This reductionist approach to science is now subject to a major controversy, which will be addressed in the following sections.

3.1.3. Modern Developments of the Concept of Knowledge

In 1781, Kant opposed the empiricism of Hume, and proposed that our understanding of the external world is grounded not solely in experience, but in both experience and a priori concepts, hence offering a non-empiricist critique of the rationalist philosophy of the empiricists of the Renaissance. This is termed the analytic-synthetic distinction (a priori/a posteriori propositions). In response to Kant's critique of pure reason, Hegel (1812, 1813, 1816/1929) developed dialectical logic (thesis, anti-thesis, synthesis), popular today as a method of reasoning as well as the foundation of systems theory. Whereas the formal logic of his predecessors is linear, Hegel's logic is circular, and uses contradiction in a constructive way.

The search for knowledge and truth took a radical turn with Russell and Whitehead's (1910) attempt to push forward symbolic logic as the basis of philosophy. Opposing the idealism of Hegel and Kant, they asserted that all mathematical truths could be derived from logical propositions made of symbols. This view led to the development of logical positivism and the creation of the Vienna circle, philosophers advocating that all knowledge is based on logical inference grounded in the use of symbolic logic and experience. Logical positivism attempted to create a unified science based on a

universal logical language that could explain all scientific systems (once reduced into smaller entities).

Logical positivism attracted many notable critics, foremost among them being Polanyi, a philosopher who greatly influenced the field of knowledge management. He opposed the positivism prevailing at the beginning of the 21st century, arguing that it failed to acknowledge the importance of the concepts of tacit knowing and imagination. Polanyi developed the notion of personal knowledge, seeing the scientific method as merely a tool to gain insights into objective truth rather than being the final objective truth itself (Polanyi, 1958). Popper also strongly opposed logical positivism, as well as trying to solve the problem of induction raised by Hume, with the philosophy of falsificationism. He asserted that all scientific knowledge is falsifiable, and therefore induction is unreliable, while deductive processes constitute the basis for scientific inquiry (Popper, 1959). Therefore, knowledge can never be said to be true, just superior to its predecessor. However, the fact that any part of a complicated theoretical construct might be susceptible to falsification raised a serious problem for falsificationists to solve (Chalmers, 1999).

Kuhn addressed this dilemma by differentiating rival scientists into different paradigms, proposing that science is characterized by a succession of periods of 'normal' science in which scientists hold their theories in the face of anomalies, and periods of great revolution during which major conceptual changes are achieved (Khun, 1962). However, he was not able to assert why there was a progressive step accompanying the revolutionary phases. In 1978, Lakatos proposed a methodology that combined the views of Popper and Kuhn, suggesting the replacement of Kuhn's paradigms with 'research programs' of two parts. The first part is the hard core of the research program, comprising its fundamental principles, which scientists do not try to question. The second part is the protective belt, made of peripheral principles which bear the blame for apparent failures of the whole research program. For Lakatos, a progressive program is one that remains cohesive and leads to novel predictions that are confirmed. Therefore, the replacement of a degenerative program by a progressive one is Lakatos' view of Kuhn's revolution (Chalmers, 1999). However, Lakatos was left with the problem of identifying when a degenerative program should be abandoned. As Popper had realized, some good theories were born falsified.

Lakatos may not have solved all the epistemological problems of the concept of knowledge, but he highlighted a key consideration: Research programs are an attempt to create cohesiveness among their constituents. Cohesiveness is central to systems thinking, and is increasingly used in knowledge management to define the concept of knowledge, as will be examined in Section 3.4. New Models of the Concept of Knowledge.

3.1.4. Towards a Holistic Approach to Knowledge

Linear and reductionist thinking have dominated the debate about the concept of knowledge and led to a major epistemological problem: the regress argument. Because it is not possible to have an ultimate truth, any proposition needs a justification. That justification is actually another proposition, which in turn needs a justification. Obviously this can repeat with an infinite regression of propositions. As seen in Chapter 1, three potential conclusions arise. First, the series is infinite; this is the problem of induction raised by Hume (1777). Second, it ends with a proposition without justification (and, therefore, the series is deductively wrong). Third, the series ends with a previously specified proposition and forms a loop. Coherence theory helps to solve the problem of the regress argument by moving away from linear thinking and reductionism to adopt a holistic perspective. It suggests that a proposition is true to the extent it is coherent with another statement or system of statements (Hunt, 2003). Despite some difficulties with coherence theory, it provides the basis for the construction of sets of coherent beliefs, laying the foundation for constructivism.

The concept of knowledge is undergoing a transition due to the development of the constructivist epistemology along with new developments in several disciplines such as cognitive psychology, artificial intelligence, and systems thinking.

3.1.5. Constructivism, Cognitive and Connectionist Psychology, and Artificial Intelligence

The term constructivist epistemology was coined by Piaget (1967) to represent his philosophical perspective that all knowledge is constructed, and assumed not to reflect any external transcendent realities. Knowledge is viewed as contingent on convention, human perception, and social experience. As argued by Berger and Luckmann (1966), all knowledge is derived from and maintained by social interactions.

Constructivism significantly influenced the creation of disciplines such as cognitive psychology, by merging with Gestalt principles (a theory of mind and brain asserting that the operational principle of the brain is holistic, with self-organizing tendencies). Cognitive psychology, named by Neisser (1967), postulates the mind as having a certain conceptual structure; it considers how people understand, diagnose, and solve problems through the use of mental processes. Cognitive psychology commenced by equating mental processes with algorithms. The brain was understood as a computer running software. This perspective led directly to the development of artificial intelligence, pioneered by Simon (1969/1996). As a constructivist and cognitive psychologist, Simon developed the concept of organizational decision-making (1947/1997), for which he received a Nobel Prize in 1978. Artificial intelligence featured the development of expert systems and neural networks, commonly used in knowledge management practice. However, these last two developments were principally due to the emergence of an alternative perspective in the early 1970's, known as connectionism. Connectionist psychology surfaced in reaction to the cognitivist perception of the brain as a complicated computing machine (von Krogh and Roos, 1995).

Two main deficiencies of the cognitivist perspective were raised by Varela and others. First, the linearity of the information sequencing viewed by cognitivists, and second, the consequent lack of resilience of the cognitivist model of the brain, as one broken rule or loss of information would severely reduced the efficiency of the system to perform. As argued by Varela (1992), it had been known by neuro-biologists for quite some time, that even damaged, the brain could still process information efficiently (see also Kauffman, 1995). Hence, connectionists suggested a different form of organization for the brain based on dynamic global networks composed of simple elements (neural networks) featuring emergent properties based on self-organizing processes (von Foerster, 1962). As suggested by Varela, Thompson, and Rosh (1992), one important aspect of such emergent behavior is 'learning', a center-piece of the recent knowledge management focus (see Chapter 4 for a discussion of this point). Learning brings another crucial concept into play: memory. From a connectionist point of view, the learning system has a history which impact on its development and activity. From such epistemological development, more radical views on knowledge were espoused by von Glasersfeld (1987), who claims that knowledge is the self-organized cognitive process of the human brain. It also led to the notion of 'collective mind' (Weick and Roberts, 1993), center to organizational learning in knowledge management (see Chapter 4).

While cognitivists and connectionists share the same basic assumptions, the latter group made the link between knowledge and system dynamics, the perspective of systems thinking that examines the behavior over time of complex systems. This is further discussed in the next section.

3.1.6. Systems Thinking, Chaos, and Complexity

As introduced in Chapter 2, systems thinking is a holistic approach to science, in contrast to reductionism. It emerged following the publication of von Bertalanffy's *General System Theory* (1950, 1968). Systems theory features the notions of positive and negative feedback, feedback systems, and open systems. Among its assumed propositions is that the whole is greater than the sum of the parts. Systems theory opposes the view that an element of a system can be extracted from its environment for meaningful study, because the system possesses properties that cannot be identified or understood from the analysis of its constituent elements in isolation. Systems thinking, exemplified by von Bertalanffy's organismic psychology, matches Piaget's constructivist learning theory as an approach to knowledge management (von Bertalanffy, 1968).

Chaos theory opposes the common notion that reality is linear, instead proposing concepts such as strange attractors and non-linear feedback, used in systems thinking and particularly in complexity theory. However, chaos theory remains deterministic, while the emergence of complexity theory identifies a domain between deterministic order and randomness (Cilliers, 1998). Complexity theory suggests that innovation and creativity occur when systems operate at the "edge of chaos," where they show emergent behaviors that enhance their ability to adapt to a particular situation of their environment (Bak, 1996). Hence, complexity theory provides a framework to understand how knowledge forms at the level of individuals and is then incorporated into knowledge processing at the collective level of the organization (McElroy, 2003). Complexity theory also gives insights into how each agent of the organization is self-evolving with its own rules through its own knowledge processing system (a connectionist perspective), and how it influences the evolution of the whole organization (McElroy, 2003). Finally, complexity theory illustrates how systems achieve negative entropy through the use of dissipative structures, a concept pioneered by Prigogine (1969).

While complexity theory developed formally in the West, many of the ideas feature in established Eastern philosophies. For example, Buddhism refutes the notion of causation, implying the existence of non-linear feedback systems. Confucian societies ordered themselves on the principle of the community being greater than any individual or the sum of its constituents (Jones and Culliney, 1998). In Daoism, the self is relational, defined through its relationships to its environment, thereby constituting an element within a complex system (Jones and Culliney, 1999). The Dao also professes to follow the flow of nature, which equates to the notion that an element of a system going against the overall behavior of a system is doomed to fail. The notion of the yin and yang underlying the Dao also portrays an important similarity with complexity theory as it illustrates the idea of seeking balance through tension between two opposite forces (chaos and order). This can clearly be identified as being at the edge of chaos where the emergence of a system is favored (Jones and Culliney, 1999).

Although very interesting, reconnecting Eastern and Western philosophical approaches is not the main purpose of this thesis as it could be an entirely separate thesis of its own. This discussion has been kept to a minimum in order to focus on the central topic of this thesis: knowledge management.

3.1.7. The Origins of Knowledge Management

Drawing mostly on developments in philosophy, cognitive science, and systems theory, the field of knowledge management appeared in the late 1980s and developed through the 1990s. 1986 saw the first general usage of the terms 'knowledge management' (Kellogg, 1986) and 'management of knowledge' (Wiig, 1997), although the juxtaposition of the two terms had surfaced earlier (e.g., Apte, 1982; Jayaraman, 1984) and the term 'knowledge worker' had been used by Drucker since 1959. The systems and processes used to manage organizational knowledge, based primarily on the work of artificial intelligence and expert systems, progressively acquired new labels such as 'knowledge acquisition,' 'knowledge engineering,' and 'knowledge-based systems,' leading to the notion of knowledge management (Jasimuddin, 2006). Knowledge management is a multi-disciplinary field linked to information systems, organization theory, strategic management, and human resources management (Jasimuddin, 2006). Knowledge management will be further discussed in Chapter 4; this subsection is only a brief account of its origin in the context of the philosophical evolution discussed in this section.

As argued by Kawalek (2004), systems thinking has the potential to provide methodological guidance for practitioners in knowledge management. Recent development of the field illustrates the influence of systems thinking initiated through the work of Zeleny, Ackoff, and others, who will be discussed in the following sections.

3.2. Data, Information, Knowledge, and Wisdom

In order to build a systematic body of knowledge or set of theories in knowledge management, philosophers and academics have long discussed the taxonomy of the constructs relevant to the concept of knowledge. This section will discuss the most important of these: data, information, knowledge, and wisdom, as well as the traditional knowledge pyramid that links them.

3.2.1. Terminological Origins

The knowledge management literature has focused on distinguishing among data, information, knowledge, and wisdom for many years (Nonaka and Takeuchi, 1995; Matthews, 1998; Awad and Ghaziri, 2004, Wiig, 2004; Hicks, Dattero and Galup, 2006). Examining the linguistic origins of these terms offers only a glimpse of their current   meanings   (see

Table 3.1), as these concepts have evolved substantially over time. Paradoxically, the earliest recorded usage that could be identified for each term occurs in reverse order from their generally perceived level of simplicity: wisdom is the oldest of these four terms in English, and data the latest, whereas according to the traditional knowledge hierarchy, data is the simplest concept, and wisdom the most complicated.

The development of our understanding of knowledge management is predicated on defining new concepts, and redefining existing ones, as human activities progressively require (and result in) a deeper understanding of the natural environment that surrounds us. In this context, the following subsections examine the four basic constituents of the traditional knowledge pyramid.

Table 3.1: Linguistic Origins of Data, Information, Knowledge, and Wisdom

Term	Origin	First recorded usage in English *
Data	Latin (datum, dati)	**1646,** HAMMOND: 'From all this heap of *data* it would not follow that it was necessary.'
Information	Adopted from Old French (informacion), adapted from Latin (informātiōn, informationem)	**1386,** CHAUCER: 'Whanne Melibee hadde herd the grete skiles and resons of Dame Prudence, and hire wise *informacions* and techynges.'
Knowledge	Middle English (knaulage, knowleche). Constructed on Old English and Teutonic origins.	**1300** apx., CURSOR M.: 'To mak knaulage with sum-thing Til sir august, Þair ouer-king.'
Wisdom	Old English and Frisian (wísdóm), as well as Old Saxon (wîsdôm)	**888,** ÆLFRED BOETH.: 'Þa com Þ ær gan in to me heofencund *Wisdom*.'

*: from Oxford English Dictionary, 2nd ed. under revision (2008), http://www.oed.com/

3.2.2. Defining Data

From its Latin definition, data is something that is given; until the development of modern science, data was used as a synonym for gift. However, as scientific researchers adopted the term, it has evolved from something that is given to something that is considered to be a given (fact), into a synonym for fact in the sense of something that is known to be true. Some recent researchers hold to this definition, e.g. Davenport and Prusak (1998, p. 2), who equated data with "discrete, objective facts about events," and Liebowitz and Wilcox (1997), who defined data as representations of a fact, number, word, image, picture, or sound.

Most knowledge management academics define data more specifically as unprocessed or unorganized facts (O'Dell and Grayson, 1998; Dixon, 2000; Awad and Ghaziri, 2004) or "raw facts, not interpreted" (Bourdreau and Couillard, 1999, p. 25), as well as "raw material" (Drucker, 1995, p. 109). In a similar vein, data is often defined as measurements (Applehans and Leidner, 1999; Desouza, 2005). Slightly variant definitions exist; Ackoff (1989, p. 3), for example, stated that "data are symbols that represent properties of objects, events and their environments" (although a case could be made that symbols are just another type of representation of something that is taken as given by our senses).

Drawing an apparent consensus from the literature, the definition of data can be reduced to: Data are considered to be unprocessed basic representations of reality.

3.2.3. Defining Information

From its Latin form, information relates to the action of making, conceiving, or forming an idea. From this base, the definition of information has varied somewhat, mostly relating to the concept of data.

Information has been defined as "data that makes a difference" (King, 1993; Davenport and Prusak, 1998, p. 3) or "differences that make a difference" (Bateson, 1979, p. 5). Other definitions are a bit more precise. For example, Drucker (1995, p. 109) defined information as data "organized for a task, directed toward specific performance, applied to a decision"; for O'Dell and Grayson (1998, p. 5) it is "patterns in the data", while Nonaka and Takeuchi (1995), as well as Galup, Dattero, and Hicks (2002), described information as data in context. Smith (2001, p. 312) combined the two latter definitions and stated that "information is data that have relevance, purpose, and context."

Some definitions focus on the process aspect of the concept. For example, information has been defined as "the result of a human's interpretation of data" (Lueg, 2001, p. 152), as the fusion of data (Desouza, 2005), as data that has been assigned a meaning (Liebowitz and Wilcox, 1997), or as "data that is 'in formation' " (Dixon, 2000, p. 13), and as "phrases or images (e.g., graphs) that provide the results from analyzing and interpreting data; phrases or images that carry meaning" (Bourdreau and Couillard, 1999, p. 25).

Another definitional stream in the knowledge management literature relates to the utility of information. Ackoff (1989) described information as being data processed to be useful. Similar definitions are provided by Thierauf and Hoctor (2006, p. 4), with information being "structured data useful for analysis and decision making", and by Laihonen (2006, p. 127), who defined information as "structured data that supports decision making."

Finally, some definitions of information kept their focus on facts, such as those by Applehans, Globe, and Laugero (1999) describing information as a statement of fact about measurements, and Awad and Ghaziri (2004), defining information as "facts and figures based on reformatted or processed data." The latter authors also characterized information as an "aggregation of data that makes decision making easier" (p. 36) and

as having a "meaning, purpose, and relevance" (p. 37); this definition represents a combination of the different streams identified above.

Although it has been argued that there was no real consensus among definitions of information (Hicks, Dattero, and Galup, 2006), it is quite clear that definitions from the knowledge management literature all point to a similar definition of information which can be stated as: Information is considered to be data that has been processed in some meaningful ways.

3.2.4. Defining Knowledge

The concept of knowledge has been debated since at least the time of the ancient Greeks. In 369 BC, Plato, through the voice of Socrates in Theaetetus, conceptualized knowledge as a true belief with an account – commonly identified as the concept of justified true belief – but then acknowledged that this definition remained inadequate. Knowledge has since then been endowed with many other definitions although, a stream of the literature still adheres to this original definition (Goldman, 1991; Nonaka and Takeuchi, 1995; Alavi and Leidner, 1999; Bourdreau and Couillard, 1999).

Relating knowledge to action is quite common in the literature; indeed, all of the just-cited authors do so. Argyris (1993) defined knowledge as the capacity for effective actions, and Sveiby (1997, p. 37) as "a capacity to act," while Applehans, Globe, and Laugero (1999) described it as the ability to turn information and data into effective actions. Stacey (1996), through his complexity-based definition, characterized knowledge as social acts, whereas Ackoff (1989, p. 40) stated that "knowledge is know-how," a notion that will be discussed in section 3.3.1 on Know-How, Know-What, Know-Who, and Know-Why.

Most definitions of knowledge relate it to experts and experience, ranking knowledge above data and information in terms of abstraction. For example, Awad and Ghaziri (2004, p. 37) defined knowledge as "a higher level of abstraction that resides in people's minds" and "includes perception, skills, training, common sense, and experience." Similarly, Liebowitz and Wilcox (1997) deemed knowledge to be the whole set of insights, experience, and procedures that are considered correct and true and that therefore guide the thoughts, behavior, and communication of people. This latter definition shows a combination of the previously detailed themes found in the definitions of knowledge across the literature.

The principal stream of definitions in the knowledge management literature links knowledge to information. Knowledge has been defined as information in context (Aune, 1970; Galup, Dattero, and Hicks, 2002; Desouza, 2005), "information whose validity has been established through tests of proof" (Liebeskind, 1996, p. 94), "information that has been authenticated and thought to be true" (Vance, 1997), "information in action" (O'Dell and Grayson, 1998, p. 5), "experience or information that can be communicated or shared" (Allee, 1997, p. 27), and "meaningful links people make in their minds between information and its application in action in a specific setting" (Dixon, 2000, p. 13). Expanding from this base, Wiig (2004, p. 74) defined knowledge as "facts, perspectives and concepts, mental reference models, truths and beliefs, judgments and expectations, methodologies, and know-how," all providing an understanding of how to create new meanings from isolated information.

Although definitions of knowledge show greater disparity than the definitions of data and information, it is possible to recognize a common thread relating knowledge to the concept of information, but at a higher level. Therefore, a synthesized definition of knowledge can be: Knowledge is considered to be information that has been processed in some meaningful ways.

3.2.5. Defining Wisdom

Almost no authors in the knowledge management literature have defined wisdom. However, those definitions that exist appear to be more consistent than those for knowledge or information. Ackoff (1989) defined wisdom as an evaluated understanding, whereas Matthews (1998) described wisdom as the critical ability to use knowledge in a constructive way and to discern ways in which new ideas can be created. Awad and Ghaziri (2004, p. 40) defined it as "the highest level of abstraction, with vision, foresight, and the ability to see beyond the horizon." Most recently, Thierauf and Hoctor (2006, p. 4) defined wisdom as the "ability to judge soundly over time".

3.2.6. Definitions Compared

These definitions share a key conceptualization: Wisdom is considered to be at a higher level than data, information, and knowledge. Consequently, wisdom can be considered to be knowledge that has been processed in some meaningful ways.

Table 3.2 provides a compilation of alternative ways of defining data, information, and knowledge. This table demonstrates that there is no consensus within the literature of knowledge management, but it also shows interesting similarities. Most of the authors defined knowledge, fewer defined information, fewer still defined data, and almost none defined wisdom. Consequently, wisdom has been omitted from These definitions share a key conceptualization: Wisdom is considered to be at a higher level than data, information, and knowledge. Consequently, wisdom can be considered to be knowledge that has been processed in some meaningful ways.

Table 3.2 although the concept does form part of the discussion presented here.

These definitions share a key conceptualization: Wisdom is considered to be at a higher level than data, information, and knowledge. Consequently, wisdom can be considered to be knowledge that has been processed in some meaningful ways.

Table 3.2: Alternative Definitions of Data, Information, and Knowledge

	Data	Information	Knowledge
Thierauf and Hoctor, 2006		Structured data useful for analysis and decision making	Obtained from experts based on experience
Desouza, 2005	Transduced outputs of sensors	Fusion of data; creation of the network incorporating both data and the relationships among data	Placement of information in its larger context (a necessary condition for understanding
Wiig, 2004		Data organized to characterize a particular situation, condition, context, challenge, or opportunity	Facts, perspectives and concepts, mental reference models, truths and beliefs, judgments and expectations, methodologies, and know-how. Understanding how to create new meanings out of isolated information
Awad and Ghaziri, 2004	Static, unorganized and unprocessed facts. Set of discrete facts about events	Facts based on reformatted or processed data. Aggregation of data that makes decision making easier and has a meaning, purpose and relevance	Higher level of abstraction that resides in people's minds. Includes perception, skills, training, common sense, ad experiences
Galup, Dattero, and Hicks, 2002		Data in context	Integrated information in context
Dixon, 2000	Unsorted bits of facts	Data that has been sorted, analyzed, and displayed	Meaningful links people make in their minds between information and its application in action in a specific setting

	Data	Information	Knowledge
Bourdreau and Couillard, 1999		Result of analyzing and interpreting data that carries meaning	Professional expertise appropriate for the domain. Things that are held to be true and drive people to action
Alavi and Leidner, 1999			Justified personal belief that increases an individual's capacity to take effective action
Applehans, Globe, and Laugero, 1999	Measurements	A statement of fact about measurements	Ability to turn information and data into effective actions

(continues)

	Data	**Information**	**Knowledge**
Davenport and Prusak, 1998	A discrete, objective fact about events	Data that make a difference	A fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information
Liebowitz and Wilcox, 1997	Representation of a fact, number, word, image, picture or sound	Data that has been assigned a meaning	The whole set of insights, experience, and procedures that are considered correct and true and that, therefore guide the thoughts, behavior, and communication of people
Vance, 1997			Information that has been authenticated and thought to be true
Stacey, 1996			Social acts
Drucker, 1995		Data with special relevance and purpose	
Nonaka and Takeuchi, 1995		Data put in context. Information is about meaning	Justified true belief. Knowledge is tied to action.
Argyris, 1993			Capacity for effective action
King, 1993		Data that make a difference	
Goldman, 1991			Justified true belief
Ackoff, 1989	Symbols	Data that are processed to be useful	Ability to answer "How" questions
Aune, 1970			Information in context

3.2.7. The Traditional Knowledge Pyramid (and Variations)

The definitions of data, information, knowledge, and wisdom lead us to the traditional knowledge "DIKW" pyramid illustrating the idea that facts processed in meaningful ways produce data, information, knowledge, and finally wisdom. The traditional knowledge hierarchy first appears in the knowledge management literature with the work of Zeleny (1987). The knowledge hierarchy is now usually seen as a pyramid ascending from data to wisdom as first suggested by Ackoff (1989). Of course, this

point of view implies that data can be found in much larger quantities than wisdom, which explains the pyramid shape. Ackoff introduced a pyramid with five constructs: data, information, knowledge, understanding, and wisdom, in which the existence of higher levels is predicated on existence of the lower ones. Traditionally speaking, the knowledge management literature retained only the four concepts of data, information, knowledge and wisdom, ordered into a hierarchy. Note that facts are not depicted in Figure 3.1, as their role is implicitly understood as subsumed within data.

Figure 3.1: The Traditional Pyramid
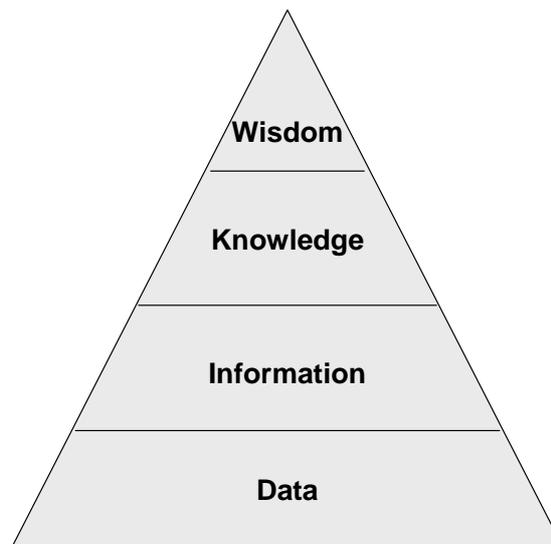
The traditional model implies that data, information, knowledge, and wisdom are distinct and cannot be mixed, a notion reinforced by the rigid categorizations shown in the pyramid (Figure 3.1). Additional (new) data, information, knowledge, and wisdom are sorted into their respective existing bases.

Various modifications to this pyramid have been suggested. Many of these implied the addition of constructs within the pyramid, such as understanding (Ackoff, 1989) or realization and action/reflection (Kakabadse, 2003). Matthews (1998) proposed to replace the pyramid by a cycle or a helix in which wisdom precedes creativity, itself leading to innovation, which ultimately enables the creation of new data and the launch of a new cycle. The traditional order was reversed by Saint-Onge (1996, p. 12), on the basis of "depth of meaning," with data on top (least depth of meaning) and wisdom on the bottom. Inverting the hierarchy was also proposed by Tuomi (1999), on the basis that data are more important than knowledge, and that knowledge must exist prior to the possibility of creating data. Nissen (2002) proposed a bidirectional approach, distinguishing between knowledge seekers and knowledge creators. According to

Nissen, the knowledge seeker puts data into context to create information, and information that is actionable becomes knowledge. The knowledge creator needs knowledge to create information, which is in turn needed to create data. Therefore, a general hierarchy of data, information, knowledge, and wisdom should allow transitions among constructs in both directions – a notion supported by Williams (2006).

Another interesting framework is provided by Bellinger, Castro, and Mills (2004), who modified a hierarchy of knowledge based on the model of Berger and Luckman (1966).

Figure 3.2: The Traditional Pyramid Revisited by Bellinger, Castro, and Mills (2004)

Connectedness

Wisdom

Understanding principles

Knowledge

Understanding patterns

Information

Understanding relations

Data ⟶ **Understanding**
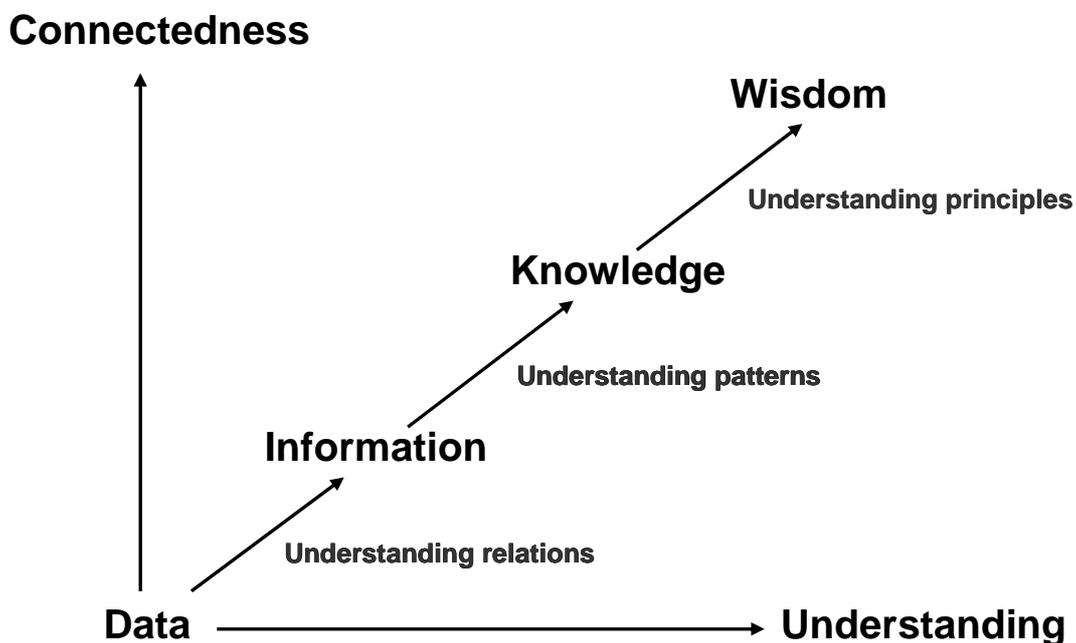
This model depicts transitions from data to information, knowledge, and wisdom through an ascending amount of connectedness and understanding. The model asserts that data is transformed into information, then into knowledge and eventually into wisdom through the influence of understanding of relations, patterns, and principles respectively. The model therefore suggests that understanding is the transformational relationship among data, information, knowledge, and wisdom which permits creation of an outcome of a higher level. Although this model does not address the issue of whether one can transition in the reverse direction from wisdom to data, it adds value by providing an initial holistic perspective employing the notion of connectedness.

3.2.8. Discussion: Data, Information, Knowledge, and Wisdom

Reductionism and decomposition have proved useful in enhancing our appreciation for components and details. Subsequent integration of conceptual bits and pieces into a systemic perspective is an essential process in this cyclical evolution. Although the traditional knowledge pyramid (Figure 3.1) is quite well accepted within the literature, it has been challenged in the past, and as we will see later on, this model is even more challenged by new theories.

First, all the definitions and models reviewed have led to a linear hierarchy, where data is the basis for information, which is the basis for knowledge, which is itself the basis for wisdom. Following the same reasoning, the reverse of the ascent from data to wisdom is also possible. For example, wisdom can be used as the basis to collect or generate new data. Authors can describe it as a pyramid, a hierarchy, or a circle; but the established hierarchy remains linear as there are no feedback loops. Therefore, the first step for improving these models is to place them within a holistic framework. As discussed in the opening section on Origins and Developments, what is needed is a systems thinking approach that considers the non-linearity of reality.

The previous models have neither a starting point nor an ending point. The literature focuses mostly on defining the difference between information and knowledge, but pays little attention to the definition of data. It seems that data is considered to be the most basic unit of knowledge management. However, as will be shown in Section 3.4 on the New Models of the Concept of Knowledge, this is debatable. It is also questionable as to whether wisdom should be the most developed concept in the model. The literature does not clearly address the question as to the existence of any possible higher level above wisdom. Consequently, the traditional model examined in this section needs clearer boundaries.

All these issues will be dealt with in section 3.4 on New Models of the Concept of Knowledge by presenting and discussing some of the latest models of the concept of knowledge introduced in the knowledge management literature.

3.3. Knowledge Classifications

The taxonomy of knowledge-related constructs does not stop with the traditional pyramid. The literature designates multiple types of knowledge, using nomenclature

such as know-how, know-what, know-who, and know-why (Lundvall and Johnson, 1994), or tacit and explicit (Nonaka and Takeuchi, 1995). Holsapple (2003, p.178) has identified 23 representative knowledge attributes in the literature, each featuring several dimensions. As he suggested, these do not explain what knowledge is; rather, they help to understand the many qualities of knowledge. The next two sections will provide a discussion of some of these distinctions in order to foster a better understanding of these concepts and their role in knowledge management. Of course, it is beyond the scope of this chapter to discuss all of the existing representations of knowledge, and priority has been given to the ones that are considered the most well-known and used in the field, as well as the more relevant ones to the purpose of this thesis (as one would expect from research using a pragmatic coherentist approach – see Chapter 1). Since this research builds on the very foundations of knowledge management, the next sections discuss the earliest distinctions among the types of knowledge; however, in order not to completely overlook the other taxonomies, the following table provides a brief summary of some of the representative knowledge attributes as presented by Holsapple (2003).

Table 3.3: Representative Knowledge Attributes

Attributes	Nature of Dimension	References
Mode	Tacit vs. explicit	Teece, 1981; Nonaka, 1991; Nonaka and Takeuchi, 1995
Type	Descriptive vs. procedural vs. reasoning	Bonczek et al., 1981, Holsapple and Whinston, 1987
Domain	Subject area or problem domain (e.g., marketing, engineering, policy, etc.)	Van der Spek and Spijkervet, 1997
Orientation	Domain vs. relational vs. self	Dos Santos and Holsapple, 1989
Applicability	Range from local to global	Novins and Armstrong, 1998
Management level	Operational vs. control vs. strategic	Anthony, 1965
Usage	Practical vs. intellectual vs. recreational vs. spiritual vs. unwanted	Machlup, 1982
Utility	Progression of levels from a clear representation to one that is meaningful, to one that is relevant, to one that is important	Holsapple and Whinston, 1996
Proficiency	Degree of expertise embodied	Wiig, 1993
Source	Origin of knowledge	Novins and Armstrong, 1998
Immediacy	Latent vs. currently actionable	Stewart, 2002
Age	Range from new to established to old knowledge	Van der Spek and Spijkervet, 1997
Volatility	Degree to which knowledge is subject to	Pritchard, 1999

	change	
Abstraction	Range from concrete to abstract	Boland et al., 2001
Conceptual level	Automatic vs. pragmatic vs. systematic vs. idealistic	Wiig, 1993
Resolution	Range from superficial to deep	Wiig, 1993
Recursion	Knowledge vs. meta-knowledge vs. meta-meta-knowledge	Bonzeck et al., 1981

*: adapted from Holsapple (2003)

Note that this chapter does not discuss the common distinction between individual and organizational knowledge (although Section 3.3.2 will provide a starting point). This classification, identified as public/private by Holsapple and Whinston (1996), individual/social by Spender (1995, 1996), and as a range of levels from object, individual, group/community, and organizational to public by Ford (2003), is excluded from this chapter as it is more concerned with the knowledge management system and will be discussed in more detail in the following chapters.

3.3.1. Know-How, Know-What, Know-Who, and Know-Why

The distinction between know-how, know-what, and know-why was initially linked to the knowledge hierarchy. Zeleny (1987) proposed that the constructs data, information, knowledge, and wisdom are respectively related to the concepts of know-nothing, know-how, know-what, and know-why. Ackoff (1989) suggested a different framework, introducing the aspects of 'who' and 'when', in which:

1. data are viewed as symbols;

2. information provides answers to 'what,' 'who,' 'where,' and 'when' questions;

3. knowledge answers 'how' questions;

4. understanding answers 'why' questions; and

5. wisdom is an evaluated understanding.

Lundvall and Johnson (1994) redefined these constructs into what is now the main distinction used in the knowledge management literature (i.e., Know-How, Know-What, Know-Who, and Know-Why). *Know-what* (sometimes replaced by know-that) refers to knowledge about facts, for example knowing the ingredients of a recipe for a cake. *Know-how* equates to the capability of doing something, e.g., how to make the cake. Know-how requires some know-what and sometimes some *know-why*, which is the understanding of basic principles and laws of nature. Finally, *know-who* refers to the

specific social relations held by an individual; it is knowledge about who knows what and can do what. Know-what and know-why are similar in the sense that they can be stored, reproduced, and exchanged fairly easily. This is not the case for know-who and know-how (Lundvall and Johnson, 1994), which tend to be tacit by nature, and more difficult to convert into an explicit form.

3.3.2. Tacit, Implicit, and Explicit Knowledge

One area of academic dispute regarding the definitions and nature of the various constructs of knowledge relates to the distinction between tacit, implicit, and explicit aspects. The most common distinction is between tacit and explicit knowledge, although a minority of academics add a third category by further distinguishing between tacit and implicit knowledge (Wilson, 2002; Day, 2005). This discussion is central to the field of knowledge management as it relates to the notions of organizational and individual knowledge.

From a linguistic point of view, the Oxford English Dictionary (2008) defines 'implicit' as 'implied though not plainly expressed; naturally or necessarily involved in, or capable of being inferred from.' This implies that implicit is contextual. 'Tacit' is defined as 'not openly expressed or stated, but implied; understood, inferred.' These two terms bear similar definitions, and there is little purpose in differentiating them here; for the sake of clarity, both will henceforth be referred to as tacit knowledge, as originally named by Polanyi (1966). The advocates of the 'implicit' distinction may argue with this decision, but the following paragraph will provide some explanation as to why this is a pragmatic choice. The debate between tacit and explicit knowledge commenced with the work of Polanyi and is immortalized by the sentence 'we can know more than we can tell' (Polanyi, 1966, p.4). Polanyi referred to the tacit power of the mind by which all knowledge is discovered and then held to be true.

Although the first explicit/tacit distinction was introduced in the management literature by Nelson and Winter (1982), it is the work of Nonaka and Takeuchi (1995) that has dominated the knowledge management field. Nonaka and Takeuchi made this distinction the focus of their SECI theory. The SECI model illustrates the transformation processes between tacit and explicit knowledge forming a spiral through the four processes of socialization, externalization, combination, and internalization (SECI), during which both types of knowledge expand quantitatively and qualitatively. This model is described and discussed some more in Chapter 4.

Explicit knowledge can be expressed in formal and systemic language, and can be shared by codifying it through many sorts of data, which can be stored (Nonaka, Toyama, and Konno, 2001). By contrast, the literature describes tacit knowledge as highly personal (Polanyi, 1956 and 1969; Wagner and Sternberg, 1985; Vincenti, 1990; Raghuram, 1996; Davenport and Prusak, 1998; Nonaka and Konno, 1998; Gore and Gore, 1999; Meso and Smith, 2000; Stenmark, 2001; Kupers, 2005) and obtained by experience (Polanyi, 1958; Nonaka and Takeuchi, 1995; Augier and Vendelo, 1999; Wagner and Sternberg, 1985). Tacit knowledge is rooted in actions, procedures, routines, commitments, ideals, values, and emotions (Nonaka, Toyama, and Konno, 2001), and is more complicated to handle than explicit knowledge, because of its highly personal and subjective nature. As suggested by Selamat and Choudrie (2004), tacit knowledge resides in individuals' minds and is transparent. Tacit knowledge is part of a personal skill or capability that individuals can rely on in their daily life without being aware of it, let alone understanding it (Kupers, 2005).

It is also important to note that not all tacit knowledge can be made explicit (Tsoukas, 2003). As suggested by Polanyi in *The Tacit Dimension* (1966, p.4), "formalizing all knowledge to the exclusion of any tacit knowing is self-defeating." Indeed, tacit knowledge is necessary to solve problems. As suggested by Plato in Meno, if all knowledge is explicit, then neither a problem can be known nor can its solution be looked for as it would be impossible to know that the problem exists. This is why Polanyi (1966) suggested that things that can not be told can still be known.

A conclusion here is that tacit knowledge cannot be 'extracted' or 'captured' as easily as some suggest, and that not all tacit knowledge can be made explicit in any case. However, this is not to say that tacit knowledge cannot be made explicit at all (see Wilson, 2002, for example). This therefore answers the question of whether differentiating between implicit and tacit knowledge is necessary or not. The answer is 'no' as having such a distinction is a reductionist approach based on the disjunctive logic of either/or. As discussed and hopefully demonstrated in this section, the conjunctive logic approach indicates that knowledge can be both tacit and explicit, and that it may not be possible to make all tacit knowledge explicit (or vice versa) but that this can be partially accomplished, and also that it may not be necessary. Therefore, knowledge management must discover suitable ways of creating, acquiring, interpreting, storing, disseminating, and applying tacit knowledge (Strach and Everett, 2006). The next subsection takes this discussion a step further.

3.3.3. Discussion: Types of Knowledge

The dualistic (tacit/explicit) view of knowledge affords ample room for debating extension of this dichotomy to the related constructs of data, information, and wisdom discussed in section 3.2 on Data, Information, Knowledge, and Wisdom. Most academics seem to view the dualistic aspect of tacit and explicit to be relevant only for the knowledge construct itself. This could be the case if one discards the structure of the knowledge pyramid and considers only the constructs of know-what, know-why, know-who, and know-how. Some academics hold the view that data and information are explicit, and that knowledge and wisdom are tacit (e.g., Heskett, 2002, Zeleny, 2006). Others suggest that the distinction between tacit and explicit exists along a continuum between data and wisdom, sometimes completely and sometimes partially (Saint-Onge, 1996; Monroe and Lee, 1999; Alavi and Leidner, 2001). Although wisdom may be explicit, and data tacit, the likelihood is high that one will find more tacitness in wisdom than in data, and conversely more explicitness in data than in wisdom, a view illustrated in Figure 3.3.

Figure 3.3: The Knowledge Hierarchy with the Tacit/Explicit Continuum
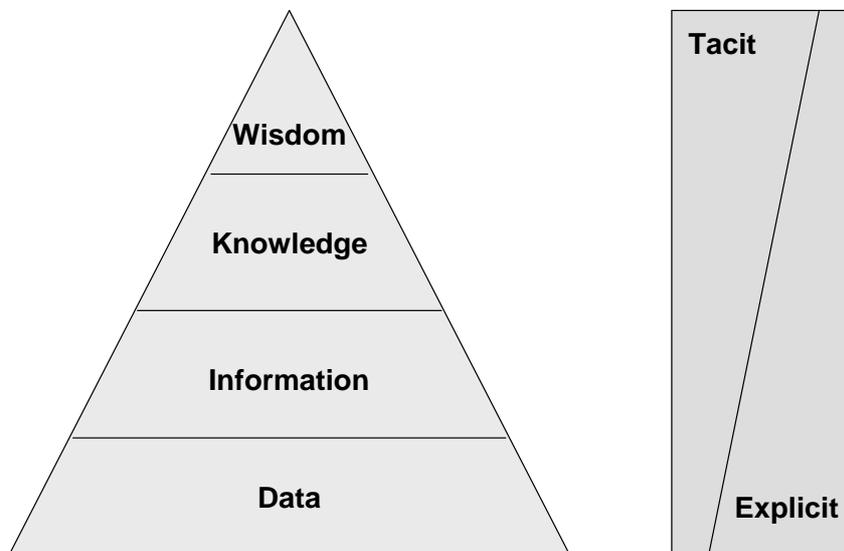
All these developments and the move from reductionism to holism are critical to the field of knowledge management. Although it had been created with intentions of holism, the field of knowledge management entered a reductionist phase, leading to multiple divergent taxonomies of knowledge with a wide variety of definitions of the constructs constituting them, which in turn gave birth to the traditional DIKW pyramid. This model, based on linear thinking, has slowed the evolution of the field of knowledge management.

To progress, it seems that the concept of knowledge requires a new systemic perspective matching the non-linearity of reality, as well as clearer statements of boundaries and transitional possibilities. Various scholars have attempted to address these issues, with several recent models of the concept of knowledge exhibiting some interesting initiatives; these are discussed in the next section.

3.4. New Models of the Concept of Knowledge

The development of systems thinking and complexity theory highlighted the need for a deeper and more integrated understanding of the concept of knowledge. A more comprehensive model of knowledge should purport to include concepts such as non-linearity, specification of relationships and feedback systems, and system boundaries. Three models that address the issues raised in the two preceding sections have been chosen to illustrate the latest attempts to build a better framework to illustrate the concept of knowledge.

3.4.1. Get Rid of the Pyramid, Get On the Cycle: Firestone & McElroy

Firestone and McElroy (2003) proposed abandoning the traditional pyramid, adopting instead an approach in which data, information, knowledge, and wisdom are redefined as different types of information and linked to a knowledge life cycle framework introduced by McElroy in 2000.

In their model, Firestone and McElroy questioned the definitions of all of the constructs constituting the traditional pyramid, and reached the conclusion that all were just different types of information. Indeed, they argued that data is in fact a type of information whose conceptual context provides the data with structure and whose purpose is to represent observation. They then defined knowledge as a subset of information in the sense that knowledge is processed information that has passed tests and evaluations aimed at eliminating errors and seeking the truth. Finally, they described information as being data plus conceptual commitments and interpretations, or such commitments and interpretations alone. Hence they defined information as processed data. Firestone and McElroy introduced a new construct into the model, 'just information,' but did not further explain it. It is believed that the use of the term 'just' refers to the concept of justice as Firestone and McElroy used this notion to define wisdom (see below). Their concept of 'just information' should not be confused with

Plato's view of knowledge as 'justified true belief,' although there appear to be some superficial similarities.

Their model (Figure 3.4) links information (i.e. data, 'just information,' and knowledge) to a cycle of problem solving and information creation which demonstrates the importance of feedback loops. In this model, wisdom is not illustrated. Indeed, according to Firestone and McElroy, wisdom is either a form of knowledge about what is right to do, and therefore a form of information as well, or a kind of decision, in which case it is not information. This ambiguous aspect of wisdom led them to discard the construct.

Figure 3.4: Get Rid of the Pyramid, Get On to the Cycle
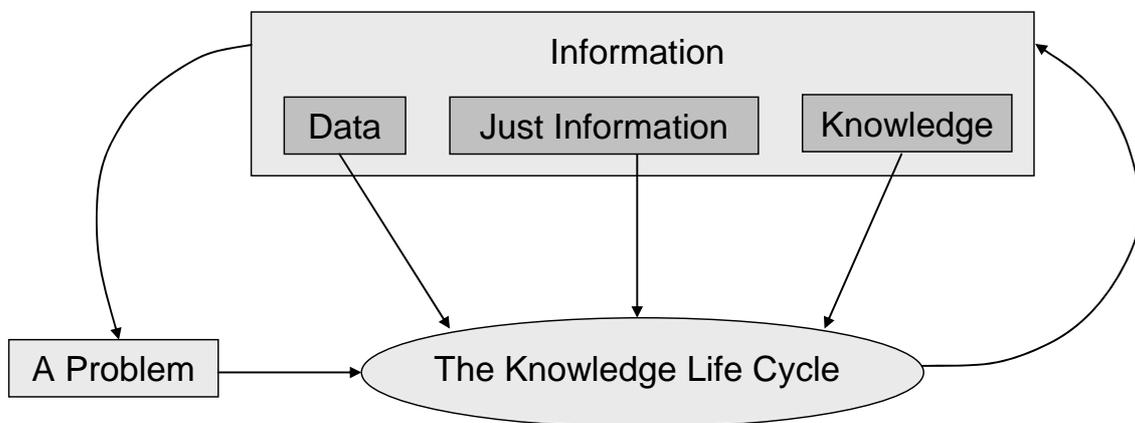
*: From Firestone and McElroy (2003, p.19)

The main difficulty with this model concerns its definitions. Data is defined as a type of information, but information is defined as processed data (a circular argument). Hence, there is a logical inconsistency at the foundation of the model (i.e., data is a type of processed data). However, the appeal of this model is that it directly challenges the traditional pyramid and tries to answer the first point raised in Section 3.3.3 on the different types of knowledge (i.e., non-linearity) by proposing a holistic model with a feedback system.

3.4.2. The Agent-in-the-World Model

This model was introduced by Boisot and Canals in 2004 in the *Journal of Evolutionary Economics*. Mirroring the approach of Firestone and McElroy (2003), the conceptual thinking behind this model focuses on the information level. Boisot and Canals argue for a clearer distinction between data and information on one side, and information and knowledge on the other. Coming from an economic perspective, they totally ignored the

wisdom aspect of the knowledge taxonomy found in the traditional pyramid. Boisot and Canals' model is illustrated in Figure 3.5**: The Agent-in-the-World**.

Figure 3.5: The Agent-in-the-World
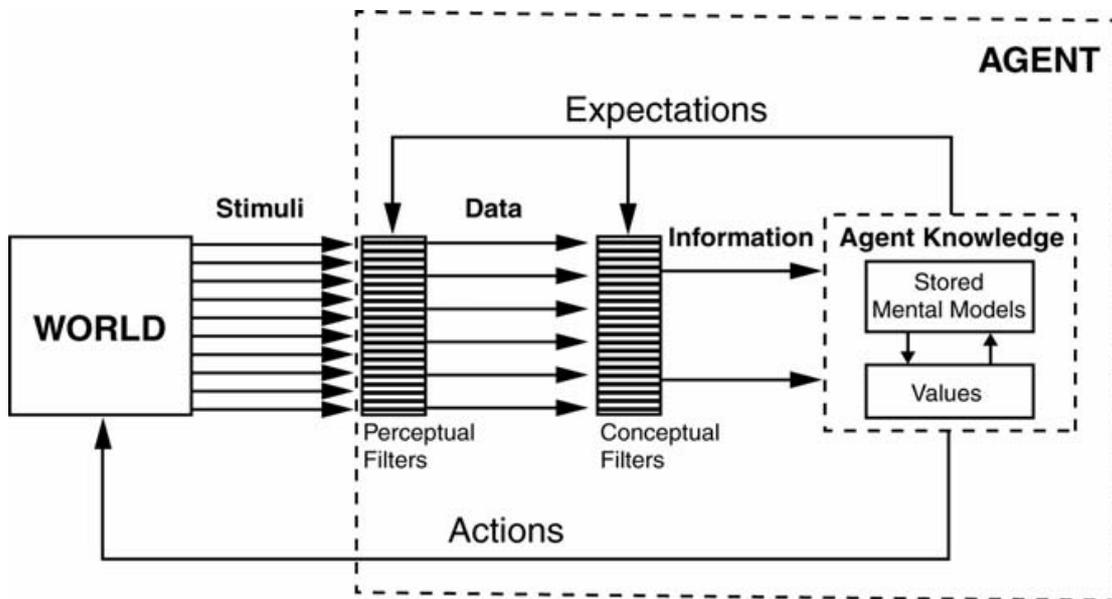
*: From Boisot and Canals (2004, p. 48)

Based on the idea that data is originated in discerning differences in physical states of the world, Boisot and Canals defined data as being the discernable stimuli that could be registered by an agent. They further defined information as the significant regularities that could be extracted from data, hence equating information with an extraction from data that has the potential to cause useful modifications of an agent's knowledge base. They suggested that information was a set of relations between the receiving agents and the incoming data, which implies that agent disposition plays an important role in what is considered data or information.

Thus, following Arrow (1984), Boisot and Canals defined knowledge as a set of expectations held in agents' knowledge bases, which are modified by incoming information. In that sense, the traditional pyramid (Figure 3.1) can be found in their model, as knowledge is an extraction of information, itself an extraction of data, and quantities decrease along the path from data to knowledge. However, they addressed the environment boundary aspect (data are discernable stimuli from the world), and they proposed a feedback system linking prior knowledge to incoming data and information. They further developed the model to include perceptual filters in order to explain that some stimuli are registered as data, and some are not. Similarly, they added a

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conceptual filter, representing the notion of cognitive activities being required to create new knowledge.

Boisot and Canals suggested that this model implies that data, information, and knowledge are distinct economic goods with specific utilities. Hence, data is portrayed as a carrier of information, which is itself a modifier of expectations or state of knowledge. They concluded that knowledge is what allows agents to act in adaptive ways. Boisot and Canals presented their model as an initial reflection of what had to be done to create a framework that would take into account the pervasive roles of data, information, and knowledge.

This model addresses some of the boundary issues raised in Section 3.3.3. However, due to its epistemic perspective, it only takes into consideration the (agent's) boundary between data and the environment. It does not allow for any physical (explicit) form of information or knowledge, which is a clear distinction with the model from Firestone and McElroy (2003) presented in the preceding section. Boisot and Canals (2004) followed a non-reified perspective of knowledge, which is one of the new approaches to knowledge management, as we will see in the next chapter. However, this is inconsistent with the perspective embraced in Section 3.3.3, as well as the one commonly agreed by experts in the field of knowledge management, as will be shown in Chapter 5.

3.4.3. The Five Tier Knowledge Management Hierarchy

This model was created by Hicks, Dattero and Galup and presented in the Journal of Knowledge Management in 2006. The idea behind the birth of this model is to extend the traditional knowledge hierarchy (Figure 3.1) by adding a new personal knowledge class consisting of two tiers: the individual tier and the innovation tier. Hicks et al. commenced from the simplified knowledge pyramid consisting of only data, information, and knowledge, omitting wisdom (paralleling Firestone and McElroy). According to them, individuals create, use, and maintain data, information, and knowledge, which they call the codified knowledge tiers. Therefore, the individual tier has been positioned as the foundation for their hierarchy, innovation being the highest level as it integrates all of the tiers by using strategy to exploit both personal and codified knowledge assets. To resolve the debate over the definitions of data, information, and knowledge, Hicks et al. replaced these terms respectively with facts, influences, and solutions, adopting these definitions:

- Individual knowledge is defined as ''knowledge contained only in the mind of a person.''

- Facts are defined as ''atomic attribute values about the domain.''

- Influences are defined as ''data in context that has been processed and/or prepared for presentation.''

- Solutions are defined as ''clear instructions and authority to perform a task.''

- Innovation is defined as ''the exploitation of knowledge-based resources.''

Figure 3.6 illustrates the model with its two dimensions of volumes and actionability of knowledge management assets. Hicks et al. retained the notion that there should be more assets at the bottom of the hierarchy (in accordance with the traditional pyramid) and fewer at the top, which contains assets that are more actionable.

Figure 3.6: The Five Tier Knowledge Management Hierarchy
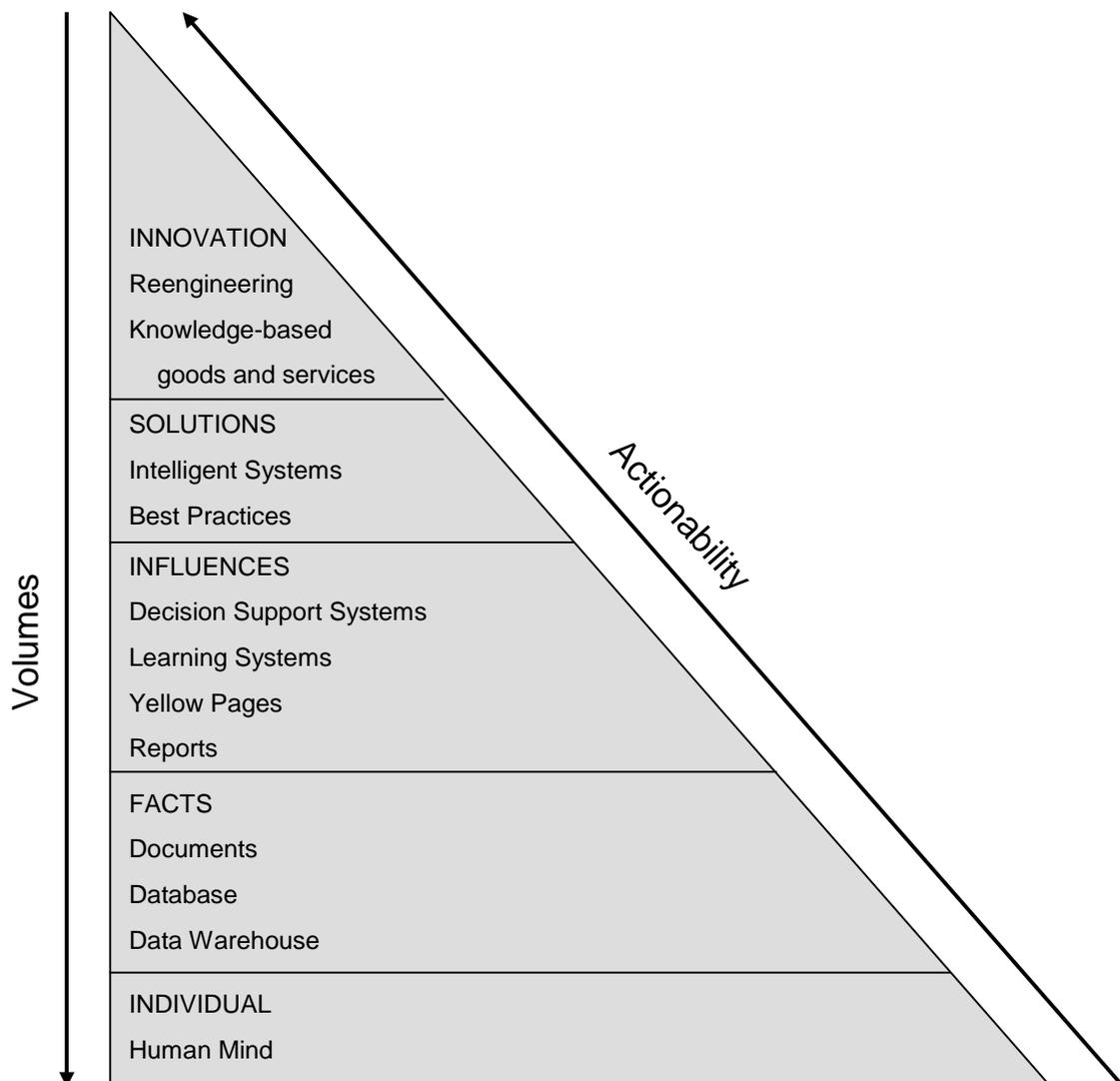
Hicks et al. argued that the individual tier is linked to the three tiers above it as the role of the individual is to create, use, and maintain them. According to them, a codified knowledge management system is only effective if the knowledge that it obtains from the knowledge holder can be delivered to the knowledge seeker. Therefore, they suggested that the three codified tiers should be implemented as a set of software solutions.

In the model, the facts tier is presented as a source of raw data that can be furnished to higher-level tiers through the use of analytical software. Facts are assumed to be organized for the purpose of creating influences. The influence tier has the role of assisting people in decision-making; influence is considered to be integrated data in context through presentations or processing such as learning systems or decision support systems. The role of the solution tier is to make decisions and execute them; this tier is a shareable source containing the complete solution for a specific task and the authority to act upon it. Expert systems are one example of this type of asset. Finally, the innovation tier is described as the result of combining knowledge from any tier with strategy. It is based on the proposition by Edvinsson, Dvir, Roth, and Pasher (2004) that innovation equals the reuse plus invention of knowledge times their exploitation.

The Five Tier model is interesting as it focuses on the practical side of knowledge management and tries to link the concept of knowledge to practice. It also partially solved some of the issues raised in Section 3.2.8 on Data, Information, Knowledge, and Wisdom. First, it addressed the problem of feedback, as all five tiers are linked, although the representation of the model lacks this precision; it does not conceive feedback as a main feature. Second, the model addresses the boundary issue of the traditional knowledge pyramid by adding two personal classes of knowledge assets. However, part of the boundary issue remains, as nothing in the model explains where the three codified knowledge tiers come from (or where 'wisdom' went) nor how they relate with their environment.

3.4.4. Towards a Change of Perspective in Knowledge Management

The three models proposed as replacement for the traditional pyramid approached the issues raised in Section 3.2 on *Data, Information, Knowledge, and Wisdom* and *Types of Knowledge* from different angles and with different levels of success. All three models

incorporated feedback systems. The Agent-in-the-world model (Boisot and Canals, 2004) and the five tier model (Hicks, Dattero, and Galup, 2006) proposed new boundaries for a systemic concept of knowledge, the former suggesting a stimuli approach using perception filters, the latter suggesting the addition of individual knowledge and innovation. These new models provide insight into the concept of knowledge and illustrate the need for a change of perspective in knowledge management from reductionism to holism. All were presented by their authors as a first step into such a change.

The initial goal for the field of knowledge management was to create a holistic concept of knowledge; this commenced with the work of Zeleny (1987) and Ackoff (1989), but shortly fell into reductionism. It then underwent evolution (as did the concept of knowledge), and is presently ready to evolve from a reductionist approach towards a holistic one. The traditional DIKW pyramid is no longer satisfactory as it does not present the whole picture necessary to understand the concept of knowledge, failing to provide key linkages among the concepts (notably including feedback loops, permeable boundaries, and potential conversion among tacit and explicit forms of knowledge).

As shown by several researchers (Holsapple and Joshi, 1999, Heisig, 2009), the field of knowledge management is fragmented among different perspectives that cannot portray an integrated concept of knowledge. The future of knowledge management lies in a refinement of systems thinking into more theoretical and practical applications.

3.5. Summary

The historical development of the concept of knowledge provides an understanding of how a reductionist perspective entered the debate between philosophers in the West and played an important role in the development of the theory of knowledge. From the idealism of Plato and the deductive empiricism of Aristotle, the debate of the concept of knowledge has been subject to many influences including the whirlpool of reductionism induced by rationalists such as Descartes, and the work of the inductive empiricists, such as Bacon and Locke, attempting to pursue the conceptual development of the self. Modern philosophers representing varying epistemologies (e.g. logical positivists and falsificationists) eventually progressed towards systems thinking, intending to create more epistemological cohesiveness. Idealists such as Kant and Hegel helped to create dialectical logic, whereas Kuhn and Lakatos proposed the premises of holistic accounts

of science in the West. This move towards holism bridged a gap between the East and the West with the foundation of constructivism and the consequent appearance of systems theory and complexity theory. The latter shares numerous ideas featured in established Eastern philosophies (e.g. refutation of causation, self-organization, and flows of energies).

Many definitions of taxonomies of knowledge (such as know-how, know-what, know-who, and know-why; or tacit and explicit) can be found in the literature, along with a wide variety of definitions of the constructs constituting them (typically data, information, knowledge, and wisdom). Although it had been created with intentions of holism, the field of knowledge management entered a reductionist phase, leading to the birth of the traditional DIKW pyramid. This model, based on linear thinking, has slowed the evolution of the field of knowledge management. Although several recent models have attempted to move away from the traditional pyramid, and provide a more systemic approach, none achieved sufficient improvements in regards to the reconceptualization needed by the field. To progress towards a systemic and integrative theory of knowledge management, it seems that the concept of knowledge requires a new systemic perspective matching the non-linearity of reality, as well as clearer statements of boundaries and transitional possibilities.

This reconceptualization will be further discussed in Chapter 6. Preceding that, a review of the knowledge management literature is required to fully grasp the dimension of the changes involved in establishing a systemic and integrative theory of knowledge management incorporating the development of knowledge processing systems.

Chapter 4. From Knowledge to Knowledge Processing

This chapter builds on the concept of knowledge to approach the concept of knowledge processing, which is at the heart of knowledge management. While Chapter 3 focused on the philosophy of science, this chapter is very much concerned with the field of knowledge management.

Originating from developments in philosophy, cognitive science, and systems theory, the field of knowledge management grew through the rapid expansion of information technology, particularly artificial intelligence and experts systems. Multidisciplinary by nature, knowledge management developed rapidly in many directions, particularly in management and information science. While providing a strong and rich base for exponential growth, this also diluted the focus of the field. Concentrating heavily on the 'information' side of the discipline led to a situation in which the social aspect of knowledge management was mostly ignored. While a review of the literature illustrates how this has been partially corrected, this history has left the field in a confused state. The main consequence is a crucial lack of integration and a proliferation of models without a common focus.

This chapter includes four sections:

- Section 1 provides an account of the historic development of the knowledge management literature and provides some insights about its lack of integration. It also explains how the concept of knowledge processing appeared and the place it has in the future development of the field.

- Section 2 examines comparative studies illustrating the most common characteristics of knowledge management frameworks found in the literature, illustrating the lack of integration of the field, as well as discussing the shortcomings of these frameworks.

- Section 3 introduces several knowledge management frameworks that incorporate notions of complexity theory, focusing on one promising framework in particular, discussing its benefits and deficiencies in comparison to the traditional frameworks. It concludes with a discussion of what is still needed to promote the development of the knowledge management field.

- Section 4 is a summary of this chapter, and provides the basis for the next chapter, which presents a Delphi study on the concept of knowledge.

4.1. Evolution of the Field of Knowledge Management

As introduced in Section 3.1.7, the field of knowledge management surfaced in the late 1980s, drawing mostly on developments in philosophy, cognitive science, and systems theory, but it was only in the late 1990s that it reached a tipping point and experienced exponential growth (Wilson, 2002). This section discusses that growth and the reasons underlying the consequent lack of integration from which the field is now suffering, leading to a second tipping point and a new evolutionary phase.

4.1.1. Rapid Growth Resulting in Lack of Integration

In order to share understanding within the discipline, scholars have tried over the years to produce a common model or framework which would describe the core elements, concepts, and principles of knowledge management (Heisig, 2009). Organizations have then used these frameworks to prescribe the fundamental elements of knowledge management, communicate clearly about knowledge management, and design and evaluate knowledge management solutions (Holsapple and Joshi, 1999; Lai and Chu, 2000).

As shown by Wilson (2002) and more recently by Heisig and Orth (2005), the knowledge management literature has grown very quickly since the end of the 1990s. The first known usage of the term 'knowledge management' in an academic title was by Jayaraman for his doctoral dissertation in 1984. The term had, however, surfaced earlier (Apte, 1992), and Drucker had been employing the term 'knowledge worker' since 1956. It is only in 1986 that the first general usage of the terms 'knowledge management' (Kellogg, 1986) and 'management of knowledge' (Wiig, 1997) appeared in academic publications. According to Wilson, from 1986 to 1996, there were only a few occurrences of the term in each year's academic publications. However, from 1997 to 2001, growth was exponential. Similar findings were related by Heisig and Orth (2005), and while only nine new knowledge management frameworks appeared in the year 1997, 567 new frameworks appeared between 1998 and 2003 in the literature, with 156 new ones in 2003 alone. Although Heisig and Orth (2005) ended their analysis with the year 2003 and Wilson his in 2001, it is expected that the field has continued to grow at a rapid pace.

It is neither the goal nor the scope of this thesis to analyze or compare all the existing knowledge management frameworks; this has been accomplished by others, notably

Heisig (2009) (preceded by Holsapple and Joshi, 1999), who analyzed more than 160 knowledge management frameworks. Some of their results are valuable to contextualize the development of the field of knowledge management. Following the typology utilized by Rubenstein-Montano et al. (2001), which classifies knowledge management frameworks into three classes (i.e. prescriptive, descriptive, and hybrid frameworks), Heisig (2009) demonstrated that half of the frameworks in the literature are of the hybrid nature, and that since 1999, a large majority of the new frameworks show a hybrid character. Heisig also showed that (as previously discussed in Chapter 3) there is not a uniform understanding of the term knowledge used in knowledge management frameworks found in the literature. He also found that the most frequently used dichotomies to describe the elements of knowledge were the distinction between tacit and explicit knowledge, and between individual and collective knowledge.

According to Wilson (2002), 61% of the early academic publications in knowledge management (during the period 1986-1996) dealt with computing and its applications. Therefore, before the 1997 surge in publication, 'knowledge management' meant some kind of computer application based on the notion of 'knowledge bases' in the expert systems field. Although the foundations for a system-based field of knowledge management already existed (see Zeleny, 1987; Ackoff, 1989), they were mostly ignored. This probably gives some insights into the underlying origins of the current dilemma with the term 'knowledge management' itself. Indeed, it has been generally agreed in the field that knowledge cannot really be 'managed' in the classical sense of the term (see Denning, 1998; Sveiby, 2001a; Wilson, 2002) and that the term 'knowledge management' was probably not the best choice to name the field (see also Kontzer, 2001; McElroy, 2003). This is summarized by Sveiby (2001b):

> I don't believe knowledge can be managed. Knowledge Management is a poor term, but we are stuck with it, I suppose. "Knowledge Focus" or "Knowledge Creation" (Nonaka) are better terms, because they describe a mindset, which sees knowledge as activity not an object. It is a human vision, not a technological one.

The rapid growth of the field and the various streams of development created the basis for its lack of integration. Definitions of knowledge management illustrate this point, and as indicated by Wilson (2002) and McElroy (2003), among others, there is no consensus on this definition in the literature.

The lack of integration is also due to the general confusion about the term knowledge management. Wilson (2002) showed that definitions of knowledge management used by consulting companies tend to be misnomers for information management. In his analysis, he illustrated how Accenture, Cap Gemini Ernst and Young, Deloitte and Touche, the Gartner Group, McKinsey and Company, and PricewaterhouseCoopers, all large and well known consulting companies, use knowledge and information as synonyms and limit knowledge management to information management and, sometimes, intellectual capital. Wilson also showed how the same confusion exists in many business schools around the world, which position knowledge management as part of their information management courses.

Recent development of the field illustrates the influence of systems thinking going back to the work of Zeleny, Ackoff, and others. As argued by Kawalek (2004), systems thinking has the potential to provide methodological guidance for practitioners in knowledge management. Similar to the evolution of the concept of knowledge discussed in Chapter 3, knowledge management started from a systemic perspective (see the work of Zeleny, 1987) but rapidly became lost in reductionism due to the growing influence of computers and information technology. Knowledge became a commodity that large consulting companies tried to harness and control with large knowledge repositories and computing systems (which could be viewed as information repositories). The next subsection takes this discussion further.

4.1.2. A New Phase of Development in Knowledge Management

Many scholars agree that knowledge management attained a new phase in its life cycle in the early 2000s (Firestone and McElroy, 2003; Koenig, 2000; Snowden, 2002). As highlighted by Heisig (2009), after the technological euphoria and hype that preceded a period of disillusionment, knowledge management is now pursuing a path that should lead to a better understanding of its success factors. Initiatives launched by standardization bodies worldwide have tried to provide a common understanding of knowledge management (see Standards Australia (2001, 2003), BSI (2001, 2003a, b, c) in Britain, DIN (2006) in Germany, and CEN (2004) at the European Level). Although many agree that knowledge management has reached a tipping point in its evolution, there is some dissension about how and why that is.

Providing a first perspective on the state of knowledge management, Koenig (2000) suggested that the field had entered the third stage of its evolution. According to him,

the first stage was driven primarily by information technology when large companies, particularly the large international consulting firms, realized that they were mostly trading information and knowledge. The second stage of knowledge management occurred by adding recognition of the human and cultural (contextual) dimensions of knowledge into knowledge management frameworks (Koenig here sees Senge (2000) and Nonaka and Takeuchi (1995) as the main influencing works). Koenig defined the third stage of knowledge management as awareness of the importance of the retrievability of content. Hence, the focus shifted to identifying, understanding, and making use of the arrangement, description, and structure of that content.

Snowden (2002), while also identifying three stages (which he termed generations), presented a slightly different and more subtle perspective. According to him, the first generation focused on the appropriate structure and flow of information to decision makers and a computerization of major business applications. During this generation, knowledge was managed, and the word itself was not problematic. By 1995, Nonaka and Takeuchi's SECI model had given birth to the second generation after large companies realized that their content re-engineering had been done at the cost of long-term efficiency. As Stacey (2001) suggested, what had been called knowledge management was nothing more than content management. Snowden proposed the Cynefin model (which is presented in more detail in a subsequent section) as the starting point of the third knowledge management generation. Snowden suggested the necessity of adopting a new perspective on knowledge, one that embraced the paradoxical nature of knowledge as a thing and a flow at the same time. His work will be further discussed later on as he is one of the precursors of the integration of ideas from complexity theory into knowledge management.

The third perspective on the evolution of knowledge management is provided by Firestone and McElroy (2003). They advocate not three but two generations (or stages). As argued by McElroy (2003), the first generation focused on enhancing information (and sometimes knowledge) integration, but with little done to enhance knowledge production. The most striking distinction between their first and second generation knowledge management is the integration of an explicit connection with organizational learning. Paralleling Koenig's and Snowden's perspectives, the first generation focuses on knowledge as an object while the second concentrates on knowledge processes, which are social in nature. From the perspective of its first generation, knowledge management is viewed as the management of knowledge (similar to the idea of content

management discussed previously). However, from the perspective of the second generation, knowledge management is understood as the management of knowledge processing; it is embedded in systems thinking and more particularly in complexity theory. According to McElroy, "not only is knowledge processing a social process, it is a self-organizing one" (2003, p. 29). The distinction between knowledge management and knowledge processing is crucial to differentiating between first and second generation knowledge management.

This last perspective of the evolution of knowledge management stresses the importance of a systemic framework that encompasses not just knowledge integration (knowledge supply in McElroy's terminology), but also knowledge production (the demand side) within an organization, a concept that is linked to the notion of organizational learning, itself tied to the idea of self-organization (Stacey, 2001). This perspective of the necessary evolution of knowledge management has been called upon by several other scholars (see also Bennet and Bennet 2003, 2004; Boisot, MacMillan, and Han, 2007) and although not all of them specifically employ complexity theory (e.g. Allard, 2003; Heisig, 2009; Holsapple and Joshi, 2003), they all agree on the need to develop more systemic frameworks in knowledge management. Knowledge management therefore has to deal with the management of a system of complex social processes that McElroy (2003) termed the knowledge processing system. This concept, which will be further discussed in Section 4.3, is a central pivot of this thesis. However, before that discussion, it is useful to review what constitutes the traditional knowledge management body of frameworks, and before commencing this analysis, it is important to agree on a definition of knowledge management in order to be clear about the lens used to judge these frameworks.

This thesis follows the definition provided by McElroy (2003), based on the work of the Knowledge Management Consortium International (KMCI), which sees complexity theory as a lens to develop knowledge management to a higher level. The definition is the following: Knowledge management "is a management discipline that seeks to enhance organizational knowledge processing" (p. 70). Furthermore, the knowledge management process is defined as "an ongoing, persistent, purposeful interaction among human-based agents through which the participating agents manage (handle, direct, govern, control, coordinate, plan, organize, facilitate, enable, and empower) other agents, components, and activities participating in basic knowledge processing (knowledge production and knowledge integration), with the purpose of contributing to

the creation and maintenance of an organic, unified whole system, producing, maintaining, enhancing, acquiring, and transmitting the enterprise's knowledge base" (p. 71).

4.2. Conception and Organization of the Classical Knowledge Management Frameworks

Following the perspective introduced in Section 2.5, this section examines the conception and organization of classical knowledge management frameworks found in the literature. This will illustrate the lack of integration in the field and help to understand the strengths and deficiencies of the classical frameworks and provide a baseline for their comparison to the complexity-based frameworks examined in Section 4.3. Using the terms introduced in Chapter 2, this section looks at the frameworks modeling the knowledge processing system in which processes are conventionally referred to as knowledge activities and in which the active units are people (since the knowledge processing system is social by nature).

4.2.1. Place of Knowledge in Knowledge Management Frameworks

As shown by Heisig (2009), the large majority of knowledge management frameworks present explicit statements regarding the term 'knowledge'. Heisig found that the most common (52%) descriptors for the concept of knowledge were dichotomies such as explicit versus tacit or internal versus external. This is consistent with the findings illustrated in Chapter 3 and highlights the disjunctive logic underlying the development of the knowledge management field. As reported by Heisig (2009), the second most common way of describing knowledge (29%) in knowledge frameworks adopts a strategic perspective using concepts such as 'knowledge assets and resources' or 'intellectual capital'. This is followed (20%) by the use of the traditional knowledge pyramid taxonomy (as discussed in Chapter 3) and the concept of an organizational knowledge base (16%).

Alavi and Leidner (2001) have extensively discussed the influence of the knowledge perspective taken by scholars and its impact on the models of knowledge management they use. Table 4.1 illustrates their main findings.

Table 4.1: Knowledge Perspectives and Their Implications

Perspectives		Implications for Knowledge Management (KM)	Implications for Knowledge Management Systems (KMS)
Knowledge vis-à-vis data and information	Data is facts, raw numbers. Information is processed/interpreted data. Knowledge is personalized information.	KM focuses on exposing individuals to potentially useful information and facilitating assimilation of information	KMS will not appear radically different from existing IS, but will be extended toward helping in user assimilation of information
State of mind	Knowledge is the state of knowing and understanding.	KM involves enhancing individual's learning and understanding through provision of information	Role of IT is to provide access to sources of knowledge rather than knowledge itself
Object	Knowledge is an object to be stored and manipulated.	Key KM issue is building and managing knowledge stocks	Role of IT involves gathering, storing, and transferring knowledge
Process	Knowledge is a process of applying expertise.	KM focus is on knowledge flows and the process of creation, sharing, and distributing knowledge	Role of IT is to provide link among sources of knowledge to create wider breadth and depth of knowledge flows
Access to information	Knowledge is a condition of access to information.	KM focus is organized access to and retrieval of content	Role of IT is to provide effective search and retrieval mechanisms for locating relevant information
Capability	Knowledge is the potential to influence action.	KM is about building core competencies and understanding strategic know-how	Role of IT is to enhance intellectual capital by supporting development of individual and organizational competencies

*: From Alavi and Leidner (2001, p. 111)

Scholars can share several perspectives from the categorization made by Alavi and Leidner (2001), which consequently can lead to a myriad of knowledge management frameworks. However, it should be noted that Alavi and Leidner had a strong information technology focused perspective on knowledge management. In their summary table, knowledge management systems (KMS) refer to a class of information systems applied to managing organizational knowledge, i.e. "they are IT-based systems developed to support and enhance the organizational processes of knowledge creation, storage/retrieval, transfer, and application" (p.114). This thesis has a very different view of knowledge management systems, and their fourth column has been retained only for

review purposes. This column emphasizes the information technology focus of the field. Table 4.1 overall illustrates the impact of different perspectives of knowledge on the knowledge management framework.

Paralleling the general evolution of the field, one perspective of knowledge has fueled many debates: knowledge as an object (also called the 'reified' view of knowledge). This view, entrenched in first generation knowledge management, has been challenged by the emergence of second generation knowledge management, as presented in the preceding section. The 'non-reified' view of knowledge advocated by Nonaka (1994), Nonaka and Takeuchi (1995), and Sveiby (1997) argues against the common Western notion of knowledge-as-object based in the early development of the field. Primarily based on ideas from Polanyi (1958) and Wittgenstein (1995), the non-reified view of knowledge tends to make a clear distinction between knowledge as a non-object and information as an object. Although it constitutes a step away from the commodity view of knowledge, this conceptualization has some deficiencies (as illustrated in Section 3.3.3) and remains partially reductionist.

To overcome these issues, some scholars advocate a dual and conjunctive approach encompassing knowledge as both an object and non object, and shifted the main focus to importance of knowledge flows. This is consistent with a more systemic approach of knowledge management focusing on the purpose of the system rather than its components (e.g. Nonaka and Takeuchi, 1995; McElroy, 1999, 2003; Snowden, 2002; Holsapple and Joshi, 2003). This latter perspective is one underlying this thesis. However, much dissension exists among the advocates of this perspective, as there is no common ontology or epistemology in the field. Furthermore, some scholars preferring the reified or non-reified views of knowledge do employ knowledge flows, as well as knowledge management activities, but with quite different interpretations. This is the topic of the next subsection.

4.2.2. Knowledge Activities in Knowledge Management Frameworks

Outside the debate concerning this term, it has to be acknowledged that even by following a systemic perspective, whether it is an object or a flow, knowledge needs somehow to be 'managed'. Table 4.2 provides an overview of the main activities of knowledge management frameworks found in the literature. Note that a small number of frameworks is not presented in this table as they will be presented in more detail in the next section.

Table 4.2: Summary of Knowledge Management Activities in the Literature

Author	Knowledge Management Activities
Holsapple and Whinston, 1987	1. Procure; 2. Organize; 3. Store; 4. Maintain; 5. Analyze; 6. Create; 7. Present; 8. Distribute; 9. Apply
Nonaka, 1994	SECI Cycle 1. Socialize (convert tacit knowledge to tacit knowledge) 2. Externalize (convert tacit knowledge to explicit knowledge) 3. Combine (convert explicit knowledge to explicit knowledge) 4. Internalize (convert explicit knowledge to tacit knowledge)
Leonard-Barton, 1995	1. Shared and creative problem solving 2. Importing and absorbing external technological knowledge 3. Experimenting, prototyping 4. Implementing and integrating new methodologies and tools
Wiig, 1995	Knowledge Evolution Cycle 1. Create knowledge (learn, innovate, research); 2. Capture and store knowledge; 3. Organize and transform knowledge; 4. Deploy; 5. Apply
Andersen and APOC, 1996	1. Share; 2. Create; 3. Identify; 4. Collect; 5. Adapt; 6. Organize; 7. Apply
Szulanski, 1996	1. Initiation (recognize knowledge needs and satisfy that need) 2. Implementation (knowledge transfer takes place) 3. Ramp-up (use the transferred knowledge) 4. Integration (internalize the knowledge)
Alavi, 1997	1. Acquisition (knowledge creation and content development); 2. Indexing; 3. Filtering; 4. Linking (involves screening, classification, cataloguing, integrating, and interconnecting internal and external sources); 5. Distributing (packaging and delivery of knowledge in the form of web pages); 6. Application (using knowledge)
Davenport and Prusak, 1997	1. Determine requirement, 2. Capture, 3. Distribute, 4. Use
van der Spek and Spijkervet, 1997	In the Act Process 1. Develop; 2. Distribute; 3. Combine; 4. Hold
Lai, 2000	1. Initiation, 2. Generation, 3. Modeling, 4. Repository, 5. Distribution and transfer, 6. Use, 7. Retrospect
Zollo and Winter, 2002	Knowledge Evolution Cycle 1. Generative variation (scanning, recombination); 2. Internal selection (evaluation, legitimization); 3. Replication (knowledge sharing and transfer, adaptive variation, problem solving); 4. Retention (enactment, routinization)
Holsapple and Joshi, 2003	Parts of a system of knowledge activities - Acquiring (identifying, capturing, organizing, and transferring from the environment) - Selecting (identifying, capturing, organizing, and transferring within the organization) - Internalizing (assessing, targeting, structuring, delivering) - Using, separated in two sub-categories: - Generating (monitoring, evaluating, producing, transferring) - Externalizing (targeting, producing, transferring)
Heisig, 2005	1. Apply; 2. Create; 3. Store; 4. Share (in a Cycle)

*: Based on, and extended from, Holsapple (2003)

A study by Heisig (2009), partially replicating and extending Holsapple and Joshi's (1999), after analyzing more than 160 knowledge management frameworks, identified that there were six main activities in all frameworks, which are (in order of frequency of occurrence): Use, identify, create, acquire, share, store. All six except 'acquire' were found to be discussed in the majority of the frameworks analyzed.

4.2.3. Critical Success Factors in Knowledge Management Frameworks

The knowledge management activities identified in the previous subsection are influenced by contextual factors, which can be understood as 'critical success factors,' a term suggested by Heisig (2009). Depending on the specific arrangement of the knowledge management system and its environment, these factors can both enable and obstruct knowledge management activities (see Bullinger and Prieto, 1998; Skyrme, 1999; Prange, 2002). Hence, critical success factors act as filters and influence the successful implementation of knowledge management. The literature has proposed many possible factors, as highlighted by Lai (2000) in Table 4.3.

Table 4.3: Identified Influences on Knowledge Management

Author	Factors
Leonard-Barton, 1995	Leadership, technology, education, reward and incentive systems, values and norms
Andersen and APQC, 1996	Culture, measurement, technology
Szulanski, 1996	Reward and incentive systems
van der Spek and Spijkervet,1997	Culture, leadership, measurement, technology, reward and incentive systems
Holsapple & Joshi, 1999	Culture, leadership, measurement, technology, reward and incentive systems, external factors

*: Adapted from Lai (2000)

More recently, while examining 160 knowledge management frameworks, Heisig (2009) identified four main categories of critical success factors in the literature: human-oriented factors (culture, people, leadership); organization (process and structure); technology (infrastructure and applications); and management process (strategy, goals, and measurement). Heisig also reported that a broad consensus existed over the fact that the one-sided emphasis on one of the factors did not constitute a holistic approach to knowledge management. Therefore, when related to the concepts introduced in Section 2.5, these factors have to be understood and managed as a whole in a satisfying way that allows for optimal effectiveness of the knowledge management system in relation to its objective(s) (as opposed to controlling these factors in order to optimize the efficiency of the system's output in comparison to a prediction).

4.2.4. Towards a Systemic Framework of Knowledge Management

Many scholars, including Holsapple and Joshi (1999), Rubenstein-Montano et al. (2001), and more recently Heisig (2009), have extensively analyzed the literature in a search for systems thinking based knowledge management frameworks. Rubenstein-Montano et al.'s (2001) conclusions were that most frameworks were not consistent with systems thinking because they were mostly prescriptive in nature and therefore centered on knowledge management tasks (ignoring the descriptive dimension); they overlooked the notion of double-loop learning (and hence the idea of feedback systems); there was a lack of cohesiveness across frameworks as there is no shared definition of what constitutes a knowledge management framework; and there were many frameworks sharing common concepts but without a common ordering or structure. Holsapple and Joshi (1999) found similar results when they stated that the dimension of knowledge resources had received little attention; that there was neither a common or standard way of characterizing knowledge activities or influences on the knowledge management system; and that no individual knowledge management framework subsumed the others.

Through his study, Heisig (2009) corroborated these earlier findings and found that more hybrid models had surfaced in the literature, hence moving towards a systemic perspective. However, he also noted that most of Holsapple and Joshi's (1999) conclusions remained valid. As discussed in Chapter 2, for a knowledge management framework to be consistent with systems thinking and complexity theory, it should consider the different active environments surrounding the system, the functions of the system, the transformations occurring within the system through time, and the purpose of the system. Referring to the findings made by Heisig and his predecessors, there is no framework of knowledge management that seems to integrate all necessary aspects of the knowledge management system. Furthermore, many frameworks lack crucial insights from complexity theory, such as feedback (as highlighted by Rubenstein-Montano et al., 2001), openness and recognition of the influence of the environment, or (last but not the least) the energy flows necessary for the functioning of this system. This last concept has been overlooked by all the frameworks found in the field.

As mentioned earlier, a small number of knowledge management frameworks was purposefully ignored up to this point, the reason being that they are based on complexity theory. Their analysis in the following section discusses whether they share the same deficiencies as the more traditional models reviewed in this section.

4.3. Towards Complexity Theory Based Knowledge Management Frameworks

Complexity theory suggests that innovation and creativity occur when systems operate at the "edge of chaos," where they show emergent behaviors that enhance their ability to adapt to a particular situation of their environment (Bak, 1996). Hence, complexity theory provides a framework to understand how knowledge forms at the level of individuals and then influences knowledge processing at the collective level of the organization. It also gives insights into how each agent of the organization is self-evolving with its own rules and its own knowledge processing system, and how it influences the evolution of the whole organization (McElroy, 2003). This section reviews the main knowledge management framework based on complexity theory in order to compare it with the traditional frameworks reviewed in Section 4.1. It should be noted that McElroy's is not the only knowledge management framework based on complexity theory, but it is thought to be the most promising one. In order to give some justice to other complexity scholars, a brief discussion of other complexity-based models is provided as a first subsection.

4.3.1. Still Lacking Energy…

It should be noted that comprehensive knowledge management frameworks based on complexity theory are rare. Many frameworks mention concepts similar to complexity theory while not explicitly stating if they belong to that category (e.g., Boisot's I-space, Senge's Deep Learning Cycle). Others have such complicated models that they remain fairly confusing for the reader (e.g., Williams, 2008), or compile excellent ideas but fall short of articulating an integrated model (e.g., Benet and Benet, 2004).

The most recognized complexity-based framework in knowledge management is probably the Cynefin Model developed by Snowden (2002). This framework rejects the tacit-explicit conversion of Nonaka and others, as well as the fact that the term knowledge management may be an oxymoron. Snowden suggests that all this can be achieved by embracing the paradoxical nature of knowledge as both a thing and a flow. This implies adopting the four 'spaces' of the Cynefin model (known, knowable, complex, and chaotic) and its spiral of knowledge flows. Refreshing in its simple conception, the model introduces valid points about self-organization of social systems and natural flows of knowledge. However, while this model is based on complexity theory and attempts to model the underlying sense-making process supporting knowledge creation, disruption, and utilization, it has been criticized by many for its

lack of clarity and several inconsistencies (see Firestone and McElroy, 2003). Apart from the fact that this model has several conceptual flaws (e.g., confusing utilization of language regarding knowledge as a flow, questionable use of leadership types), it is mostly too narrow a model to encompass all the knowledge management activities it claims to do. Although complex systems are incompressible and to model them is self-defeating in many ways (see Chapter 2), this should not imply that they need to be minimalist either.

Fortunately, the complexity-based part of the field of knowledge management is growing rapidly, with many new publications appearing in journals such as *Emergence* and its affiliated publishing organization. However, looking at the literature, the same conclusion as in Section 4.2 can be drawn: Aside from their other deficiencies, and similar to the traditional frameworks, none of them incorporate the concept of energy, which with respect to system theory is a major flaw. This point will be further discussed in Subsection 4.3.3, following the next subsection's discussion of the most promising complexity-based knowledge management framework found in the literature.

4.3.2. The Knowledge Life Cycle

The Knowledge Life Cycle (KLC) framework is the outcome of a collective effort of the Knowledge Management Consortium International (KMCI), coordinated by McElroy and Firestone. The KLC, as presented by McElroy (2003; see Figure 4.1), depicts the organizational knowledge processing environment from a complexity-based perspective.

McElroy suggests that people engage in learning activities when they experience a need to fulfill desired outcomes that they can not reach with their current knowledge. Hence, people identify gaps and engage in learning activities that eventually lead to knowledge claims (conjectures, assertions, arguments, or theories) in order to close these gaps. However, during the process of formulating knowledge claims, people are interacting with each other. McElroy suggests that they form groups sharing the same ideas, and discuss, compare, and evaluate those ideas. These processes of knowledge claim, formulation, and evaluation are what McElroy describes as 'knowledge production' in the KLC. After being evaluated, knowledge claims fall into three categories: survival claims, undecided claims, and falsified claims. Outputs from the evaluation process will eventually be recorded as metaclaims (claims about knowledge claims).

Figure 4.1: The Knowledge Life Cycle
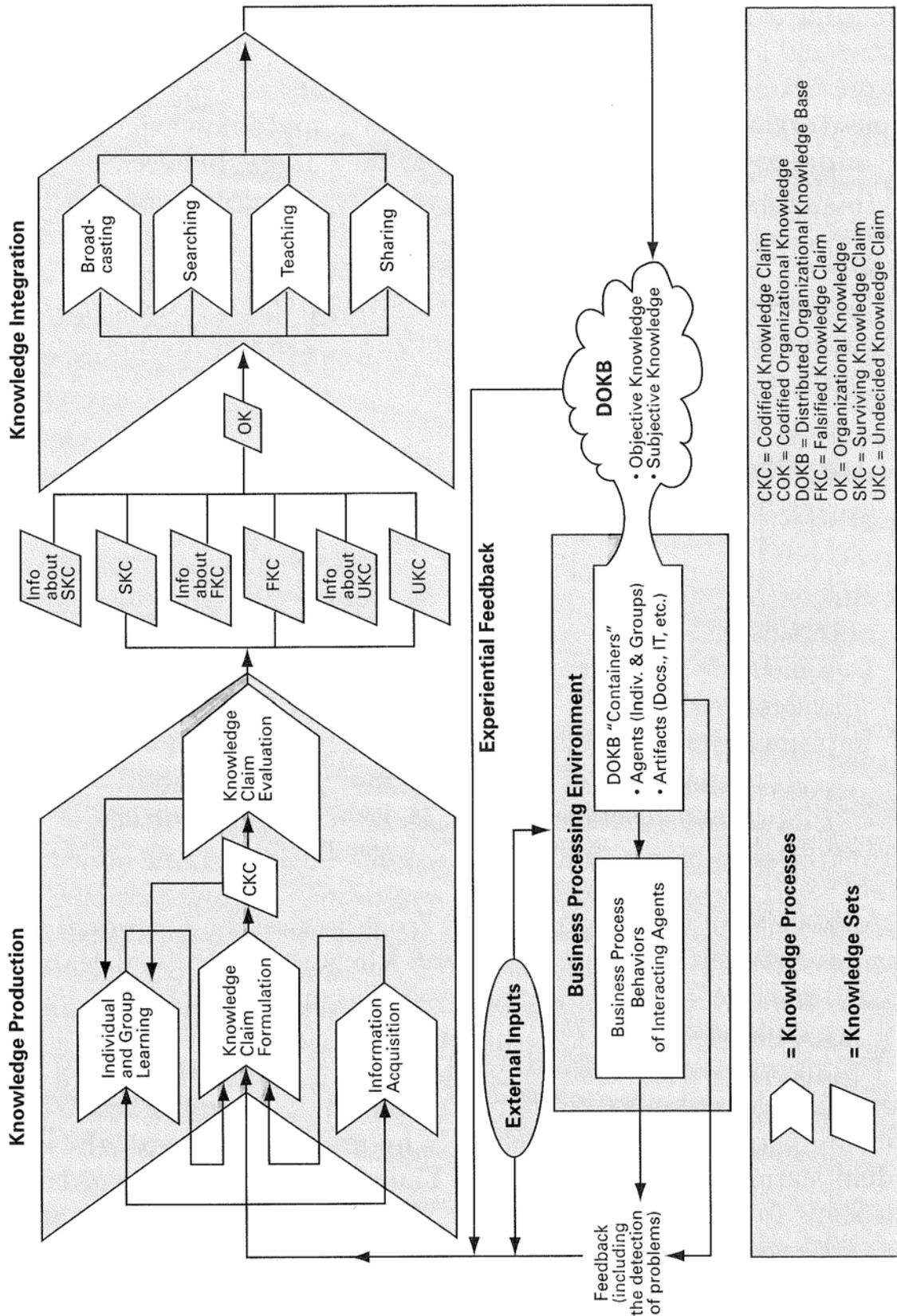
Because knowledge claims can be evaluated at different levels of the organization, knowledge claims may eventually be integrated within the Distributed Organizational

Knowledge Base to facilitate sharing. This is what McElroy describes as the 'knowledge integration' process. Knowledge production and knowledge integration (the knowledge processing activities) are followed by knowledge use, which occurs within the context of business processing, and completes the cycle; the detection of new knowledge gaps will lead to a new cycle.

In the context of the KLC, successfully integrated knowledge is of two forms: subjective and objective. Subjective forms of knowledge can be seen as "beliefs or belief predisposition held in the minds of the agents (individuals, teams, groups, communities, departments, divisions, etc.)"(McElroy, 2003, p. 8). Objective forms of knowledge are "linguistic expressions and/or encodings in speech or in objects, such as files, documents, computer systems, microfilms, disks, videos, tapes, books, articles, papers, essays, lectures, music, other work of art, and so on" (McElroy, 2003, p. 8-9). The combination of these objective and subjective forms of knowledge creates the Distributed Organizational Knowledge Base.

As its name indicates, the KLC is a cycle; it has a starting point (i.e., knowledge gap detection) and a finishing point (i.e., choice of newly validated knowledge). It is also a feedback system, as it shows several feedback loops within the model processes, as well as among them (see Figure 4.1). There is a distinction between the knowledge processing environment where knowledge is produced and integrated into the organization, and the business processing environment where the knowledge is used (McElroy, 2003). Agents operate in both environments, but not at the same time. McElroy suggests that the knowledge integration process of the KLC represents the supply side of knowledge management, whereas the production process of the KLC corresponds to the demand side of knowledge management. These two sides are linked by the experimental feedback that McElroy refers to as knowledge use.

According to McElroy (2003), the KLC is a systems-thinking representation of learning occurrence in social systems. Organizational agents can also encounter KLC in their personal lives. McElroy (2003) suggests that there are three levels of learning in an organization: the top-level organization, subgroups within the organization, and individuals. This implies that the individual and group learning sub processes in the KLC contain lower-level KLCs. Furthermore, each knowledge level has its own KLC, and outcomes vary among them because validation criteria may differ from one KLC to another. As suggested by McElroy (2003), KLCs are fractals.

In the KLC model, McElroy also suggests that knowledge differs from information because of metaclaims. Metaclaims are used to provide insight about the value, performance history, or veracity of the information or knowledge claims made within the knowledge processing system. Without enough metaclaims, a knowledge processing system is more like an information processing system that deals with information management rather than knowledge management (McElroy, 2003).

Although the KLC framework is based on complexity theory and addresses many issues that traditional models fail to integrate, it still exhibits several deficiencies. First, while the use made by McElroy of the cycle metaphor is interesting, it is also problematic. Indeed, it implies a starting point and an ending point, with clear temporal separations among processes (although some knowledge processes may occur simultaneously). This issue may arise from the KLC model's perspective of knowledge, as described in Subsection 4.3.1.

Second, although McElroy distinguishes between knowledge processing and business processing while describing the model, he contradicts this view several times in his book (e.g. pp. 11 and 189) and then associates the knowledge processing system with the whole KLC framework, differentiating it from the business processes. Therefore, it seems more appropriate to consider the KLC as a knowledge processing system. Indeed, it is arguable that knowledge is not being processed while being used, at least in a tacit/implicit way.

Finally, and this is probably the most important shortcoming, the KLC framework (like many other self-claimed systemic models) ignores the energetic aspect of systems (i.e., how is the activity of the KLC energized?). Although the KLC framework is based on complexity theory, and proves to be one of the, if not 'the', best complexity-based attempts to create an integrative framework of the knowledge management process, it still lacks many insights from its conceptual groundings.

4.3.3. The Need for an Integrative Framework

In some ways, knowledge management seems to be still in its infancy. Whether or not it is currently in a second or even third stage of evolution, and although its foundations go back as far as the ancient Greeks, it is still a young academic field in search of its general paradigm. Nonaka, Holsapple, Koenig, Heisig, Snowden, Stacey, and McElroy, among others, have all provided great improvements and fruitful iterations, and their

work shows that the field lacks a common integrative approach. It is uncertain that the field is ready to mature through a comprehensive integration as argued by some advocating their own revolution (McElroy and Snowden being the two most obvious examples). Because it seems that the current state of knowledge management shows the need for such an integration to overcome the risks of becoming a fad, it warrants further enquiry. Knowledge management has been harmed by a strong focus on information technology, and seems in a state of profound confusion. Even some of the founding fathers such as Drucker and Zeleny have shown some signs of disillusionment about knowledge management in general (Kontzer, 2001; Zeleny, 2006).

However, the situation may not be as desperate as it seems. McElroy has indeed provided an interesting grounding transition with the concept of knowledge processing. The use of complexity theory seems to open promising avenues to discover answers to what is still required for an integrative theory of knowledge management. Western management has traditionally viewed organizations as highly structured and passive information processing machines, gathering information from their environments, employing it in order to resolve existing problems (Nonaka et al., 2001). This is a view of the organization that ignores the underlying dynamism of knowledge creation processes. Instead, an organization should be seen as a venue (Nonaka et al., 2001) or a field (Bourdieu, 1977) that facilitates interactions among the members of the organization. Guided by the rules specific to the given field, the role of an organization's members is to identify and analyze problems, in essence to apply existing knowledge of patterns of movement in an ever-changing, complex environment. This process results in the development and application of new knowledge.

As argued by McElroy (2003), knowledge management is not so much about managing knowledge but about managing knowledge processes. Therefore, the focus of knowledge management should be on studying the knowledge processing system, defined as the system of social processes through which knowledge is created, diffused, and utilized within a human organization. In order to understand an organization's knowledge management capabilities, it is therefore more important to appreciate the dynamics of its KPS than to ascertain the depths and/or scope of its existing knowledge base.

Chapter 2 outlined the requirements for the conceptualization of models of social complex adaptive systems (of which the knowledge processing system is an example). Reviewing the literature, it has been found that these principles are not commonly

followed, and that one of the most basic and crucial aspects of systems theory is missing from the current knowledge management frameworks: the concept of energy. Social energy, as presented in Chapter 2, should therefore become a central part of a new knowledge management framework.

However, before attempting such a conception, the state of the field of knowledge management needs to be examined more closely. The next chapter provides a Delphi study grouping many of the central authors mentioned in this literature review, and may answer some of the questions raised in this one.

4.4. Chapter Summary

Although it originated from developments in philosophy, cognitive science, and systems theory, the field of knowledge management has been diverted from its original course to a reductionist approach by the rapid expansion of information technology, particularly artificial intelligence and experts systems, to which it has been strongly associated. This heavy focus on the 'information' side of the discipline has led to a situation in which the social aspect of knowledge management had been overlooked. While the review of the literature illustrates how this has been partially corrected, it has left the field in a state of confusion about what is knowledge management. Many scholars have attempted to create systemic frameworks of knowledge management using systems thinking and complexity theory. However, a review of the existing literature shows that a better understanding of the concept of a knowledge processing system is needed, and that all current frameworks lack a sufficient integrative approach. The main shortcoming to date is the fact that all frameworks have ignored the energetic aspect of the knowledge processing system.

The main consequence is a crucial lack of integration and a proliferation of models without a common focus or thorough systemic approach. This situation warrants further investigation to determine the extent of the damage and what avenues could lead to viable solutions. A need for a more comprehensive knowledge management framework has therefore been identified, and this shall be addressed in Chapter 6. Preceding that, a Delphi study will provide further insights into the state of the field of knowledge management. This may, or may not, provide some answers as to what the field is currently aiming at achieving, and whether or not any consensus can occur that could facilitate reaching a more integrated state.

Chapter 5. The Current State of Knowledge Management

This chapter describes the implementation of a Delphi study, the aim of which was to help answer questions raised in previous chapters, examine constructs related to knowledge management, and uncover possible avenues to reach a better integration of the field. Chapters 3 and 4 have raised a number of questions concerning the scope of knowledge management, the definition and integration of some of the constructs within the field, and the practical applicability of some concepts to real organizational settings. Consequently, it was decided to gather empirical evidence on some of these issues from leading writers in the field, and this chapter reviews their opinion about the underlying understanding of knowledge management, the basic ability to manage knowledge, and how the different constructs within the traditional knowledge hierarchy might be integrated. Combined with findings from Chapters 3 and 4, the Delphi study proposed in this chapter will provide a comprehensive picture of the current state of knowledge management.

The Delphi method offers a possible way of reaching consensus around clusters of ideas, potentially providing insights into some integrative solutions for the field of knowledge management. As suggested by Linstone and Turoff (1975, p. 4), Delphi studies are useful when "the problem does not lend itself to precise analytical techniques but can benefit from subjective judgments on a collective basis." Paraphrasing Czinkota and Ronkainen's justification for their recent use of the Delphi method to examine globalization, it is believed that the study of knowledge management remains heavily dependent on the in-depth thoughts, evaluation, vision, and imagination of experts in the field – both practitioners and academics. Their informed consensus is more likely to indicate future directions than the opinions of many uninformed survey participants (1997, p. 842, and 2005, p. 122).

The individuals selected for invitation to this Delphi study were all experts in fields relevant to the concept of knowledge, identified through their publications in top refereed journals in the field of knowledge management in the last five years. The study was conducted in three rounds during November and December 2007, retaining 35 experts in the final round.

This chapter includes five sections.

- Section 1 discusses the Delphi method, its origins, and its field of application. The traditional advantages of conducting a Delphi study, as well as common shortcomings of this method, are also briefly examined.

- Section 2 outlines the application made of the Delphi study to assess the current state of the field of knowledge management, and provides some information about the panel of experts used during this study.

- Section 3 presents the results of this Delphi study, and highlights the different themes that emerged during the course of this research. Relevant results and analysis are discussed.

- Section 4 discusses the main results of this Delphi study, and gives some implications for the reconceptualization of knowledge management. Limitations and area of further research are also addressed.

- Section 5 is a summary of this chapter, and provides the relevant background for the next chapter on the reconceptualization of knowledge management.

5.1. The Delphi Method

This section introduces the Delphi method, beginning with its historical origins and discussing its principal features and research utility. The various fields in which it has been applied are also briefly overviewed. The section concludes with a summary of the principal advantages and disadvantages of conducting a Delphi study.

5.1.1. History, Features, and Applications

In ancient Greece, Delphi was the site of the most important oracle, at the temple of Apollo on the slopes of Parnassus. This oracle was famous for its ability to forecast the future (as well as being somewhat cryptic in its prognostications). In the modern academic arena, 'Delphi method' is the designation given to a research and decision support method named after this mystical oracle. Although the first Delphi study was run in 1948 in the United States in the context of defense research at the Rand Corporation (Gupta and Clarke, 1996), the method only became known after a publication mentioned it in 1963. In that study, Dalkey and Helmer (1963) sought a method to obtain a reliable consensus about the opinions of various defense experts on the effects of a possible major nuclear attack.

The Delphi method was developed as a qualitative, long-range forecasting technique that elicits, refines, and draws upon the collective opinion and expertise of a panel of experts (van Zolingen and Klaassen, 2003). It is a group technique aimed at obtaining the most reliable consensus of opinion from a sample of experts by using a series of intensive questionnaires within a controlled feedback process (Dalkey and Helmer, 1963). As argued by Landeta (2006), building on Linstone and Turoff (1975), later development of the technique eliminated the need to achieve consensus. It is now accepted that its application can go beyond forecasting and it is operationalized as a method of structuring communication among experts grouped in a panel which can provide valuable contributions in order to resolve a complex problem (Linstone and Turoff, 1975). Furthermore, the Delphi method is flexible, and (reputedly) simple to execute. It provides a convenient solution to manage a group of experts spread around the world working in different time zones without the problem of trying to arrange for direct interactions (Landeta, 2006).

The Delphi method amounts to gathering experts' judgments through successive iterations (rounds) of a questionnaire. The experts interact indirectly through the questionnaire; the results can be used to show convergence of opinions and/or to identify non convergence. The Delphi method is particularly useful for long-range forecasting studies (20-30 years) as expert opinions are then the main source of information available (van Zolingen and Klaassen, 2003). The Delphi method can also be applied if the individuals having to exchange views cannot be brought together due to lack of time or money (Linstone and Turoff, 1975).

Landeta (2006) continued research initiated by Gupta and Clarke (1996), showing the use of the Delphi method from 1965 through 2004 (see Figure 5.1). The results show that academic interest surged in the early 1980s, and has remained fairly stable ever since, with an average of approximately 60 dissertations and theses annually over the past 2.5 decades. This implies that after the effect of fashion or novelty had been overcome, the Delphi technique became accepted by the scientific community as a valid research technique (Landeta, 2006). Overall, the results obtained by Landeta show that the use of the Delphi technique is well established in academia, with increasing quantities of articles published in disparate fields (p. 470).

Figure 5.1: Number of Delphi Dissertations and Theses from 1965 to 2004 (derived from Landeta, 2006, p. 471)
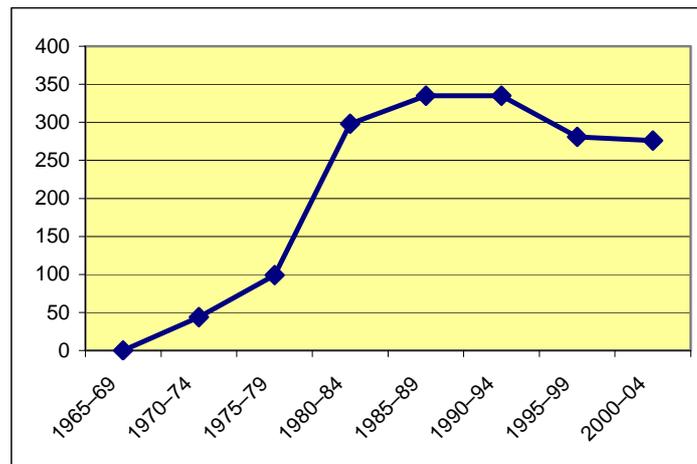
Although the Delphi method was originally applied by the Rand Corporation for military forecasting purposes, it has been used in many other areas since then, such as national planning (Helmer and Quade, 1963), world trend forecasting (Gordon and Helmer, 1964), and sales (Basu and Schroeder, 1977). In a review of 463 papers using the Delphi method over the years 1975 to 1994, Gupta and Clarke (1996) report a very broad application of the Delphi method in business, education, health care, real estate, engineering, environment, social science, tourism, and transportations. As mentioned by Czinkota and Ronkainen (2005), the method has also been applied to the fields of library and information science and communications studies. Other Delphi studies have been conducted in tourism, product management, and organizational policy (Landeta, 2006), education studies (van Zolingen and Klaassen, 2003), e-commerce (Addison, 2003), internet banking (Bradley and Stewart, 2003), international business (Czinkota and Ronkainen, 2005), and – more closely related to our topic – knowledge management (Scholl, Lönig, Meyer, and Heisig, 2004).

5.1.2. Types of Delphi

There are four main types of Delphi techniques recognized widely in the literature: classical Delphi (used for forecasting), policy Delphi (used for policy development), decision Delphi (used for decision-making), and hybrid Delphi (using any mix of the three preceding types). It has been traditionally conducted by mail, but is increasingly being administered via electronic communication, which allows for shorter time

between rounds (Mitchell, 1991; Zipfinger, 2007) as well as lessening the work of the researcher.

The Delphi method is usually round-based, mostly due to the fact that data needs to be analyzed and feedback prepared for the next round; however, new types of computer-aided Delphi allow for round-less Delphi, such as the one conducted by Gordon and Pease (2006). Panelists are then confronted to real-time feedback, which can be problematic as they may not receive the same data. A more detailed comparison of different Delphi approaches is provided by Rauch (1991), van Zolingen (2003), and Zipfinger (2007). Table 5.1 provides a comparative summary of these three approaches.

Table 5.1: Comparisons of Classical, Policy, and Decision Delphi

	Classical Delphi	**Policy Delphi**	**Decision Delphi**
The context is that…	reality is given; its interpretation is clear; and consequences are discussed	reality is given; its interpretation will be discussed	reality will be created
The aim is to…	produce forecasts	produce policies	produce decisions
The aim is achieved by…	creating a consensus	defining and differentiating views	preparing and supporting decisions
The procedure focuses on…	Facts	ideas and concepts	decisions
The panelists are…	unbiased experts	lobbyists	decision makers
The panelists try to…	obtain realistic statements and prognoses	support and succeed in their standpoints	create a basis for realistic and useful decisions
The participation has to…	be high in absolute terms (i.e., many experts)	consider all relevant groupings	cover a high percentage of the relevant decision makers
The researcher tries to…	arrive at a stability among responses	structure conflicts	arrive at a stability among decisions
The feedback serves for…	obtaining the realistic answer or prognosis	getting well defined group opinions	stimulating and informing the decision makers
Anonymity means that…	the participants in the panel are not known and all answers are anonymous		the participants are known at the start, but answers are anonymous
The reason for the anonymity is to…	hinder arrangements and personal influences	facilitate extreme viewpoints and objectivity	support personal answers and raise the participation
The strict objectivity of the evaluation has…	Mainly methodological reasons (to be unbiased)	mainly pragmatically reasons (to get a complete picture)	mainly ethical reasons (the director of the study must not influence the decision process)

*: adapted from Rauch (1991) and Zipfinger (2007)

Other types of Delphi can be found in the literature, including EFTE Delphi (Estimate, Feedback, Talk, Estimate; see Nelms and Porte, 1985), which allows for group discussions in between rounds, and conversational Delphi, which replaces questionnaires with interviews (see Mitchell, 1991). It has also been proposed that interviews be conducted before the first round in order to improve the first questionnaire (Hill and Fowles, 1975; Mitchell, 1991). These modifications of the Delphi technique introduce a face-to-face component. Although this can bring more information and ensure a better understanding of the questions at hand, it can be seen as a trade-off as it becomes more time-consuming (and may therefore become expensive). A face-to-face activity is also problematic when dealing with experts scattered around the globe, and depending on the nature of the study, and the experts in consideration, it may also be impossible to get them to agree to meet face to face (Mitchell, 1991).

5.1.3. Description of the Method

There are several features of the Delphi method that are commonly agreed in the literature (Dalkey, 1969; Linstone and Turoff, 1975; Gupta and Clarke, 1996; van Zolingen and Klaassen, 2003; Landeta, 2006). Combining features suggested in the literature with generally accepted assumptions and the researcher's experience, the characteristics of the Delphi method can be summarized as follows:

1.   It is an *expert-based* process: The participants of the Delphi are experts or key people in the relevant areas considered by the study.

2.   It is a *managed* process: One or several process managers select participants, address them, receive and consolidate responses, provide feedback, and produce a final summary document. The process manager is usually assisted by a research team to ensure efficiency of the analysis. This process may be facilitated by technology, e.g. email, statistical software, artificial intelligence analysis, etc.

3.   It is an *anonymous* process: All individual answers are anonymized. Panelists are usually anonymous, although some types of Delphi allow for non-anonymous participation while ensuring anonymous feedback.

4.   It is an *indirect interactive* process. There is no direct interaction among the panelists; all interchanges are managed by the process managers. The process manager is responsible for ensuring continuing interaction with the experts. (One variant, the decision Delphi method, involves direct discussions among participants between rounds.)

5.   It is an *iterative* process: There are several iterations – usually 2 to 4 – during which panelists are consulted on the same set of questions, which may evolve through refinement or extension. Panelists are invited to reconsider their answers based on feedback from other respondents.

6.   It is a *controlled feedback* process: The information exchanged among the experts is gathered, analyzed, and dispatched through standardized questionnaires by the process manager. This allows for deletion of any irrelevant information as well as avoiding potential negative influences from psychological effects that could occur in direct confrontations.

7.   It is an *aggregative* process: All the opinions of the experts are taken into consideration and will be incorporated into the final outcome (although some may be invisible or subordinated). Delphi studies generally facilitate quantitative and statistical analysis.

8.   It is a *potentially asynchronous* process: Because responses go directly to the process manager, who sends the next questionnaire with feedback to each participant, the panel of experts does not need to share the same geographic location or time schedule. (The real-time Delphi method requires synchronicity.)

5.1.4. Limitations in the Use of the Delphi Method

There are several issues that need careful attention before conducting a Delphi study on a specific topic. Linstone and Turoff (1975) identified eight pitfalls for the Delphi method. Apart from issues such as the applicability of the method to a specific problem, and the design and administration of the questionnaire, the implementation of a Delphi study also requires careful selection of the respondents and their expertise. Many authors have raised issues related to the selection of experts such as their origin, their individual bias, or the reason for them to be considered experts (Gordon and Helmer, 1964; Sackman, 1974; Linstone, 1975; van Zolingen and Klaassen, 2003).

A further issue when carrying out a Delphi study is the lack of incentive for the panelists. A researcher should always ask himself: What's in it for the experts? They have to be self-motivated, and the effort required on their part to respond to the questionnaires needs to be taken into account. Experts may be interested in the outcome of the study, and assuring them of access to the findings is considered a possible solution. Another important issue is the time necessary to carry out the study (Gordon

and Helmer, 1964; Huckfeldt and Judd, 1974). Designing the first questionnaire is a fairly simple task, but analyzing and designing the feedback and following questionnaires so that the study remains appealing to the experts is time-consuming. This can put a lot of pressure on the research team that wants to maintain a short time frame for the study in order to keep the attention of the panelists.

The most criticized aspect of the Delphi method is probably the validity and reliability of its application. Sackman (1974) argued that the Delphi technique was not based on traditional scientific methods, and was so inherently misleading that there was no possible way to improve it. He suggested that the Delphi method should be abandoned completely. Fortunately, as suggested by Rowe (1999), the solution to these issues could be to more precisely define the Delphi method, in order to inhibit misuse of the technique. The potential validity of the Delphi method is perhaps best illustrated by Linstone and Turoff (1975, p. 570): "The strength of Delphi is, therefore, the ability to make explicit the limitations on the particular design and its application. The Delphi designer who understands the philosophy of his approach and the resulting boundaries of validity is engaged in the practice of a potent communication process. The designer who applies the technique without this insight or without clarifying these boundaries for the clients or observers is engaged in the practice of mythology."

In spite of its apparent weaknesses, the Delphi method, if used in the proper context and in the right format, results in a better decision process than do consensus groups, nominal group technique, and interacting groups (Van de Ven and Delbecq, 1974; Erffmeyer and Lane, 1984; Landeta, 2006), while producing decisions of greater quality than ones made through consensus groups and interacting groups (Dalkey, 1968, 1969; Erffmeyer and Lane, 1984). Most classical Delphi studies aim at forecasting, and therefore require calculations and estimates from the experts, these being subsequently used to assess the validity and reliability of the method. Policy and decision-making Delphi are more qualitative in nature, and do not suffer from this. Indeed, the Delphi method is particularly useful when applied to complex problems requiring more judgment analysis (Kaynak, Bloom, and Leibold, 1994; Mitchell and McGoldrick, 1994). It has also been suggested that it is relevant for assessing industries in rapid change (Jilson, 1979), which is extended here to include the field of knowledge management.

In the context of this thesis, the issues mentioned above relating to validity and reliability are irrelevant as the method has not been used with a quantitative purpose as it would be inconsistent with the epistemological stance introduced in Chapters 1 and 2. The next section illustrates this point further.

5.2. Assessing the Current State of Knowledge Management

This Delphi study was conducted in three rounds with feedback to participants after each round. It aimed to examine the consensus among knowledge management experts on definitions of constructs related to the concept of knowledge, gather information on how these constructs relate to each other, and how they integrate knowledge management theories. The Delphi technique used is a hybrid of policy and classical approaches, with minor adaptations that allow for consensus mapping and theory building. This study focused on the tensions and patterns that arose within the panel, and very little forecasting was asked of the experts. In essence, this method was used to assess the conclusions based on the literature review raised in Chapters 3 and 4, and explore avenues to build more robust theoretical foundations for the field of knowledge management.

5.2.1. Methodology

The individuals selected for this Delphi study were all experts in fields relevant to the concept of knowledge, chosen on the basis of their publications in knowledge management journals. These were primarily in the *Journal of Knowledge Management*, which is regarded as the premier outlet in the field, or management journals featuring relevant articles (e.g. *Organization Studies)*. Some currently well-known and respected book authors, who had published in highly-ranked journals in the past, were also selected. One question in the first questionnaire also proposed self-nominations from the experts. This 'snowball' effect helped to identify several other experts, and invitations were extended to some of them, after it had been verified that they qualified as experts.

Familiarity with the terminology was therefore expected, although with different interpretations and orientations due to the diverse backgrounds of the invitees. At all stages of the Delphi, the experts were invited to comment on any aspect of the questionnaire, terminology, or approach, anywhere within the questionnaire document or in a separate email. Addressing the issue of self-motivation, it had been assumed that

due to the current vibrant state of the field of knowledge management, experts would be interested in participating in a study researching its evolution. This was later confirmed by the results and feedback received from questions about the present application of the method (see Questions Q3.10a/b).

To facilitate collection of responses as well as transmission by email, all documents (questionnaires and feedback) were prepared as Microsoft Word (version 2003) document files. Formatting was kept to a minimum; fields were not used, to permit the experts to add comments anywhere they chose. Feedback from the first and second rounds was included in the questionnaires sent to the panelists in the subsequent round, highlighted with a vertical line at the left edge (single for Round 1 feedback, double for Round 2 feedback); new questions were formatted in bold in order for them to stand out. In some cases, feedback on a previously-asked question was provided, and experts were requested to respond to the same question again, as their opinion could have changed or been influenced by the feedback. This is a fundamental aspect of the Delphi process. In other cases, feedback was given on a question to serve as the basis for a new question. In all cases, experts could revise their previous answers if they wished to do so (but none did). In the third round, some feedback did not lead to new questions, either because consensus had been reached or because going further would have taken the research away from the objectives of this particular Delphi project. However, comments were still welcome. For logistics reasons, previous personal answers were not included in the questionnaires. It was assumed that panelists would retain a copy of previous rounds, but they were offered a copy of their previous answers by email if desired.

Instead of focusing only on building consensus, the study purposely challenged traditional views and put classical models to test, including answers from both outliers and consensus into the feedback given to the experts. Extensive quantitative and qualitative feedback was provided, including frequency data with distributions and ranges as well as subjective observations about the process and the focal content of the study. Original questionnaires and feedback can be found in Appendices 1 (first round questionnaire), 2 and 3 (second and third round questionnaires, incorporating feedback from the first and second rounds, respectively), and 4 (final feedback, following the third round). Table 5.2 provides a summary of the questions asked and how they evolved through the three rounds of this Delphi study. For formatting reasons, the wording of the questions in Table 5.2 has been amended (the full original wording is on display in Appendices 2-4). This table highlights the general aspect of the question

asked in the first round, and shows how this led to an expansion of the number of questions in rounds two and three. It also indicates which questions disappeared from the questionnaire after the second round feedback.

Prior to the administration of this Delphi study, a pilot version of the first round questionnaire was tested on six academic staff at the University of Otago. These pilot respondents were not 'experts' in knowledge management per se (although most had a solid theoretical understanding of it). However, they helped develop a feel for what kind of answers would come back from the first round questionnaire, as well as providing some feedback on the time required to fill in the questionnaire, and how to refine it. Due to the time-consuming nature of the Delphi method, and the fact the pilot respondents could not qualify as experts, the pilot incorporated neither feedback nor a second questionnaire, and all pilot responses were consequently discarded from further analysis.

In a Delphi study, the number of rounds should be kept to a minimum to prevent fatigue and reduce time pressure on the experts (Mitchell, 1991). Most Delphi studies result in a consensus after two rounds (Dodge and Clark, 1977; Erffmeyer, Erffmeyer, and Lane, 1986; van Zolingen, 2003). Due to the present adaptation of the method to map consensus, this research consisted of three rounds. This allowed minimizing the number of rounds, while still being able to map any consensus from questions that would emerge from the answers of the first questionnaire (and would therefore have to be asked during the second round).

Table 5.2: Delphi Question Summary

Topic	Q	Round 1	Q	Round 2	Q	Round 3
Managing knowledge	1.	Is it possible to manage knowledge?	1a.	Do you agree that it is sometimes possible to manage knowledge?	1a.	Can tacit knowledge be managed?
			1b.	Under what kind of conditions is it possible to manage knowledge?	1b.	If yes, under what conditions?
			1c.	What is the purpose of KM[2]?	1c.	Who should be "managing" knowledge at the organizational level?
The knowledge pyramid	2.	Is the "knowledge pyramid" the standard view of the concept of knowledge in KM?	2a.	What are the main flaws of the knowledge pyramid?		
			2b.	About 5% mentioned that the pyramid did not represent the concept of knowledge. Do you agree, and why?		
Other models of knowledge	3a.	Do you know of any other models/ representations of knowledge?	3a.	What are the main contributions of the SECI[3] model? What are its main flaws?	3a.	What do you see as the relationship between "tacit" and "explicit" knowledge?
	3b.	Which model is your preferred representation of knowledge? Why?	3b.	Position the models on the provided timeline.	3b.	Do you see complexity theory as the common denominator of these rising models, or is there some other reason or shared factor?
			3c.	Comment about the contributions and/or flaws of any of the models listed.	3c.	Do you believe complexity theory is just the next fad, or will it provide an enduring foundation for a better understanding of knowledge?
			3d.	Should a distinction be made between the understanding of "knowledge" in academia and that in business practice? Why?	3d.	The panel believed that no distinction was to be made by a factor of almost 3 to 1. However, most also noted that such a gap does exist. What can be done to reduce this gap?
Influences	4.	What, or who, has most influenced your thinking about the concept of knowledge?	4a.	What are your main comments and/or criticisms about this result?	4a.	Would you like to make any further observations about these results?

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[2] KM: Knowledge Management
[3] SECI: Socialization Externalization Combination Internalization model (Nonaka and Takeuchi, 1995)

Need for new models	5.	Do we need new models or representations of knowledge?	5a.	Why is there some dissatisfaction with the state of research in KM, and its application to practice?	5a.	Do you agree that KM will need to reach the stage of a new paradigm (using a pluralistic and integrative approach) to make real progress in terms of applicability (bridging the gap between theories and practice)?
			5b.	Should KM be unified by creating models or frameworks acceptable to both academics and practitioners?		
			5c.	What should be the main characteristics of a model of the concept of knowledge?	5b.	What should be the main characteristics of a model of knowledge processing?
Definitions of DIKW[4]	6.	Define: data, information, knowledge, and wisdom.	6a.	Do you agree that these definitions indicate a hierarchy?	6a.	Do you agree with the need for a major reconceptualization of the discipline?
			6b.	If this is a hierarchy, is it complete?		
			6c.	What connects these definitions?	6b.	Is 'understanding' the connecting factor among data, information, knowledge, and wisdom?
Constructs related to knowledge	7.	Rank the association among constructs (table).	7a.	What patterns can you identify in the table of constructs?	7a.	Do you sense any clusters within the ranked table?
			7b.	What patterns can you identify in the table of differences between constructs?		
			7c.	Any comment on any associations described?		
			7d.	Rank the association among new constructs.		
Experts' interests	8.	What is your main field of research interest?	8a.	Indicate the degree of relationship between selected fields and KM (table).	8a.	Do you agree that KM is mainly about organizational learning, intellectual capital, and innovation management?
Experts' readings	9.				9a.	Have you read any of the works of the following philosophers?
					9b.	Have you read Polanyi's "The Tacit Dimension"?
					9c.	Have you read Nonaka & Takeuchi's "The Knowledge-Creating Company"?
The Delphi method	10.				10a.	What are your thoughts on the Delphi method?
					10b.	Any comments about our use of the Delphi method?

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[4] DIKW: Data Information Knowledge Wisdom, often seen as a continuum.

5.2.2. The Panel of Experts

The study was conducted in three rounds during November and December 2007, retaining 35 experts in the final round. Initially, invitations were sent to 353 experts in six batches of emails. This was partially due to the 'snowball' approach, but also for technical convenience, as 62 erroneous email addresses were encountered. Several trials were sometimes necessary to identify the right email address of a particular expert (58 experts had to be re-emailed, and 4 experts had to be re-emailed twice). Eventually, 27 email addresses were not correctly identified, and these experts were not reached. The first questionnaire received 88 responses, which led to 64 completed questionnaires in the first round. The difference is mostly due to experts agreeing to respond, but failing to do so in time (2), or to experts rejecting the offer due to lack of available time (22). The second round questionnaire received 47 responses, and 45 questionnaires were completed. The third round obtained 37 responses and 35 completed questionnaires. Figure 5.2 shows a summary of these results.
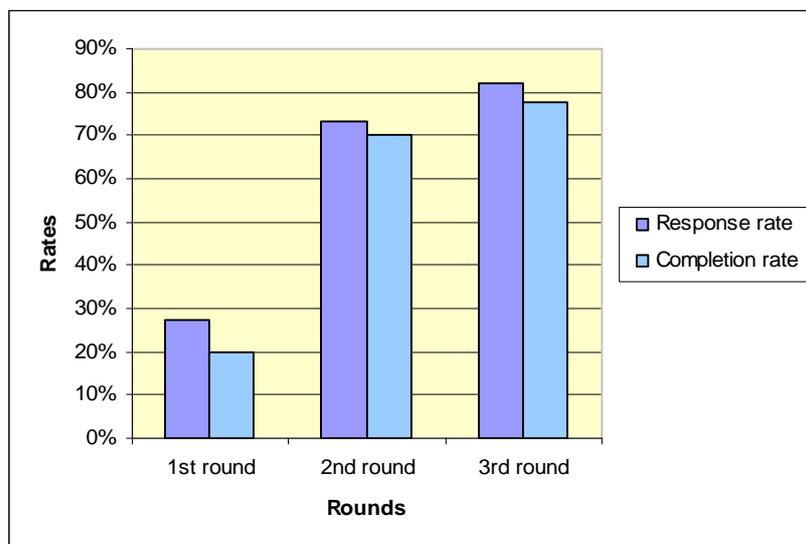
Figure 5.2: Relative Response Rates

Response rates shown in Figure 5.1 are relative to each round. The overall completion rate was equal to 10.7% (comparing the final panel to the initial selection), with a retention rate of 54.7% (or drop rate of 45.3%) to the end of the study. These results are consistent with recent Delphi studies found in the literature (Van Zolingen and Klaassen, 2003; Bradley and Stewart, 2003; Scholl, Lönig, Meyer, and Heisig, 2004;

Landeta, 2006), which show drop rates ranging from 34% to 57%[5]. This could actually be considered a good result as all these Delphi studies consisted of only two rounds, and the drop rate for the present study after the second round was only 29.7%. Although the initial response rate was lower than some found in the studies mentioned above, the initial large sample can be seen as helping to overcome this issue. Indeed, the final number of experts was in the average found in the studies cited previously, which ranged from 25 to 50 respondents (compared to 35 for this study).

The overall process of this Delphi study followed the timeline illustrated in Table 5.3. Experts were given two weeks to answer a questionnaire, and were reminded to do so after one week, and again two days before the deadline (unless they had responded already). Several 'thank you' notes were sent to those experts who excused themselves from the study after the second or third round due to time constraints (not shown in Table 5.3).

Table 5.3: Timeline of the Study

Date	Item sent
26/09/07	First questionnaire (Q1)
02/10/07	First reminder Q1
09/10/07	Second reminder Q1
10/10/07	Deadline Q1
16/10/07	'Thank you' note
19/10/07	Second questionnaire (Q2)
25/10/07	First reminder Q2
29/10/07	Second reminder Q2
30/10/07	Deadline Q2
14/11/07	Third questionnaire (Q3)
20/11/07	First reminder Q3
26/11/07	Second reminder Q3
28/11/07	Deadline Q3
20/05/08	Final feedback

Table 5.4 provides an overview of the country of origin of the final panelists, indicating the 13 countries represented with their respective numbers of experts. Note that out of the 35 experts, there were 4 practitioners and 1 government agent, the remaining 30 being academics. This is consistent with the selection method of the experts, which was based on academic publications.

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[5] Note that the 15% drop rate from one Delphi study presented by Landeta (2006) has been ignored due to its distinctiveness and lack of methodological resemblance to the other studies.

Table 5.4: Origin of Final Panelists

Countries	N
United States of America	9
Spain	6
United Kingdom	5
Australia, China, Finland, Israel, Italy, New Zealand	2
Czech Republic, Greece, the Netherlands	1
Total: 13 countries	35

In the original panel from the first round, 18 countries were represented (including 7 practitioners and 2 government agents). 16 countries remained after the second round (with 4 practitioners and 1 government agent).

5.3. Results

In order to organize the results of this study, five interrelated themes were developed. The choice of these themes is directly correlated with the results obtained during the three rounds of the Delphi. Hence, the following results are presented in a different order than the initial arrangement found in the questionnaires sent to the experts. Tables Table 5.5 and 5.6 outline these themes and the related questions comprising them in order of their appearance in the results (presented in Figures 5.3 to 5.8 which will be introduced later in this chapter). A subsequent section presents the results of questions that are not included in the five emerging themes, beginning with the results from questions R2.Q3.c and R2.Q6.b which did not feature in the feedback provided to the experts, followed by the results of the questions regarding the Delphi method itself.

Table 5.5: Color Key for Table 5.5 and List of Questions by Theme

Theme	Questions
Theme 1: Definitions of constructs	R1.Q6, R2.Q6.a, R2.Q6.c, R3.Q6.b, R1.Q7, R2.Q7.a/b, R3.Q7.a
Theme 2: Knowledge frameworks	R1.Q2, R2.Q2.a/b, R1.Q3.a, R2.Q3.a, R3.Q3.a, R2.Q5.c, R3.Q5.b
Theme 3: Managing knowledge	R1.Q1, R2.Q1.a/b, R3.Q1.a/b, R2.Q1.c, R3.Q1.c
Theme 4: The state of KM	R2.Q6.a, R1.Q2, R3.Q6.a, R1.Q3.a/b, R2.Q3.b, R3.Q3.b/c, R1.Q5, R2.Q5.a, R2.Q3.d, R3.Q3.d, R2.Q5.b, R3.Q5.a
Theme 5: Influences on KM	R1/2.Q8, R3.Q8.a, R1.Q4, R2.Q4a, R3.Q4a, R3.Q9.a/b/c
No theme	R2.Q3.c, R2.Q6.b, and R3.Q10.a/b (Delphi method)

Table 5.6: Emerging Themes

Topic	Q	Round 1	Q	Round 2	Q	Round 3
Managing knowledge	1.	Is it possible to manage knowledge?	1a.	Do you agree that it is sometimes possible to manage knowledge?	1a.	Can tacit knowledge be managed?
			1b.	Under what kind of conditions is it possible to manage knowledge?	1b.	If yes, under what conditions?
			1c.	What is the purpose of KM[6]?	1c.	Who should be "managing" knowledge at the organizational level?
The knowledge pyramid	2.	Is the "knowledge pyramid" the standard view of the concept of knowledge in KM?	2a.	What are the main flaws of the knowledge pyramid?		
			2b.	About 5% mentioned that the pyramid did not represent the concept of knowledge. Do you agree, and why?		
Other models of knowledge	3a.	Do you know of any other models/ representations of knowledge?	3a.	What are the main contributions of the SECI[7] model? What are its main flaws?	3a.	What do you see as the relationship between "tacit" and "explicit" knowledge?
	3b.	Which model is your preferred representation of knowledge? Why?	3b.	Position the models on the provided timeline.	3b.	Do you see complexity theory as the common denominator of these rising models, or is there some other reason or shared factor?
			3c.	Comment about the contributions and/or flaws of any of the models listed.	3c.	Do you believe complexity theory is just the next fad, or will it provide an enduring foundation for a better understanding of knowledge?
			3d.	Should a distinction be made between the understanding of "knowledge" in academia and that in business practice? Why?	3d.	The panel believed that no distinction was to be made by a factor of almost 3 to 1. However, most also noted that such a gap does exist. What can be done to reduce this gap?
Influences	4.	What, or who, has most influenced your thinking about the concept of knowledge?	4a.	What are your main comments and/or criticisms about this result?	4a.	Would you like to make any further observations about these results?

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[6] KM: Knowledge Management
[7] SECI: Socialization Externalization Combination Internalization model (Nonaka and Takeuchi, 1995)

Topic	#	Question		Question		Question
Need for new models	5.	Do we need new models or representations of knowledge?	5a.	Why is there some dissatisfaction with the state of research in KM, and its application to practice?	5a.	Do you agree that KM will need to reach the stage of a new paradigm (using a pluralistic and integrative approach) to make real progress in terms of applicability (bridging the gap between theories and practice)?
			5b.	Should KM be unified by creating models or frameworks acceptable to both academics and practitioners?		
			5c.	What should be the main characteristics of a model of the concept of knowledge?	5b.	What should be the main characteristics of a model of knowledge processing?
Definitions of DIKW[8]	6.	Define: data, information, knowledge, and wisdom.	6a.	Do you agree that these definitions indicate a hierarchy?	6a.	Do you agree with the need for a major reconceptualization of the discipline?
			6b.	If this is a hierarchy, is it complete?		
			6c.	What connects these definitions?	6b.	Is 'understanding' the connecting factor among data, information, knowledge, and wisdom?
Constructs related to knowledge	7.	Rank the association among constructs (table).	7a.	What patterns can you identify in the table of constructs?	7a.	Do you sense any clusters within the ranked table?
			7b.	What patterns can you identify in the table of differences between constructs?		
			7c.	Any comment on any associations described?		
			7d.	Rank the association among new constructs.		
Experts' interests	8.	What is your main field of research interest?	8a.	Indicate the degree of relationship between selected fields and KM (table).	8a.	Do you agree that KM is mainly about organizational learning, intellectual capital, and innovation management?
Experts' readings	9.				9a.	Have you read any of the works of the following philosophers?
					9b.	Have you read Polanyi's "The Tacit Dimension"?
					9c.	Have you read Nonaka & Takeuchi's "The Knowledge-Creating Company"?
The Delphi method	10.				10a.	What are your thoughts on the Delphi method?
					10b.	Any comments about our use of the Delphi method?

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[8] DIKW: Data Information Knowledge Wisdom, often seen as a continuum.

The next five sections present the questions and panelists' feedback for each of the five themes identified above. In each case, initial questions are presented first, followed by summaries of the panelists' responses in the form of the feedback provided to the panelists with the questions constituting the subsequent round, ending with the final feedback given after completion of the third round. The questions from the three rounds are differentiated per the following coding key:

- 'Q': Question, followed by the number of the question, and preceded by the round indicators (see below)

- 'R1': Round 1 questionnaire indicator

- 'R2': Round 2 questionnaire indicator

- 'R3': Round 3 questionnaire indicator

- '<u>Feedback</u>': Feedback on the question above, given at the next round.

Note that the original question, feedback wording, and spelling have been retained, as well as the feedback formatting when possible, but some adjustments had to be made to fit the arrangement of this thesis. Therefore, original question are in bold font, comments from the researchers that were included in the feedback are in italics, and additional comments from the researcher are introduced by this sign: (#). See Appendices 1 (original questionnaire), 2 and 3 (first and second feedback and questionnaires), and 4 (final feedback) to view the original formatting. The order of the questions in this chapter has been altered to create a narrative matching the themes presented in Table 5.6.

5.3.1. Theme 1: Definitions of Constructs

The panel of experts were asked to provide their own definitions of key constructs related to the concept of knowledge to assess the range of variation and to determine whether a consensus would arise, thereby favoring any particular model.

Figure 5.3 presents the results for this theme.

Figure 5.3: Delphi Questions and Feedback for Theme 1

R1.Q6) Please complete the following sentences (briefly):

    Data is …
    Information is …
    Knowledge is …
    Wisdom is …

Feedback: The definitions given by panel members covered most of the wide range found in the literature, fairly well adhering to standard definitions, with some variation. We believe that a reasonable consensus has been reached. For the moment, our overall working definitions of these four concepts are as follows:

Data are unprocessed raw representations of reality.
Information is data that has been processed in some meaningful ways.
Knowledge is information that has been processed in some meaningful ways.
Wisdom is knowledge that has been processed in some meaningful ways.

R2.Q6.a) There appears to be a hierarchy indicated by these definitions. Your thoughts on this?

Feedback: It's clear that many nerves were frayed by this question – which is in part what we were trying to accomplish. The panel as a whole is not a whole; the tensions arising from opinion consolidation in the Delphi approach are quite evident here.

Some highlighted the issue of the oxymoron "unprocessed raw representation of reality," since creating a representation involves processing; however, most interpreted this as meaning a "basic" representation of reality, with minimal processing, which matches the consensus of the panel from the first round.

While 59% of the panel agreed that there was a hierarchy, many recognizing the pyramid, 42% argued that the definitions were inadequate and confusing (although more than 20% agreed on the definitions of data and information). Furthermore, 45% of the panel again raised problems with the pyramid. Memorable quotations arose in response to the simplistic tautology presented for your comments in the second round. A sample of our "top ten" follow, in no particular order:

(1)   "This is as close to a tautological quatrain as I have ever seen. Wow!"

(2)   "These 'consensual definitions' are not definitions but tautologies. Information is data? Knowledge is information? Wisdom is knowledge? And 'in some meaningful ways'? What clarity, what a precision, what a mess."

(3)   "First e.g. it is arguable there is no such thing as 'unprocessed raw representations' – a representation is by definition 'processed' in some cognitive/perceptual sense. It is an IT myth, convenient perhaps for referring to marks on cards, or on magnetic tape etc. (bits) to think of those as 'data' which are thus 'raw representations'."

(4)   "The only vaguely defined piece here is data, all the rest is mechanically derived from it, leading to wisdom is 'representations of reality processed in some meaningful ways'. Nobody can do anything meaningful with that."

(5)   "Knowledge / wisdom – we have no real idea (generally) what we mean by these, which is why we describe them in meaningless ways as 'processed X' "

(6) "All the talk about 'processing' simply avoids the hard questions while seeming to provide an answer. Since no one has said what kind of 'processing' turns 'data' into 'information' the whole 'hierarchy'(whichever way round) is just so much verbiage."

(7) "… it follows that the remaining definitions are vague and unhelpful and are only there to define an imagined Pyramid that doesn't exist."

(8) "I think the KM field needs to get past its fascinated repetition of this hierarchy as if it is somehow meaningful or beneficial. I think it holds up progress in the KM field."

(9) "Does 'has been processed' mean 'e.g. by computers'? I am afraid so."

(10) "It is mainly based on the metaphor of IT."

To briefly summarise:

1) The definitions do not define anything as somehow wisdom equals knowledge equals information equals data (tautology), and data equals nothing (oxymoron).

2) The use of 'processed X' is inadequate and incomplete.

3) KM needs to get away from the IT metaphor in general and the pyramid in particular.

R2.Q6.c) What connects these definitions? (Is there a transitional mechanism of some sort?)

Feedback: In order to keep this as brief as possible *(yes, we know it's already too long!),* we will provide just one quote here: "Certainly not the transition or the processes which need to be clearly different for various elements. The connecting feature might be the 'understanding' in my view."

R3.Q6.b) Do you agree that 'understanding' is the connecting factor among data, information, knowledge, and wisdom?

Feedback: 61% of the panel agreed that 'understanding' was the connecting factor among data, information, knowledge, and wisdom (one respondent indicated it could be a significant factor but not the only one). The most prominent answers opposing that opinion suggested that if any connecting factor existed, it was not understanding but 'categorising,' or the role played by this taxonomy in the lives of living systems, or that understanding was the bridge between knowledge and wisdom as advocated by Ackoff.

R1.Q7) Association among constructs

(#) Note to introduce the following feedback: In the first round, panelists were asked to rate the association between a set of 25 concepts and the four traditional pyramid concepts (data, information, knowledge, and wisdom). For the second round, 3 constructs suggested by the panel were added, and panelists were asked to rate these additional constructs. Second- and third-round feedback displayed differences in ratings across the table, allowing rank ordering of the concepts.

Feedback: The following table ranks these concepts[(#)] by the difference going across the table from left to right (i.e., from data to wisdom). *(For example, for the concept ranked second – enlightenment – the slope is positive from "data" to "wisdom," and the response for association with wisdom is 7.1 higher than that for data, on average.)*

Rank	Concept	Difference			
		I – D	K - I	W - K	Total
1	Wisdom	1.4	3.3	4.3	9.0
2	Enlightenment	1.7	3.4	2.2	7.3
3	Tacit	1.4	5.3	0.5	7.2
4	Judgement	2.2	3.1	1.5	6.7
5	Experience	1.9	3.9	0.2	6.1
6	Understanding	2.2	3.6	0.1	5.9
7	Intelligence	2.5	2.7	0.1	5.3
8	Mind [(*)]	1.8	2.9	0.5	5.2
9	Learning	2.5	3.4	-0.9	5.1
10	Cognition	2.1	3.5	-0.9	4.7
11	Theory	2.0	3.4	-0.8	4.6
12	Relationship	3.0	1.8	-0.2	4.6
13	Knowledge	1.9	5.9	-3.2	4.5
14	Perception	1.3	1.8	-0.4	2.7
15	Truth	0.5	1.6	0.2	2.4
16	Process	2.3	0.5	-1.1	1.7
17	Memory	1.4	1.4	-1.3	1.6
18	Organisation	1.4	0.8	-1.2	1.0
19	Existence	-0.1	0.7	0.3	0.9
20	Environment [(*)]	0.1	0.9	-0.4	0.6
21	Schema [(*)]	1.5	-0.1	-1.0	0.5
22	Reality	-0.1	0.7	-0.4	0.2
23	System	1.3	0.2	-1.5	0.0
24	Structure	1.1	-0.7	-1.1	-0.6
25	Information	5.3	-4.6	-2.2	-1.5
26	Explicit	-0.3	-1.2	-2.7	-4.2
27	Fact	-1.9	-1.4	-1.5	-4.8
28	Data	-4.6	-2.2	-1.3	-8.1

(*) New items added as result of responses in round 2.

(#) the following question was initially about the first table of constructs to rank, but as the above table provides a summary of results for both tables, only this one is reproduced and the feedback of question 7a and 7b has been merged (answers from 7c had already been merged with the ones of 7a and 7b during the study), and answers from 7d are integrated in the table above.

R2.Q7.a/b) What patterns can you identify in the above table? What do you believe they indicate?

Feedback: Summarising those responses that did describe patterns, most linked several concepts, with the results resembling clusters or factors. In particular, knowledge and wisdom were linked, and data and information were linked, implying at the minimum two clusters.

The concept with the greatest positive total difference (between data and wisdom) is wisdom, and with the greatest negative difference (between wisdom and data) is data – a near mirror that can serve to validate the responses. The sharpest single-transition rises are between information and knowledge (darkest blue cells) – which a participant stated "implies that the conversion of info into k is seriously significant." The largest increase for each transition is between the DIKW concepts themselves (for information, knowledge, and wisdom). Likewise, the sharpest drops are between the DIKW concepts (red cells), for data, information, and knowledge. The concept with the least total change (lowest sum of absolute values of transitions) across the four DIKW concepts is existence, closely followed by reality and environment.

R3.Q7.a) Some panellists suggested clustering of the concepts in the above tables could provide insights. Do you sense any clusters (within the ranked table)? If so, please comment about them.

Feedback: Although we were hoping for a wide range of provocative or innovative clustering suggestions, instead the panel as a whole rejected this approach. Few suggested clusters, while many commented about either contingent clustering or the inappropriateness of clustering (a few comments about the "nice colours" were also received…). The most common observation regarding potential clusters was that there seems to be a continuum between tacit and explicit.

Here is a comment that, in our view, summarises the notion of concept clustering quite well: "You could group the various terms according to their neighbourhood with D-I-K-W. The terms which are on the edge may provide insights to the transitional mechanisms. The I-K border is certainly one of the most intriguing."

Among the more oppositional comments is the following, which impugns the credibility of the panel while summarising objections to the results of the clustering consensus: "Again, the respondents seem to think that Information and Data are alike, and that knowledge and wisdom are alike. They also seem to believe that knowledge and wisdom are both more subjective in the sense that they are more closely associated with judgment, understanding, tacit knowledge, experience and enlightenment, while at the same time, they are more objective, in the sense that they are more closely associated with "truth," and "intelligence" than are data and information. What I believe these patterns indicate is confused theory about the four constructs, misunderstanding about the meaning of objectivity and subjectivity, confused psychological theory, lack of a good theory for distinguishing types of knowledge, and confusion about the theory of truth. In other words, the results show a severe lack of education in epistemology, psychology, and systems theory among the panelists."

The analysis of responses to question R1.Q6 led to the conclusion that many experts were defining information as processed data, knowledge as processed information, and wisdom as processed knowledge. When confronted with this conclusion, the panel reacted quite strongly against such a framework, while still conceding that it was

leading to the traditional knowledge management pyramid. This will be covered in more detail in the discussion of Themes 2 and 3, and is consistent with what was highlighted in Chapter 3 when reviewing the literature. The field is entrenched in a tautological perspective, and as will be seen with Theme 4, many experts suggested developing a way out of this conundrum. It is also important to note that the use of "possessed X" as a definition for the DIKW constructs has been rejected, while it is quite predominant in the literature, as shown in These definitions share a key conceptualization: Wisdom is considered to be at a higher level than data, information, and knowledge. Consequently, wisdom can be considered to be knowledge that has been processed in some meaningful ways.

Table 3.2: Alternative Definitions of Data, Information, and Knowledge. One of the experts (echoing others responses, but in a more interesting, argumentative manner) highlighted a possible deficiency in the panel concerning its philosophical understanding of the concept of knowledge itself. Such feedback from the panel led to new questions in that direction as a consequence. This is discussed further in Theme 5.

Question R2.Q6.c received mixed responses, with a fairly high number of experts not responding to it. However, Respondent 42 gave the opportunity to test an assumption that will underlie Chapter 6, and evaluate the propensity of agreement within the panel about the traditional pyramid as revisited by Bellinger, Castro, and Mills (2004) (see Figure 3.2). The assumption was that the construct 'understanding' would be recognized as a connecting factor among the DIKW constructs, which has been confirmed by the panel in Question R3.Q6.b.

Question 7 was included in anticipation of the likely emergence of the traditional pyramid within the definitions given by the panel. The idea was to capture some correspondence among related constructs and see if any would bring new insight for further questions. While many experts gave correspondence factors, they stayed fairly quiet about any clusters or grouping that they might have identified. This could be due to the quantity of data and the difficulty to assess it during the short time given to answer the survey (some of the panelists objected to the table and the time it consumed to complete, as well as the apparent paradigm it was based on, i.e., the DIKW continuum). Interestingly, the tables were also praised by a number of the experts who saw a potential way to map clusters of constructs and find some interesting relationships among them. Clustering and finding patterns turned out to be too big a task for the experts, 20% of whom did not answer the question in the first round, with another 15%

following that pattern in the second round. The clustering-related questions gained almost no support, receiving very few answers. Consequently, it is quite clear that the experts did not see any benefit in this approach; this analysis will follow their wise judgment and leave any complex analysis of the tables out of this chapter. Exploratory steps towards quantitative analysis have been attempted (e.g. correspondence analysis, cross table analysis, and graphs for pattern recognition), but the results were consistent with the panel comments, and nothing significantly interesting as a whole emerged.

5.3.2. Theme 2: Knowledge Frameworks

Theme 2 is constructed around the knowledge frameworks discussed by the panel of experts. Figure 5.4 presents a range of question that addressed this theme.

Figure 5.4: Delphi Questions and Feedback for Theme 2

R1.Q2) Do you believe that the "knowledge pyramid" represents the standard or most common view of the concept of knowledge in the field of knowledge management?

Feedback: Apart from the fact that a few members of the panel were not familiar with the pyramid including wisdom, the majority of the panel agreed that the knowledge pyramid was indeed the common view of the concept of knowledge (as show in the results below).

Yes	No	Other
61%	13%	26%

16% of the panel mentioned the usefulness of the pyramid *(to various degrees – particularly for educational purposes)*; however, 40% of the panel also protested about numerous perceived flaws in that model.

R2.Q2.a) Following these results, it is assumed that the knowledge pyramid is the most common view of the concept of knowledge, but that it also lacks some key features. According to you, what are the main flaws of the knowledge pyramid?

Feedback: The main flaw suggested is that the pyramid is a too simplistic model (19%). Over than that, the main flaws identified are (in order of prevalence):
- Linear model (16%)
- Does not address conversion processes (9%)
- Static model (7%)
- does not address the difference between knowledge and wisdom (7%)
- does not address the influence of the environment (5%)

R2.Q2.b) About 5% mentioned that the pyramid did not represent the concept of knowledge. Do you agree, and why?

Feedback: Although 42% of the panel thought the pyramid <u>does</u> represent the (or "a") concept of knowledge, 17% felt it represented something else – most commonly a taxonomy of concepts related to knowledge. *The remaining responses didn't address this question as intended, providing evaluative comments instead.*

R1.Q3.a) Do you know of any other models or representations of the concept of knowledge? If yes, please briefly identify them.

Feedback: The following other models or representations of the concept of knowledge were nominated by two or more respondents. *(Some definitions and ways of representing knowledge were also named.)*

		(Identifier, used in Q3b below)
21%	SECI (Nonaka & Takeuchi)	(A)
9%	Tacit/Explicit knowledge	(B)
5%	Blackler's model of knowledge	(C)
5%	Static/Dynamic knowledge	(D)
3%	Boisot's I-space	(E)
3%	Tuomi's reversed pyramid	(F)
3%	Firestone & McElroy's cycle model	(G)
3%	Cynefin sense-making framework	(H)

R2.Q3.a) According to you, what is the main contribution of the SECI model? What are its main flaws?

Feedback: Summarising the panel, the main contributions of SECI are that it introduces the dynamic nature of knowledge creation and the conversion processes between tacit and explicit knowledge, and that it incorporates both individual and organizational levels. One panellist noted that "people regard SECI as a model of the concept of knowledge (which it isn't) or of the whole of knowledge management (which it was never intended to be)."

Although 6% mentioned that the simplicity of the SECI model was one of its strength, 24% argued that it was not detailed enough or was an over-simplified representation (this is the main flaw identified by the panel). It has also been suggested that the SECI model depicts a misleading interpretation of the distinction between tacit and explicit knowledge (21%), and that it is based on weak or erroneous philosophical assumptions (18%); the most common example cited involved "justified true belief" as the definition of knowledge. Furthermore, it has been argued to be linear or unidirectional, unpractical, too focused on a Japanese context, and unclear about the distinction between information and knowledge (all 12%). Finally, it was noted that the SECI model has not been empirically validated (9%).

R3.Q3a) What do you see as the relationship between "tacit" and "explicit" knowledge? (For example: Are they mutually exclusive alternatives? Do they overlap? Can knowledge be partially tacit and partially explicit at the same time?)

Feedback: The majority of the panel (57%) indicated that knowledge has both tacit and explicit dimensions, and can therefore be both at the same time. A further 22% indicated that tacit and explicit knowledge are mutually exclusive, but convertible from one to the other, while 16% agreed that they are mutually exclusive but did not mention convertibility.

R2.Q5.c) What should be the main characteristics of a model of the concept of knowledge for it to be relevant for knowledge management?

Feedback: 52 different characteristics were suggested, ranging from purposes to components. The most frequently nominated characteristic (24%) is relevance or applicability to business. Altogether 39% of the panel honed in on the relationship between "knowledge" and reality or practice. An equal 39% focused on the social and dynamic aspects of "knowledge," emphasising characteristics such as knowledge management processes and life cycles. 30% were concerned that a model of "knowledge" should be sufficiently inclusive, flexible, and integrative. 24% indicated that the model should differentiate among forms or types of knowledge, e.g. individual/organisational, tacit/explicit, and information/knowledge. 21% stated that the model should be clear and simple. 15% suggested that a sound philosophical basis should underlie the model, and 15% emphasised that the model should be theoretically rigorous and validated.

One panellist suggested reversing the question (swapping KM and knowledge). We see this as a very different question having a different purpose, but agree that it is relevant and important. Some of our earlier questions have partially addressed this issue. Combined and modified, this suggests our next new question for this round.

R3.5.b) What should be the main characteristics of a model of knowledge processing (as opposed to a model of knowledge) for it to be relevant to knowledge management?

Feedback: The overriding conclusion is that a model of knowledge processing should show the processes involved in managing knowledge… obviously enough! The most commonly nominated feature is that such a model should incorporate the concept of sharing or distribution among individuals within a social context. Several suggestions called for the model to differentiate between individual and group or organisational processes (sometimes linking individual processing [mental] to tacit knowledge and group processes to the management of explicit knowledge). About one-fifth of respondents suggested that taxonomies of knowledge and conversion among types of knowledge should be represented; that the model should be based on a systemic framework, e.g. complexity theory; and that such a model should be relevant to practice or link academia to practice.

Some respondents mentioned characteristics that should be considered generic for good models, e.g. epistemological consistency, clarity, and simplicity. A fair number of respondents misinterpreted the question and designated characteristics of knowledge processing itself, rather than a model thereof.

Questions R1.Q2 and R1.Q2.a/b confirmed the conclusions made in Chapters 3 and 4 after reviewing the literature on knowledge management. The traditional pyramid is the predominant framework identified in the field, and the main flaws associated with it are its linearity, lack of clear conversion processes (which may explain the lack of rigor found in the definitions of the constructs in Theme 1), and no clear aspect of the influence of the environment. The environmental aspect and need for distinctions among the DIKW constructs echo the conclusion of Chapter 3 and the need for clearer definitions of boundaries. Responses from Question R2.Q2.b reinforce the idea that the pyramid does not properly address the concept of knowledge, with most of the responding experts giving evaluative arguments against it. This is further discussed in Theme 4.

Based on the literature discussed in Chapter 4, it was expected that the SECI model (Nonaka and Takeuchi, 1995) would be well recognized in the field, which is consistent with the ranking found in answers to Question R1.Q3.a. Question R2.Q3.a also brought results matching those expected (see Chapter 4), showing that the SECI model may depict a misleading interpretation of the distinction between tacit and explicit knowledge (21%), and that it is based on weak or erroneous philosophical assumptions (18%). This is supported by answers to Question R3.Q3.a which tend to suggest knowledge exists as a duality between tacit and explicit at the same time, as opposed to either/or. This finding invalidates the assumptions of the SECI model, which is the most recognized foundation of the field of knowledge management (as shown in answers to Question R1.Q3.a).

Although Questions R2.Q5.c and R3.Q5.b received many different answers (52 characteristics nominated in the former, and 48 in the latter) and concerned issues at different levels (concept of knowledge, and knowledge processing), the results showed that three characteristics emerged in both rounds: First, the need for the model to be relevant to practice (this issue is discussed in more detail in Theme 4); second, the importance of the social context with an integration of the relationship between the individual and the organization; and third, that the different types of knowledge should be taken into account. This is in line with conclusions reached in Chapters 3 and 4 and will be further addressed in Chapter 6 when considering new models of the concept of knowledge and how it might be processed at the individual and organizational levels.

5.3.3. Theme 3: Managing Knowledge

This theme regroups questions dealing with the notion of management of knowledge; Figure 5.5 presents the relevant questions and feedback given to the panel of experts.

Figure 5.5: Delphi Questions and Feedback for Theme 3

R1.Q1) Is it possible to manage knowledge?

Never – Hardly ever – Sometimes – Most of the time – Always

<u>Feedback</u>: It has been pointed out by the results of the first round that it is not always possible to manage knowledge, but we will try our best to do so in this study. The results from round 1 are provided below:

Never	Hardly ever	Sometimes	Most of the time	Always	"Yes"	Other (off the scale)
5%	7%	40%	24%	13%	3%	8%

23% of the panel objected to the question format, noting that the answer depended on the definitions given to Knowledge, Management, or Knowledge Management. *Most of these people did answer the question, however. You may have noted that this question was intended to provoke thought about the nature of the name of the field we call "knowledge management."* 10% asserted it was only possible to manage knowledge indirectly.

R2.Q1.a) Following [Round 1] results, it is assumed that it is at least sometimes possible to manage knowledge (or else, why would the field be called knowledge management?). Do you agree?

Feedback: The overwhelming perspective [all but one respondent] is that it is possible to manage knowledge – sometimes, under certain conditions, and only in certain forms. In other words, knowledge management is highly contingent. 61% stated "yes" while 36% indicated "yes, but…"

R2.Q1.b) Under what kinds of conditions is it possible to manage knowledge?

Feedback: The most common condition noted by the panel is that explicit knowledge is easier to manage (7%) or is the only form of knowledge that can be managed (30%). About one-tenth of respondents indicated that necessary conditions include the presence of (suitable) information technology, the existence of (appropriate) processes, and the existence of an open and empowering social environment. Approximately twenty other conditions were mentioned by one or two respondents.

R3.Q1.a) Can tacit knowledge be managed?

Feedback: Overall, 89% of the panel believes that tacit knowledge can be managed, at least sometimes and in some ways, often with some difficulties. Summary: Yes 40%, qualified yes 49%, no 9%, other 3% *(note: "due to rounding, sums may not equal 100%"…)*. Further exploring the "qualified yes," 17% of the panel indicated only indirect management is possible; 11% said it can be managed to some extent; and 9% believed tacit knowledge can be managed but with difficulty. 11% indicated that whether or not it can be managed depends on how "manage" is defined.

R3.Q1.b) If yes, under what conditions?

Feedback: A supportive environment was nominated by 52%, empowerment of employees 44%, an appropriate organisational structure and leadership 30%, and by making it explicit (or manageable using information technology) 30%.

Questions R2.Q3c and R2.Q6b were excluded from the feedback given to the experts, as they did not receive enough responses to warrant further discussion by the Delphi panel (some analysis will be provided in Figure 5.8). As will be seen throughout the following themes, the panel only goes in the directions it chooses, not the ones that the researcher may highlight. This self-organizing behavior will be discussed at the end of this chapter.

The panel strongly agreed that both tacit and explicit knowledge could be managed, but that it is easier to deal with the latter. Many experts mentioned the fact that knowledge was to be managed indirectly, within an open and empowering environment. Consequently, Question R2.Q1.c was an attempt to explore the idea that knowledge management may be seen as an area of research focused on the management of knowledge itself, or as an overarching bridge among the different components of the field of management, emphasizing the social nature of knowledge. The latter proved to be supported by the experts, leading to Question R3.Q1.c which partly explained why

this was the case. To the question of who was supposed to be managing knowledge in an organization, "Everyone" was the most supported answer within the panel, followed by managers, implying that knowledge is at the center of a social network of activities, facilitated by leadership. This concurs with the literature review made in Chapters 3 and 4 and emphasizes the fact that managing knowledge is a socially constructed activity that is performed by all members of an organization, and that the environment plays an important role. This will be of prime importance in the new perspectives and models presented in Chapter 6.

5.3.4. Theme 4: The State of KM

Theme 4 was the central theme emerging from this Delphi and highlights the most important results. Figure 5.6 presents the questions directly addressing the current state of the field of KM and what future may lie ahead.

Figure 5.6: Delphi Questions and Feedback for Theme 4

(#) The following question and feedback has been truncated. It only contains the relevant parts from the original feedback; the full version has already been used in Theme 1.

R1.Q6) Please complete the following sentences (briefly):

Feedback: The definitions given by panel members covered most of the wide range found in the literature, fairly well adhering to standard definitions, with some variation. We believe that a reasonable consensus has been reached. For the moment, our overall working definitions of these four concepts are as follows:

Data are unprocessed raw representations of reality.
Information is data that has been processed in some meaningful ways.
Knowledge is information that has been processed in some meaningful ways.
Wisdom is knowledge that has been processed in some meaningful ways.

R2.Q6.a) There appears to be a hierarchy indicated by these definitions. Your thoughts on this?

Feedback: 79% agreed and 21% disagreed (with a small portion of "qualified" responses on each side). Two supportive comments are that "Some years ago everybody thought KM was a fad, but now it needs to reach the stage of a new paradigm," and that "It is not only a matter of KM reaching such a stage, but of KM researchers reaching a stage of being well-informed of the theoretical and empirical research that already exists!" While 59% of the panel agreed that there was a hierarchy, many recognizing the pyramid, 42% argued that the definitions were inadequate and confusing (although more than 20% agreed on the definitions of data and information). Furthermore, 45% of the panel again raised problems with the pyramid. Memorable quotations arose in response to the simplistic tautology presented for your comments in the second round.

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(6) "All the talk about 'processing' simply avoids the hard questions while seeming to provide an answer. Since no one has said what kind of 'processing' turns 'data' into 'information' the whole 'hierarchy'(whichever way round) is just so much verbiage."

(7) "… it follows that the remaining definitions are vague and unhelpful and are only there to define an imagined Pyramid that doesn't exist."

(8) "I think the KM field needs to get past its fascinated repetition of this hierarchy as if it is somehow meaningful or beneficial. I think it holds up progress in the KM field."

To briefly summarise:

3) KM needs to get away from the IT metaphor in general and the pyramid in particular.

R1.Q2) Do you believe that the "knowledge pyramid" represents the standard or most common view of the concept of knowledge in the field of knowledge management?

Feedback: Apart from the fact that a few members of the panel were not familiar with the pyramid including wisdom, the majority of the panel agreed that the knowledge pyramid was indeed the common view of the concept of knowledge (as show in the results below).

Yes	No	Other
61%	13%	26%

16% of the panel mentioned the usefulness of the pyramid *(to various degrees – particularly for educational purposes)*; however, 40% of the panel also protested about numerous perceived flaws in that model.

R3.Q6.a) The pyramid and its inherently associated definitions remain the dominant perspective in the KM literature (and were echoed in the first two rounds here). The challenges posed by panellist comments emphasise the need for a major reconceptualisation of the discipline. Do you agree?

Feedback: 74% of the panel agreed that a major reconceptualisation of the discipline was required, many mentioning the need to get rid of the pyramid. The main reason pointed out by the disagreeing respondents was that we mostly need a better understanding of the definitions used in the field.

R1.Q3.a) Do you know of any other models or representations of the concept of knowledge? If yes, please briefly identify them. *[Note: This item is repeated from the analysis of Theme 2, to retain continuity of the questioning; the focus in this theme and Theme 2 differs with regard to this item.]*

Feedback: The following other models or representations of the concept of knowledge were nominated by two or more respondents. *(Some definitions and ways of representing knowledge were also named.)*

		(Identifier, used in Q3b below)
21%	SECI (Nonaka & Takeuchi)	(A)
9%	Tacit/Explicit knowledge	(B)
5%	Blackler's model of knowledge	(C)
5%	Static/Dynamic knowledge	(D)
3%	Boisot's I-space	(E)
3%	Tuomi's reversed pyramid	(F)
3%	Firestone & McElroy's cycle model	(G)
3%	Cynefin sense-making framework	(H)

R1.Q3.b) Which of the above is your preferred model or representation of the concept of knowledge?

Feedback:

No preferred model	Pyramid model preferred	Other model(s) preferred	Depends on the context
14%	11%	61%	14%

The most preferred model is Nonaka's SECI model (12%), with the knowledge pyramid being the second most preferred. *(However, recall that 40% of respondents indicated that the pyramid was flawed in question 2; that exceeds the number of people preferring it.)* Panel members nominated a total of 47 different models or frameworks.

R2.Q3.b) Consider how the utility of the models above has changed over time. Please position the models on the brief timeline table below by writing their identifying letter (you can position a model in one, two, or all three of the time columns). You may also write in any additional models you wish.

Feedback: We transformed the 5 point scale into values in order to obtain the following tables. We believe they show an average picture of how panellists view the evolution of the utility of the models over time.

Colour Key

from 4.5 to 5	Extremely important
from 3.5 to 4.4	Very important
from 2.5 to 3.4	Important
from 1.5 to 2.4	Somewhat important
from 0 to 1.4	Not important

Arrow Key: ↗ ➚ *increase &* ↘ ➘ *decrease, over time (bold = 0.3 or more)*

Models	Past		Present		Future
SECI (Nonaka & Takeuchi)	4.5	➘	4.0	➘	3.6
Tacit/Explicit knowledge	4.3	➘	4.0	↘	3.8
Knowledge Pyramid	3.8	➘	3.3	➘	2.7
Blackler's model of knowledge	2.8	↗	2.9	➘	2.5
Static/Dynamic knowledge	2.8	↗	3.0	↗	3.2
Cynefin sense-making framework	2.3	➚	3.0	↗	3.2
Firestone & McElroy's cycle model	2.1	↗	2.3	↗	2.4
Tuomi's reversed pyramid	1.9	↗	2.0	=	2.0
Boisot's I-space	2.4	↘	2.2	↘	2.0

One finding here could be that the only models that show increasing importance over time are the Static/Dynamic knowledge representation, the Cynefin sense-making framework, and Firestone & McElroy's cycle model *(although there was a bit of confusion about what was meant by the cycle model; some understood it as the Knowledge Life Cycle, others the Unified Theory of Knowledge)*. Both the Cynefin sense-making framework and Firestone & McElroy's cycle model are grounded in complexity theory, and the distinction between static and dynamic knowledge can be seen as conforming to complexity perspectives. Therefore, it seems that the prospects for complexity theory within the future of KM are growing.

R3.Q3.b) Do you see complexity theory as the common denominator of these rising models, or is there some other reason or shared factor?

Feedback: 58% agreed, and 12% disagreed while 24% responded "don't know." Based on the responses, it appears that "complexity theory" is understood in a wide variety of ways (some incompatible with each other), perhaps indicating that another Delphi study is in order!

R3.Q3.c) Do you believe complexity theory is just the next fad, or will it provide an enduring foundation for a better understanding of the concept of knowledge?

Feedback: No respondents believed that complexity theory is definitely just a fad. However, 20% thought it could be a fad – 'probably' or 'possibly' or 'don't know yet, ask me in ten years!,' with some writing that it could be fruitful even if it does turn out to be a fad. Half of the respondents – 49% – agreed that complexity theory will provide an enduring foundation, with another 6% agreeing but less certain. A further 17% "don't know."

R1.Q5) Do we need new models or representations of the concept of knowledge?

Feedback:

Yes	No	Maybe	Don't know	Other
36%	34%	9%	5%	17%

The main reasons given to support the need for new models were *(in order of frequency)*:
- To develop our understanding of the concept of knowledge
- To refine the current models of the concept of knowledge
- To create more descriptive models of the concept of knowledge
- To create more complex models that illustrates the complexity of knowledge
- To provide more analytical tools
- To provide different conceptualizations
- To prevent stagnation of the field of knowledge management

Here are the main theories/frameworks seen as having the best potential to achieve this *(in order of frequency)*:
- Multiple theories *(i.e., we need a combination of several theories)*
- System thinking
- Complexity theory
- Dynamic capabilities approach

The main reasons given to support the view that we do not need new models were *(in order of frequency)*:
- The current models are sufficient
- Creating new models of the concept of knowledge is not the focus of knowledge management
- We need to see how existing views complement each other
- Knowledge is too subjective to be conceptualised

R2.Q5.a) Responses to the first round showed not just a great diversity of perspectives, and adhesion to a wide range of models, but an undercurrent of dissatisfaction with the state of research in the field, as well as its application to practice. Why?

Feedback: There are apparently various reasons for the dissatisfaction in the field, the main reason apparently being the fact that KM is still in its infancy (23%). Consequently, it lacks a common understanding of the concept of knowledge (20%), and has too much variety of views (20%, most of which commented on the large number of origins of KM). 11% of the panellists also mentioned the gap between theory and practice as being a handicap for the field, and 9 % blamed the lack of empirical studies in KM.

R2.Q3.d) A couple of experts asserted that a distinction should be made between the understanding of "knowledge" in academia and that in business practice. Do you agree, and why?

Feedback: 48% of the panel strongly opposed the idea of distinguishing the understanding of "knowledge" in academia from that in business practice. The main reasons advanced were that practitioners and academics should learn from each other and use the same language, and that a distinction would make academia irrelevant to practice. Panellists agreeing with the idea that a distinction is needed (17%) suggested that it should be done on the basis of academia being about theories, and practice about how to apply them, therefore each requiring different approaches.

R3.Q3.d) The panel favoured "no gap" over "gap" by a factor of almost three to one. However, most also noted that such a gap does exist. What can be done to reduce this gap?

Feedback: Everyone who replied provided a different response, given the nature of the question. We have grouped them according to our own perceptions as best we could, resulting in the following broad results:

56% believed more collaboration, involving more interaction and mutual benefits, can reduce the gap between practice and academia. This could involve cooperative research, better communication, and corporate funding of academic investigations of organisational practices.

15% indicated that academics need to be made more aware of practice, 9% thought the opposite (that practitioners need to be made more aware of academic understandings), and 9% replied that awareness needs to be increased by both sides.

R2.Q5.b) Would it be a good idea to try to unify the field of knowledge management, particularly through the creation of models or frameworks acceptable to the vast majority of academics and practitioners in this field?

Feedback: 59% of the panellists agreed that it be a good idea to try to unify the field of knowledge management, particularly through the creation of models or frameworks acceptable to the vast majority of academics and practitioners in this field, as long as it is done pluralistically (meaning that there would be more than one model or representation) in an integrative way. However, 12% suggested explicitly that this would be difficult to achieve. *Only 25% opposed the idea, but some experts did not interpret the question as intended.*

R3.Q5.a) The results hint that KM will need to reach the stage of a new paradigm (using a pluralistic and integrative approach) to make real progress in terms of applicability (bridging the gap between theories and practice). Do you agree?

Feedback: 79% agreed and 21% disagreed (with a small portion of "qualified" responses on each side).

Two supportive comments are that "Some years ago everybody thought KM was a fad, but now it needs to reach the stage of a new paradigm," and that "It is not only a matter of KM reaching such a stage, but of KM researchers reaching a stage of being well-informed of the theoretical and empirical research that already exists!"

It is clear from the results that the traditional pyramid and its inherent flaws are a major problem for the knowledge management field. Many responses acknowledged recognition of the pyramid as the standard or traditional view of the concept of knowledge, and the experts raised many concerns about that reality. Confused definitions, misuse of dimensions such as tacit/explicit, and fascination for an IT-based metaphor seem to be the main issues arising from the panel. Following this pattern, responses to Question R3.Q6.a strongly support the idea that a major reconceptualization of the discipline is needed.

In order to explore the possible avenues to conduct this reconceptualization, and based on results assessing different models and the relative preference for them among the experts, Question R2.Q3.b tried to differentiate among various models based on their usefulness over time. Two particularly interesting results came out of this question. First, none of the models was judged 'extremely important' for the future, and overall,

most models were shown as declining in importance over time, which is consistent with a need for reconceptualization. The only models that were shown as increasing in utility were models either based on complexity theory or embracing a systemic approach. This led to Questions R3.Q3.b/c, which attempted to explore that idea. The results seem to indicate that, indeed, complexity theory may provide future grounds for the development of knowledge management, which supports the approach taken in this thesis.

Responses to Question 5 showed a split among the panelists on the need for new models. Most of the experts voting against new models were strong advocates (or even creators) of some of the models discussed in this Delphi, and it would be logical to think that their answers are fairly biased in that regard. Once again, systemic approaches were proposed to create new models, supporting the idea that complexity and system theories will take a central role in the future of the field. This question also raised unexpected comments, which led to Question R2.Q5.a to explore the current dissatisfaction that may exist in the field about its state of research. The responses indicate that this dissatisfaction may be due to the young age of the field and its current lack of development, which imply a diversity of perspectives that do not share a common general direction. This is consistent with the reconceptualization discussed earlier, and is further illustrated by the next two questions featured in this theme (R2/3.Q3.d). It seems that because the field is developing so rapidly, academics and practitioners are not always aware of each other's work, both sides following their own agendas. The results hint that a gap exists between academia and business practice and that it should be reduced by engaging both academics and practitioners in collaborations.

The responses in this theme all lead to the fact that the knowledge management field is somehow disintegrated. Results of Questions R2.Q5.b confirmed this idea, suggesting that unifying the field of knowledge management was a good idea, but that it would probably be a challenge. This led to Question R3.Q5.a which showed a strong majority of experts agreeing that the field needs to reach the stage of a new paradigm, one that would bridge the gap among the diverse perspectives found in knowledge management. This is consistent with the first part of this theme and the need for reconceptualization, and hints toward the use of a systemic approach such as complexity theory.

5.3.5. Theme 5: Influences on KM

By exploring influences on knowledge management, this theme sheds light on several issues raised in the previous themes. Figure 5.7 presents questions highlighting the interests and influences of the experts comprising the panel.

Figure 5.7: Delphi Questions and Feedback for Theme 5

R1/2.Q8) What is your main field of research interest?

39% of the panel members specifically included "knowledge management" (or KM) as within their main field of research interest. However, the areas of nearly all respondents can be considered within the broader domain of knowledge management. A simple tabulation of responses to this question isn't quite workable. To further explore this, we'd like for you to indicate the degree of relationship you perceive between selected respondents' fields and knowledge management, by marking one cell for each research interest in the following table.

Feedback: The following table illustrates the results.

Colour Key

	50-100	Orange
	35-49.9	Light orange
	20-34.9	Yellow
	0-19.9	Light yellow

%	Core	Partial overlap	Peripheral	Unrelated
Complexity theory	25.0	25.0	44.4	5.6
Decision making/support	30.6	44.4	19.4	2.8
Entrepreneurship	13.9	27.8	41.7	22.2
Human resource management (HRM)	25.0	38.9	25.0	11.1
Innovation management	47.2	38.9	11.1	2.8
Intellectual capital	55.6	27.8	11.1	5.6
Leadership	19.4	33.3	38.9	13.9
Organisational learning	61.1	22.2	5.6	0.0
Organisational behaviour	30.6	47.2	22.2	0.0
Strategy	27.8	61.1	8.3	0.0
System thinking	30.6	38.9	19.4	5.6

R3.Q8.a) Do you agree that KM is mainly about organisational learning, intellectual capital, and innovation management? (If not, then what?)

Feedback: 77% of the panel agreed with the statement. 9% of the panel also mentioned that innovation management might not be as important as organisational learning and intellectual capital, emphasising the results of round 2. 14% suggested that individual learning should also be considered.

14% of the panellists disagreed with the statement, mentioning that a better answer would be organisational learning and organisational behaviour, or all of the areas mentioned in the table (implying that knowledge management is an integrator across multiple fields).

R1.4) What, or who, has most influenced your thinking about the concept of knowledge?

Feedback: Responses over 5%:

%	Who/What
26%	I. Nonaka
16%	M. Polanyi
10%	I. Nonaka and H. Takeuchi *(in addition to the result for Nonaka above)*
8%	K. Popper J.C. Spender H. Tsoukas Complexity Theory
6%	Aristotle T.H. Davenport and L. Prusak R.M. Grant K. Wiig H. Maturana and F. Varela Philosophy of Science Plato

R2.Q4.a) What is your main comment/criticism about this result?

Feedback: We would like to share some insights into "uncommon" answers, as these might be more informative (and/or provocative) than the general agreement about the table (48% explicitly agreed or thought it not surprising). The main criticism (10%) of the table was that people in KM are not well educated in philosophy (which they should be). A list of key philosophers could include F. Bacon, R. Descartes, J. Locke, D. Hume, G. Berkeley, I. Kant, G.W.F. Hegel, J. Mittelstrass, L. Wittgenstein, *and many others…*

Some comments criticised the results:
- "The virtual absence of recent (last 10 years) researchers/thinkers is very striking and suggests that their work has (for whatever reason) had practically no impact on the panellists' thinking."
- "Lots of people reference Polanyi, but how many have read and understand it?"
- "I don't think it's surprising. But it is dangerous for KM, since the ideas of Nonaka, Nonaka and Takeuchi, and Polanyi are all subjectivist and authoritarian."

A "short list" of others who influenced members of the panel (surfacing in both Rounds 1 and 2): A. Bentley, J. Dewey, F. Machlup, A. Newell, G. Ryle, and T. Matsuda. This illustrates in part how broad the perspectives represented here are, and perhaps will help

some respondents feel that we are not ignoring them… but we really didn't believe it appropriate to list all 105 influencers nominated by the panel.

R3.4.a) Would you like to make any further observations about these results?

Feedback: Major issues arose about the disconnect between philosophy and knowledge management, with a few (9%) claiming that the two were incommensurate and could not be related. A fair number (19%) criticised the educational level of the panel (despite 105 different influencers being cited). This could reflect a shortcoming of our method, given that the panel members were selected for their expertise.

Two comments serve to reflect the range of thoughts represented. First, "Every researcher should remember how important it is to stand on the shoulders of giants." Second, "These results are a reflection of the profound ignorance about knowledge among KM practitioners. To have Nonaka, Nonaka and Takeuchi, and Polanyi as the three primary sources on the nature of knowledge among Knowledge Managers is enough, by itself, to suggest that the discipline badly needs reform." The choice of which giants is, clearly, a contentious issue!

9) Readings

As several panel members actively questioned the reading heritage of participants in the KM field, we hope you will consider answering the following. We recognise that these are probably the most "private" questions we have asked during this project, and of course we will never release this information in anything other than aggregated (totally anonymous) form.

R3.9.a) Have you read any of the works of the following philosophers (not summaries by someone else)?

Feedback:

Colour Key

	50 + %
	30-49.99 %
	20-29.99 %
	10-19.99 %
	0-9.99 %

	All or almost all	Most	Some	Very little	None
Aristotle	3.2	12.9	48.4	12.9	22.6
F. Bacon	3.2	0.0	29.0	22.6	45.2
L. von Bertalanffy	0.0	9.7	35.5	12.9	41.9
G. Berkeley	0.0	3.2	12.9	16.1	67.7
F. Capra	0.0	16.1	16.1	9.7	58.1
A. Comte	0.0	3.2	16.1	12.9	67.7
R. Descartes	0.0	6.5	38.7	22.6	32.3
J. Dewey	3.2	12.9	22.6	9.7	51.6
G.W.F. Hegel	6.5	9.7	29.0	19.4	35.5
D. Hume	3.2	6.5	22.6	22.6	45.2
I. Kant	6.5	16.1	38.7	22.6	16.1
J. Locke	6.5	16.1	38.7	3.2	35.5
K. Marx	6.5	6.5	48.4	19.4	19.4
H. Maturana (and F. Varela)	6.5	12.9	19.4	12.9	48.4
J. Mittelstrass	0.0	0.0	3.2	9.7	87.1
F. Nietzsche	6.5	16.1	22.6	32.3	22.6
Plato (e.g., Socrates)	3.2	22.6	48.4	12.9	12.9
M. Polanyi	12.9	19.4	29.0	19.4	19.4
K. Popper	6.5	32.3	9.7	29.0	22.6
J.J. Rousseau	3.2	3.2	22.6	16.1	54.8
A. Turing	0.0	6.5	12.9	16.1	64.5
J.P. Sartre	0.0	12.9	29.0	19.4	38.7
A.F. Whitehead	0.0	0.0	16.1	19.4	64.5
L. Wittgenstein	6.5	6.5	25.8	29.0	32.3

R3.Q9.b) Have you actually read Polanyi's "The Tacit Dimension"?

Feedback: 43% of the panel indicated yes, while a further 17% had partially read it.

R3.Q9.c) Have you actually read Nonaka and Takeuchi's "The Knowledge-Creating Company"?

Feedback: 89% of the panel responded yes, while a further 11% had partially read it. Therefore, every panel member has read at least part of the book.

This theme first illustrates what knowledge management *is*. From the results of Question R1/2.Q8, it can be concluded that while the experts on the panel have a wide range of interests, a large majority agreed that knowledge management is mostly about organizational learning, intellectual capital, and innovation management. While designing the list of interests for the second-round Question R2.Q8, based on respondent indications from the first round, complexity theory and systems thinking

were included, for two primary reasons: first, because both were mentioned many times across all questions by the experts, and as shown in previous themes, there was reason to think that they might be central to a reconceptualization. Second, they were both mentioned in the responses on R1.Q8, reinforcing support to include them in the table. The results show that both are closely related to knowledge management, which supports their role as reconceptualization lenses.

This theme also provides some insights into the influences on the experts, showing the predominance of Nonaka, Takeuchi, and Polanyi in the field. Out of the 105 different names or influences given by the panel in response to R1.Q4, only two responses were not people's names; one of those was complexity theory, once again reinforcing the importance of this theory for knowledge management. The results also show a mix of knowledge management academics and philosophers, which was expected due to the nature of the field (being centered on knowledge). For the second round, a condensed list consisting of all responses nominated by over 5% of the panel was provided for comments; this list contained fourteen people and two concepts. Many experts found this abbreviated list worrying, judging that it showed a lack of recent influences as well as a lack of philosophy inputs. However, these conclusions from some experts may be biased because of the fact that the whole list (of 105 nominated influences) was not provided to them due to its length and the likely negative effect on response rates this would have induced.

Consequently, a list of the most common philosophers was provided for commenting in Question R3.Q9.a. This list contained the most frequent answers from the experts, supplemented by key names identified in the literature review in Chapters 3 and 4. The results seem to indicate that most experts have not read widely in the field of philosophy, focusing mostly on Plato, Aristotle, Kant, Locke, Marx, and Polanyi (in order of descending readership), who were the only names to reach more than 50% of readership among the panel at a level of 'some' or higher, and Popper, who while not reaching that result (48%), achieved the highest readership level in the categories 'Most' and higher. He is followed by Polanyi in that regard; all other names did not show results higher than 30% for these levels (see Figure 5.7 for details). These results seem to corroborate the first-round findings from R1.Q4 and the subsequent concerns expressed by the panel regarding lack of broad influences on the field of knowledge management.

5.3.6. Other results

This section discussing 'other' (non-themed) results reports on Questions R2.Q3.c, R2.Q6.b, which were not included in the feedback given to the experts, and on the questions relating to the application of the Delphi method itself.

Feedback from Question R2.Q3.c was discarded because 33 out of the 45 experts in the second round did not answer the question. Some of the experts answering the question mentioned they had already answered it previously, and that their previous answer should be looked at in that regard. It was assumed that this question was too broad, and that its content was covered by other questions.

Question R2.Q6.b received no feedback for two reasons. The first reason is that 42% of the experts did not answer the question as expected, and their answers could not be included in a simple result framework. This may be due to the fact that this question may have been poorly conceived. The second reason is that this question (as well as Questions R2.Q6.a and R2.Q6.c) frayed many nerves in the panel. It seems fair to say that this particular question was quite leading and tried to push the answers towards a conclusion the researcher had reached while creating the models introduced in Chapter 6. Therefore, this question was discarded from the rest of the study.

Questions R3.Q10.a/b were added at the end of the third questionnaire to assess the Delphi method itself, its present application, and the experiences of the panelists during this study. Figure 5.8 provides the questions and feedback provided to the panel.

Figure 5.8: Delphi Questions and Feedback Concerning the Delphi Method

<div style="border:1px solid black; padding:10px;">

<u>**10) The Delphi method**</u>

R3.Q10.a) What are your thoughts on the Delphi method?

<u>Feedback</u>: In general, panellists appreciated the use of the Delphi approach for this study. Given that those who answered this question are those who stuck with this study through the third round, this is obviously a biased observation. (Nonetheless, we chose this approach because we believed it was the most appropriate for this portion of the overall project.)

Some favourable observations:

13% of the respondents mentioned that it had been a self-reflecting exercise, as well as a challenging one.

</div>

10% said it was a good tool to obtain feedback and experts' insight, while a further 10% added that it was a good knowledge sharing tool.

6% mentioned that it was a good method to explore consensus.

Comments critical of the Delphi method:

An equal 6% argued that the emphasis on consensus was too great.

All other critiques were voiced by one respondent each. They noted that the process was too centrally driven, closed-ended questions would have been better, the process was time-consuming, and the method is inappropriate for use in an academic setting.

Three comments in particular are worth highlighting, as they reflect our perspective:

"It is a centrally-driven methodology. I find it a bit old-fashioned. In the age of the internet some more distributed and decentralized methodologies should be devised, that allow for sideways transactions and communications. Central guidance and unilateral interpretation of answers by the part of the researchers heavily influence the results. Think about what could have come out from an ongoing all-to-all internet-based conversation? You should have given us just the protocols and a web forum and we, "the experts", would have engaged in ongoing multiple conversations, a process similar to open source software development. I bet you would have obtained different results. Delphi is a very limited way of organizing a knowledge process."

"I think a good addition to the methodology (although with this crowd it may get wild) is to facilitate a chatroom discussion. When "experts" bounce off of each other, much more happens than when they simply respond to questions."

"It is still one of the best tools to explore the degree of consensus amongst a community of interest."

R3.Q10.b) What are your comments about our application of the Delphi method?

<u>Feedback</u>: First, thank you for all of your nice comments! *(We won't reproduce them here – that's too much like patting yourself on the back, but we appreciate the notes nonetheless!)*

The majority of respondents indicated that we used the Delphi approach in an appropriate situation and applied it well. Over 20% indicated they "enjoyed" it.

The most frequent neutral observation is that the process was different from what was expected.

Second, well, some of you didn't particularly appreciate some of the aspects of this study. We won't try to change your mind – that's not the point of this project – but we will summarise some of your criticisms, for the purpose of improving both our and others' use of this approach in the future.

Small numbers of respondents (one or two individuals) indicated frustration with the process, too much emphasis on consensus, too tight deadlines, that the topic was too broad, and that our tables were sometimes difficult to interpret (one person noted elsewhere that "if you color the mess, you get colourful mess").

As a closing observation:

"I enjoyed answering your questions. Being an academic, I am not easily swayed by majority or committee view (by the lowest common denominator). I have learned from the responses of others how to simplify and sharpen my own views – so I did change in the direction of sharper differentiation and distinction. I assume many others did the same. So, after the Delphi exercise, you should have more differentiation than consensus. That would be good. You want sharp, distinct views to choose from, not a consensual, tepid, quilted and colorful mess of nothing."

Overall, this Delphi study was well received by the panel, and the experts provided many positive and encouraging comments. However, some manifested concern about this method's focus on consensus. It was not the objective to force consensus in this study but rather to map any that could be found. Furthermore, the Delphi technique can be tiring for some experts, particularly those who happen to be outliers who want to defend a perspective that may not be taken into consideration for inclusion in the feedback. In order to challenge the panel, many comments from outliers were included in the feedback, but this was not always possible. Most importantly, the feedback from some experts supported the idea that the Delphi is a knowledge sharing tool, particularly useful to explore consensus, which was the application intended by the researcher. The next section considers the method in more depth.

5.4. Reflections and Implications

This section reflects on the application of the Delphi method in this study and links the main results obtained with what was discussed in the previous chapters. Some implications for future research are also provided.

5.4.1. Reflections on the Application of the Delphi Method

Both the process and the results of this study proved to be unpredictable from the very beginning. It seems that this is consistent with the notions of complexity theory explained in Chapter 2. Considering the notion of social CAS, and applying the concept to the panel of experts, the questionnaires in Rounds 2 and 3 are therefore the outcome of self-organizing processes among the experts' responses and the researcher. Although the feedback process was planned, the content could not be foreseen and involved a tight time frame in order to ensure the retention of experts (and their interest), resulting in a low drop rate despite high workload commitments by the participants. Analysis of the data gathered during this Delphi study shows how positive and negative feedback

played significant roles in shaping the final results and how novel ideas emerged from the panel. The complex nature (in the sense of complexity theory) of the Delphi method proved to be highly suitable for the context of this thesis.

Given the nature of the knowledge management field and the respondents, it was anticipated that experts would analyze the questions. Some people challenged specific questions, or terminology, or the lack of "given" definitions – but that was part of the research focus of this project. Some questions were interpreted quite differently than expected by a few respondents. A few respondents (who can be considered as outliers) were quite vocal about omission of their exact wording or opinions in the first- and second-round feedback. However, no comments were ignored – every response was analyzed with care – but within the context of avoiding overloading participants, who were already being very generous with their time. For example, one question received two typed pages of comments from one respondent, and another question received 52 quite different responses. Part of the Delphi process is "seeking a managed consensus"; the researcher's interest went well beyond this alone, and this distinctive aspect of the Delphi approach has to be recognized as both an advantage and a shortcoming. For those individuals who opted out of the Delphi, a direct and personal correspondence continued in some cases. Despite the loss of the "group"-oriented Delphi input, these informal discussions happened to be quite instructive. It is, however, beyond the scope of this thesis to present them as collected data, as these discussions were not planned, and occurred spontaneously.

The large feedback tables that were intended to make it easier for the researcher and the panelists to summarize their comments did not receive as much credit as expected. Some respondents complained about the use of multiple colors as being distractive, while a few complained about the size of the tables. It seems that the Delphi approach is easiest to manage with closed questions, as there is less room for varying interpretations; however, closed questions dramatically reduce the potential for generating new ideas, which is a strength of this method (at least in its present application). Definitions are an issue; although this study was interested in how experts were 'mapping' concepts, defining the concepts beforehand would most certainly have tainted the results, pushing away those experts not sharing the proposed definitions and narrowing the insights obtained from the results.

5.4.2. Reflections on the Answers Given by the Panel of Experts

Panelists raised numerous issues regarding the definitions of data, information, knowledge, and wisdom. While defining these four concepts, most panelists placed them within the classical pyramid framework; however, in the third round a consensus was reached on the need to eliminate it. This echoes the need for non-linear frameworks as discussed in Chapters 2 and 3, while also supporting the necessity of a reconceptualization of the core of knowledge management frameworks, as illustrated in Chapter 4. Analysis of the panelists' readings and influences reinforces the view that the field has lost track of its roots in the philosophy of science. Many panelists had perspectives derived from the field of information science. This is in line with the discussion of the historic development of the field of knowledge management provided in Chapters 3 and 4.

As suggested by the literature, the distinction between tacit and explicit proved to be of prime importance. Furthermore, the distinction between implicit and tacit was not mentioned by the panel, which supports the argument introduced in Section 3.3.2 that these two concepts should not be separated. While a consensus does not seem to exist, many panelists suggested the existence of a continuum from tacit to explicit, as introduced in Section 3.3.3.

From the responses of the panel of experts, it seems that the broad consensus is that knowledge can be managed (although the tacit dimension poses additional difficulties). That conclusion seems rather predictable, given that the experts were drawn from publications in the field of "knowledge management." Responsibility for managing organizational knowledge was dispersed, with two-thirds of the panel locating it in management (from CEO through CKO to "all management levels") and one-third indicating it was everyone's responsibility. Hence, a supportive environment was seen as particularly important, with employee empowerment and appropriate organizational structure and leadership clearly within that context, supporting claims underlying this thesis which will be further discussed in the following chapters, where new knowledge management frameworks will be introduced.

A major re-conceptualization of the field was called for by three-quarters of respondents, but no single existing framework garnered significant support to provide the ground for it. Nearly 80% of the panel agreed that knowledge management will need to advance to a new paradigmatic stage to truly bridge the gap between theory and

practice, supporting the conclusions of Chapters 3 and 4. Systems thinking and complexity theory emerged as the most appropriate theories to support such a shift. This is the line of reasoning taken in Chapters 6 and 7, which propose the basis for the reconceptualization called for by the panel of experts.

5.4.3. Limitations and Suggestions for Further Research

Readily apparent limitations are the low number of participants, the fact that they have not rated themselves as experts, the assumption that their publications make them 'experts,' and that the selected journals are assumed to be reputable sources of experts. Delphi validity has usually been tested by replication, which would require a comparable second Delphi study. However, because the original study contacted an exhaustive sample that constitutes nearly the entire population from a sampling perspective, it is unlikely that a second, comparable panel could be obtained because all those willing to participate have already done so.

Reliability is an issue, as the primarily qualitative data obtained must be interpreted by the researcher in order to group and/or categorize the responses. Brainstorming sessions to discuss the results and classify the answers have been used, and the researcher is confident that this process has been performed accurately. However, mistakes are human, and therefore the classification could contain errors, notwithstanding the issue of replicability in that another research group might well have made different calls on some of the interpretations made of the panelists' answers.

Further research into the concepts, frameworks, and paradigm of knowledge management should be conducted. This project raised more questions than it answered, which is an indicator of a vibrant and growing field. Given the incomplete consensus obtained on nearly every issue raised by this research, years of lively debate can be anticipated as the field matures.

5.5. Summary

This chapter has provided a brief discussion of the Delphi method, its origins, and its field of application. This chapter also presented a Delphi study utilizing a panel of experts to explore existing consensus and dissension within the field of knowledge management. The purpose of this study was to examine the current state of knowledge management, and to assess issues related to questions raised in previous chapters, such

as the validity of the DIKW framework and the potential need for reconceptualization of the field. Results indicated that knowledge management is a field in flux, demanding improved conceptualizations and a developed consensus among academics and practitioners. As a step in this direction, experts hinted that complexity theory could open a suitable avenue to reach a new integrative paradigm. Additionally, this chapter has shown how the Delphi method can be altered for use in mapping consensus among a group of experts, and how it can serve as a key research tool to study a complex issue.

Concurring with the findings of Chapters 3 and 4, this chapter has confirmed the need for a reconceptualization of the field of knowledge management using complexity theory, which is the focus of the next chapter.

Chapter 6. Reconstituting Knowledge Management

The three preceding chapters have shown the need to reconceptualize knowledge management in light of systemic thinking, in particular the use of complexity theory. While not ignoring the development of the field and conceptualization of the past illustrated in Chapters 3 and 4, knowledge management needs to depart from linear thinking in order to move forward. Several scholars have started this task, and this thesis builds on their work to propose further developments. This chapter introduces the Existence to Enlightenment (E2E) model, the first conceptual contribution of this thesis. This model addresses the different issues raised throughout this thesis and proposes a systemic and radical constructivist view of the concept of knowledge. Grounded in this new framework, the Leadership Invigorating Flows of Energies (LIFE) model, the second conceptual contribution of this thesis, is then presented. While the E2E model addresses issues regarding the concept of knowledge raised in Chapter 3, the LIFE model focuses on knowledge processing as discussed in Chapter 4. These two models represent the main theoretical foundations to reconceptualize the field of knowledge management based on a complexity theory approach.

This chapter includes five sections.

- Section 1 briefly discusses the need for new models and outlines the characteristics of such models based on findings from previous chapters.

- Section 2 introduces the E2E model and explains how it answers the need for a new model of the concept of knowledge.

- Section 3 introduces the LIFE model and describes its functioning.

- Section 4 discusses the implications of the LIFE model for knowledge management.

- Section 5 is a summary of this chapter, and provides the basis for the next chapter, which is an application of the LIFE model.

6.1. The Need for New Models

The concept of knowledge remains a hotly debated topic in the knowledge management literature. The panel of experts gathered during the Delphi presented in Chapter 5 emphasized that point. Echoing the literature reviews in Chapters 3 and 4, the results of the Delphi indicate that the development of systems thinking and complexity theory in the field highlights the need for a deeper and more integrated understanding of knowledge management. There is a need to replace the traditional pyramid and provide an alternative to the classical models (e.g. SECI and the knowledge creation model) by a more systemic concept of knowledge, based on stronger philosophical foundations.

A more comprehensive model of knowledge should purport to include the concepts of non-linearity, specification of relationships and feedback systems, and system boundaries. This new concept of knowledge has to be integrated in a systemic framework depicting the knowledge processing system of an organization. Ideally, this framework should be scale-free, and should respect the same criteria as those of the concept of knowledge. Most of all, that model should address all aspects of systems and complex thinking. In particular, it has to clearly address the concept of energy, which is missing from the models found in the literature.

The two following sections present two new models, which address all these points. Together, they provide the basis for an integrated framework of knowledge management.

6.2. Towards a New Understanding of the Concept of Knowledge

The following section presents a new model of the concept of knowledge that addresses issues raised in Chapters 3 and 4, based on insights from complexity theory as called upon in Chapter 5. This model, called the Existence to Enlightenment (E2E) model, proposes an integrated framework linking the constructs of data, information, knowledge, and wisdom through a feedback system of increasing levels of understanding, bound between two states of being: existence and enlightenment.

6.2.1. Redefining the Scope of the Hierarchy

All the definitions and models reviewed in Chapter 3 have led to a linear hierarchy (Figure 3.1), where data is the basis for information, which is the basis for knowledge, which is itself the basis for wisdom. The reverse of the ascent from data to wisdom is

also possible, following the same reasoning. Authors can describe it as a pyramid, a hierarchy, or a circle, but it remains linear as there are no feedback loops. The first step for improving these models is to realize that they have neither a starting point nor an ending point. In other words, these models need clearer boundaries.

From Table 3.2 it is obvious that the literature focuses on defining the difference between information and knowledge, but little attention is paid to the definition of data. Data is not found in nature; it does not grow on trees, and it does not fall from the sky for free. Data have to be made out of something. Data are usually described as observations of reality. In prehistoric times, Cro-Magnons used pictographic representation for data while counting animals. Later in history, Sumerians applied symbolic representations of data to capture and record grain harvests and other economic data. Hence, data are more that just observations; they are a level of understanding of existence. Existence describes the whole environment that humans can grasp and create data about. Data are a very basic processed outcome of human observation of existence. This idea of including existence in a more complete framework of knowledge is consistent with the ideas of the French philosopher Jean-Paul Sartre, whose classic phrase "existence precedes essence" (and therefore any abstraction of it) is considered the essence of existentialism (Sartre, 1956; Philosophy Pages, 2006; Wikipedia, 2006a, 2006b).

Having addressed the "lower" boundary of the knowledge system, it is appropriate to turn to the "higher" boundary – seeking a state of being that will complement existence, but constitutes a logical progression "upwards" from knowledge and wisdom. What is higher than wisdom? Buddhists refer to enlightenment as the awakening of beings. To awaken is to achieve a level of insight and understanding equal to that of the Buddhas (Van Hien study group, 2003). However, they make a distinction between awakening and supreme enlightenment, as there are many levels of awakening. It is not the intention of this thesis to discuss metaphysics; however, such a concept is useful in reaching the full scope of a hierarchy of knowledge. Enlightenment is the highest form of understanding, a state of full understanding. Therefore, it should be incorporated into a model that purports to represent a complete perspective on the hierarchy of knowledge. The result is illustrated in Figure 6.1. Note that this diagram also shows development based on Bellinger, Castro, and Mills (2004) and their modified hierarchy of knowledge based on the model of Berger and Luckman (1966) which transitions from data to information, knowledge, and wisdom through an increase of connectedness

and understanding. Understanding is therefore identified as the transformational relationship among data, information, knowledge, and wisdom to create an outcome at a higher level.

Figure 6.1: The Extended Knowledge Management Pyramid
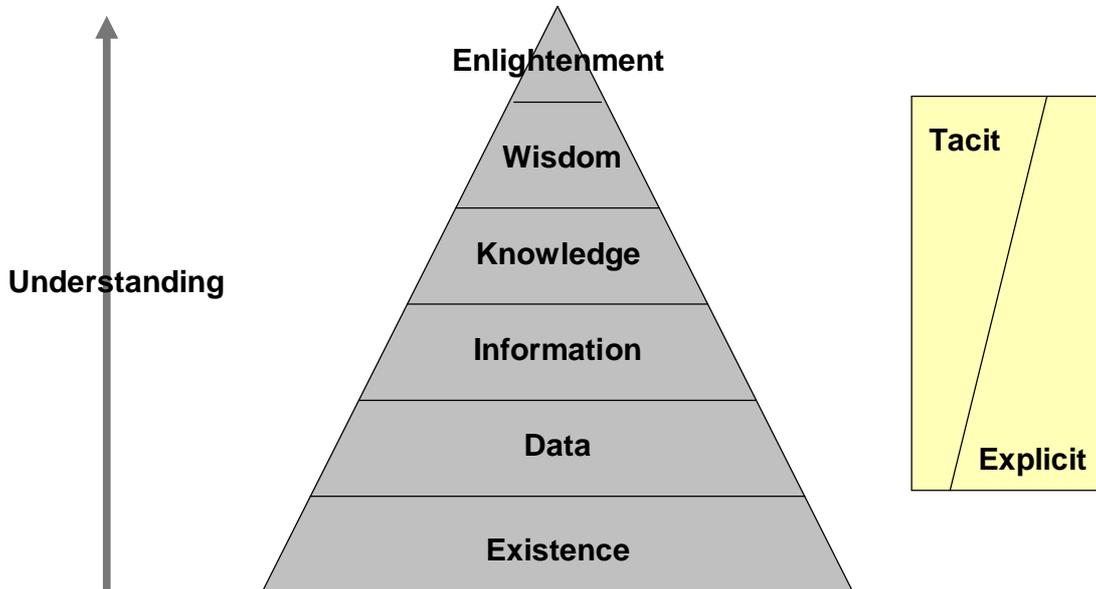
The above discussion of the extension of the traditional hierarchy is consistent with the idea of openness of complex adaptive systems. Indeed, it is suggested in this thesis that not having the two constructs of enlightenment and existence means not taking into account the appropriate borders of the knowledge system. Consequently, traditional models such as the knowledge pyramid are closed systems. Because knowledge management would profit from complexity theory (McElroy, 2000), a more coherent model of the knowledge system should be open.

Existence and enlightenment are the two states of being which provide the boundaries of the knowledge system. Data, information, knowledge, and wisdom are cognitive constructs lying in between those two states.

While this diagram summarizes useful extensions to the traditional hierarchy it still does not embrace all the improvements possible by using ideas from complex systems. In particular, the diagram still shows a linear hierarchy and it does not show any feedback systems. For example, is it possible to create new knowledge by linking new data with previous wisdom? Can new information be created by linking previous knowledge and new knowledge? How can the need of knowledge to create or use data be depicted? All the models presented previously do not help to show the relationships that exist among data, information, knowledge, and wisdom. Linear thinking is holding back the creation

of good metaphors to describe the concept of knowledge completely. What is needed is a model without a linear hierarchy between data, information, knowledge, and wisdom, because – as shown later – they are all made up from the same basic unit. They are all labels used to structure human understanding of the same construct: existence. The real distinction among them is learning experience and understanding.

6.2.2. Redefining the Basis of Knowledge Management

Simple mathematical notation can be employed to explain how data, information, knowledge, wisdom, and enlightenment relate to existence. The following is a metaphor to demonstrate this point. Data (D) is an abstraction of existence (X), therefore $D = a \times X$, a being the coefficient corresponding to the abstraction. Information is data that is processed in some way, so it can be reported as $I = b \times D$, b being a coefficient for the understanding that is required. In the same way knowledge $= K = c \times I$, wisdom $= W = d \times K$, and enlightenment $= E = e \times W$. Therefore, the system can be described in the following terms:

$D = a \times X$

$I = b \times D = ab \times X$

$K = c \times I = abc \times X$

$W = d \times K = abcd \times X$

$E = e \times W = abcde \times X$

Consequently, everything is based on abstractions from existence. One can also argue that data is made of symbols (Ackoff, 1989), but that does not change the result because symbols are still abstractions of existence. Regardless of the type of concepts applied - such as meaning, judgment, or anything else – they are still all based on the same thing. What is important is the coefficient that differs among them. The distinction among these constructs is a level of abstraction and understanding. Therefore, a, b, c, d, and e all represent transformation through different levels of understanding, the factor suggesting an exponential degree of thinking:

$D = u \times X$

$I = u^2 \times X$

$K = u^3 \times X$

$W = u^4 \times X$

$E = u^5 \text{ x } X$

It is also possible to use functional notation to express the same concepts, e.g. K = a(b(c(X))) or W = u^4(X).

Data, information, knowledge, wisdom, and enlightenment are transformations of existence. Therefore, the traditional hierarchy is obsolete, as it does not represent the totality of the possibilities. These equations emphasize that point by showing how data, information, knowledge, and wisdom could be portrayed from a different perspective.

However, this is still not sufficient. Social interactions are the basis for the existence of data, information, knowledge, and wisdom. Indeed, according to many authors, data, information, and knowledge are linked through social interactions (e.g., Nonaka and Takeuchi, 1995; McElroy and Firestone, 2003; Wiig, 2004). The fourth form, wisdom, should be added to this list, and the possibility of cognitive (as well as social) interaction as a linking mechanism should not be overlooked. These four forms can interact in non-linear ways (as well as along the traditional linear paths). Hence, existence, data, information, knowledge, wisdom, and enlightenment form a feedback system with positive and negative feedback loops. This is a non-linear appraisal consistent with complexity theory, which helps to reveal the nature of the links among data, information, knowledge, and wisdom and helps to understand why the classical hierarchy is not appropriate.

6.2.3. The E2E Model: Rethinking the Cognitive System of Knowledge

The E2E model takes its name from the metaphor it represents. The model shows the cognitive system of knowledge and how understanding permits conceptual linking of existence to enlightenment. The E2E model accommodates the classical linear hierarchy of data, information, knowledge, and wisdom, and also incorporates the extension (on both ends of the hierarchy) from existence to enlightenment previously discussed in this Chapter. Figure 6.2 illustrates this (the model without the hierarchies is shown in Figure 6.4).

Existence, data, information, knowledge, wisdom, and enlightenment are all part of a cognitive system of knowledge. Cognition is the facilitation process through which the system functions; it is the process by which knowledge and understanding are developed. One implication of complexity theory is that a cognitive system of knowledge will emphasize what a system does, not what it is composed of. Note also

that existence and enlightenment are two states of being. Therefore, cognition is involved at the transitional states between existence and enlightenment, but not at the two ends themselves. Indeed, data, information, knowledge, and wisdom are different cognitive constructions intermediate between these two states.

Figure 6.2: A New Perspective of The Concept of Knowledge
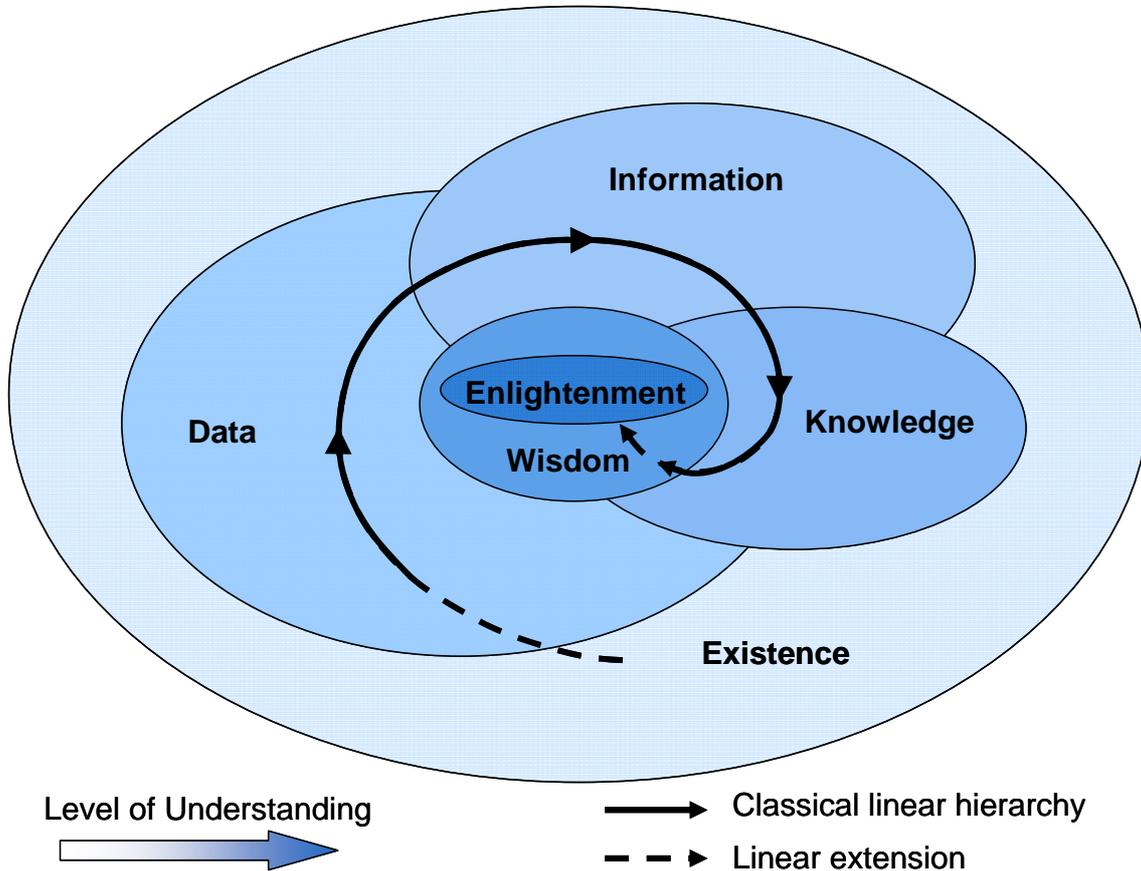
Contrary to past understandings of systems of knowledge, this model is a claim that there is no hierarchy among data, information, knowledge, and wisdom. One does not need to obtain them in a specific order. Depending on the situation, one may not even need to have all of them. For example, a new receptionist employed by an organization may not have any specific data about the customers but may have the wisdom required to manage customer relationships based on values instilled during the receptionist's formative years. Hence, one can obtain information directly from an understanding of existence, without having to acquire any data enroute. In the same manner, one can create knowledge from data without having to create information as an intermediary. This is consistent with the premise of complexity theory that systems incorporate non-linear feedback; such transitions across state boundaries similarly take place in the cognitive system. Figure 6.3 illustrates this perspective by showing all the different

cognitive paths among the constructs, which gives a very different picture than Figure 6.2.

Figure 6.3: The Different Cognitive Paths Among the E2E Constructs

Level of Understanding
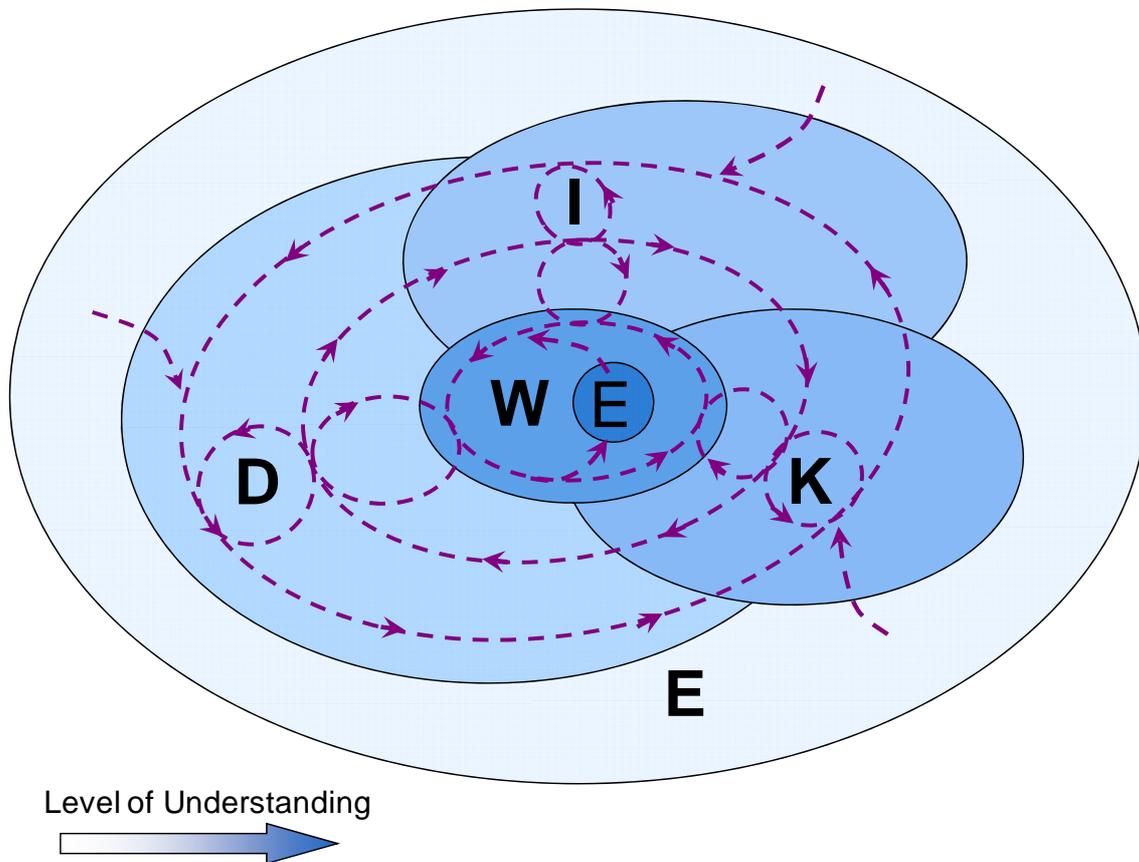
This cognitive system of knowledge is a social construct, the result of the interaction between a cognitive base (data, information, knowledge, and wisdom already possessed) and its environment through its existence. The cognitive base provides the history of the cognitive system, which is an important feature of complex adaptive systems (Bak, 1996). This implies path dependencies and the irreversibility of time, as argued by Prigogine (1997). All individuals have cognitive systems embedded in their mental processes. At a higher level, organizations also possess a cognitive system. Indeed, individual cognitive systems are constituent sub-systems of the organizational cognitive system. Again consistent with complexity theory, the cognitive system of knowledge is considered to be scale free as it exhibits self-similarity at different levels of complexity, i.e. individual, group, and organizational levels.

It is crucial to understand that it is the social interaction among people; established data, information, knowledge, and wisdom; and new data information, knowledge, and wisdom that will create valuable insights. Indeed, the cognitive base will help to create

new data, information, knowledge, and wisdom, but it is the feedback engendered by these new data, information, knowledge, and wisdom that will enable cognitive creativity.

Newly developed or acquired knowledge can be used on an existing database to create new data, but can also lead to new information, knowledge, or even wisdom. Understanding is the power that generates new links among data, information, knowledge, and wisdom. New data can resonate with the knowledge base and lead to the creation of new wisdom. New knowledge can interact with old information and create a new understanding, which could mean the creation of new data, information, knowledge, or wisdom.

New data, information, knowledge, and wisdom can therefore emerge from the combination of newly developed or acquired data, information, knowledge, and wisdom and their respective established bases. The exact output depends upon the type of understanding that is generated within the system. Thus, the model shows how different levels of understanding are required to handle the different constructs of data, information, knowledge, and wisdom. Furthermore, the need for a higher level of understanding is linked to the tacit and/or explicit nature of these constructs. The higher the level of understanding that is required, the greater the chance that data, information, knowledge, and wisdom become tacit.

But if there is no hierarchy; and if data, information, knowledge, and wisdom are different levels of abstraction of existence, their definitions should be re-examined to verify whether they are still appropriate. In this context:

(1)   Data is a basic interpretation of existence. It is a purely descriptive construct that requires a low (categorical) level of understanding of existence.

(2)   Information is viewed as a meaningful interpretation of existence, one that has a purpose. It is a connective understanding of existence. It requires a higher level of understanding than data, but a lower one than knowledge or wisdom.

(3)   Knowledge is here defined as a meaningful and procedural abstraction of existence. It has a purpose and is a procedural understanding of existence. Without knowledge, lower levels of abstraction of existence are not actionable. Knowledge requires a higher level of understanding than data and information, but a lower level than wisdom.

(4)   Wisdom is understood as a meaningful, procedural, and justified abstraction of existence based on experience. It has a purpose, relates to procedures, but it is also based on a coherent judgment of existence justified through experience. Wisdom therefore permits sound action and use of experience. Wisdom requires a higher level of understanding than data, information, and knowledge.

It is important to notice that these definitions do not imply a linear hierarchy. This means that, for example, information is not just data that has been processed in a useful manner. Furthermore, none of the definitions are linked to facts. It is thought that one needs to move away from using the word "fact" when defining such concepts as fact means "a thing that is known to be true". Indeed, it would add more confusion than precision to the definitions. Of course, data, information, knowledge, and wisdom are thought to be true by the people using them. But one needs to keep in mind that they are fallible. They are held to be true until proven wrong or superseded by something more coherent. Figure 6.4 provides an illustration of the E2E model.

Figure 6.4: The E2E Model – A Complexity-Based View of the Cognitive System of Knowledge
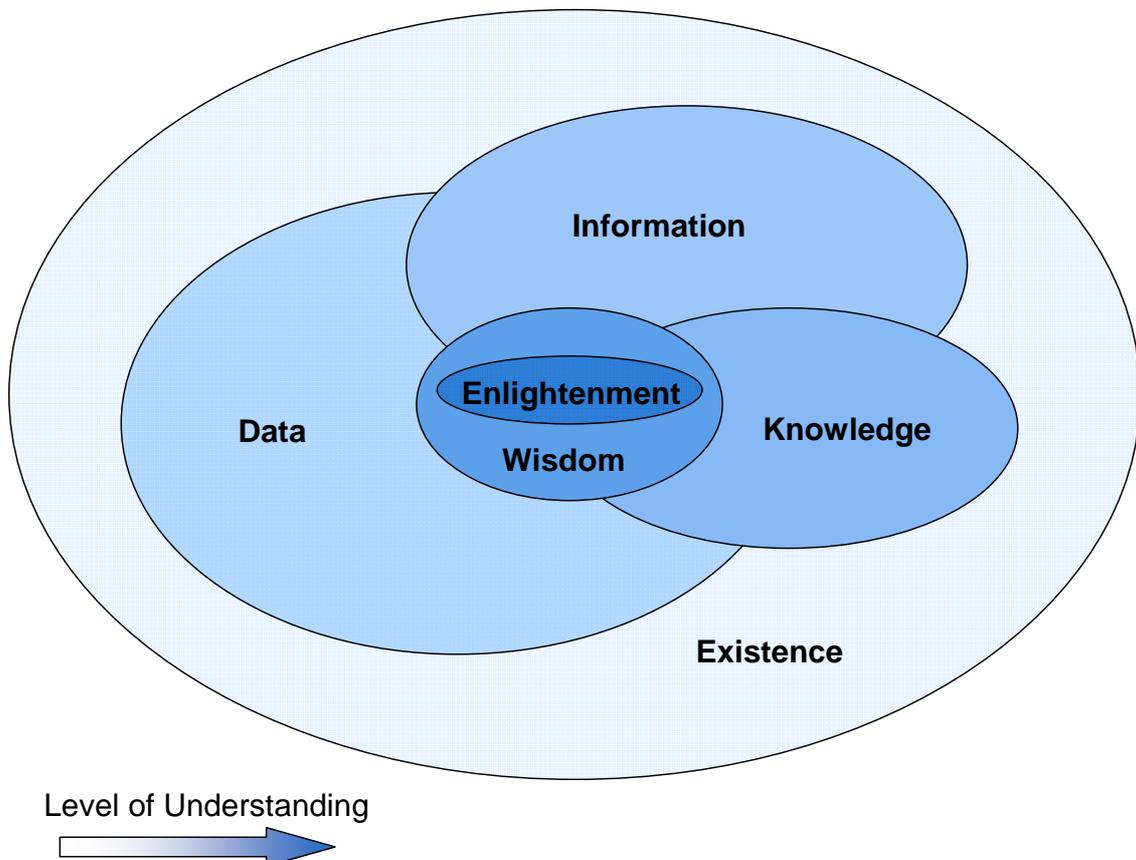
Why is wisdom not connected directly to existence in the model? Wisdom presupposes experience, and experience implies the presence of a cognitive base. Therefore, having

wisdom means one already has some form of data, information, and/or knowledge. Furthermore, as has been discussed earlier, enlightenment is the highest form of understanding. It is not something to have; it is a state of being, such as existence.

Considering non-linearity also leads to a reconsideration of the role that "metas" play in this revised model for knowledge management. The idea of meta-knowledge is shown in many models (Wiig, 2004; McElroy, 2003), but this is not extended to meta-data or meta-information. The next section provides a discussion of the metas and highlight their role in knowledge management.

6.2.4. The Metas and the Reconstitution of Knowledge Management

Meta- has been used in the literature as something referring to itself, e.g. meta-knowledge being knowledge about knowledge (McElroy, 2003; Wiig, 2004). According to the Oxford English Dictionary (2008), meta- means connected with a change of position or state, higher, beyond. Knowledge about knowledge is not meta-knowledge; it is just another kind of knowledge. It can be useful knowledge, but it has nothing meta- in itself.

Meta-data, -information, -knowledge, and -wisdom, are data, information, knowledge, and wisdom associated with a change of state; they are at a higher state of development, situated beyond (respectively) normal data, information, knowledge, and wisdom. So what are they exactly? This thesis suggests that they are the essential subject that knowledge management should administer. They are the understanding of the conversion processes. Meta-data is the understanding of how data is transformed into another form, such as information, knowledge, wisdom, or a more complex set of data. Meta-knowledge is the understanding of how knowledge is converted into data, information, wisdom, or a more complex form of knowledge. Referring to Figure 6.3, they are the understanding of all the different paths portrayed.

Essentially, the metas constitute understanding, or the form of knowledge traditionally termed "know-how," about how to extract, apply, abstract, and generalize from one level to another. However, it is not appropriate to describe the metas as just one form of knowledge as they are holistic constructs of understanding composed of data, information, knowledge, and wisdom about the conversion processes. What is interesting here is that the metas constitute understanding of how to pass from one level of abstraction to another (in both directions, to a higher degree or to a lower degree of

abstraction, in single steps or greater leaps). Therefore, the search for and understanding of the metas is the core of the concept of knowledge management as an academic subfield. (Note that this concept is to be distinguished from the practice of knowledge management, which typically concerns management of an organization's resources of data, information, knowledge, and wisdom, and interactions among them.)

6.2.5. Implications for Knowledge Management

The initial goal for the field of knowledge management was to create a holistic concept of knowledge; this commenced with the work of Zeleny (1987) and Ackoff (1989), but shortly fell into reductionism. It then underwent evolution (as did the concept of knowledge), receiving numerous new linear models such as the pyramid, and is presently ready to evolve from a reductionist approach towards a holistic one. The traditional DIKW pyramid is no longer satisfactory as it does not present the whole picture necessary to understand the concept of knowledge, failing to provide key linkages among the concepts (notably including feedback loops, permeable boundaries, and potential conversion among tacit and explicit forms of knowledge).

The field of knowledge management is fragmented among different perspectives that cannot portray an integrated concept of knowledge. The future of knowledge management lies in a refinement of systems thinking into more theoretical and practical applications, particularly using a complexity theory-based framework such as the E2E model. The next section goes a step further and introduces a new model of the knowledge processing system.

6.3. Towards a New Understanding of the Knowledge Processing System

While the preceding sections of this chapter dealt with the concept of knowledge and its reconceptualization into a systemic framework, this section takes this theoretical task one step further and addresses the reconceptualization of knowledge management itself. As explained earlier, knowledge management is not knowledge processing but rather a management discipline whose aim is to enhance knowledge processing (McElroy, 2003). Therefore, the focus of knowledge management should be on studying the KPS, defined here as the system of social processes through which knowledge is created, diffused, and utilized within a human organization. Existing models of knowledge processing do not demonstrate a systemic meaning of knowledge management and

ignore the roles of leadership and social energy. The Leadership Invigorating Flows of Energies (LIFE) Model presented in the next section arises from the principles of complexity theory and attempts to provide a more useful description of the knowledge processing system.

6.3.1. Leadership Invigorating Flows of Energies (LIFE) Model

The LIFE Model is based on the holistic approach of complexity theory and aims to give a general picture of the knowledge processing system. The name of the Leadership Invigorating Flows of Energies Model designates its purpose and key characteristics: The model illustrates the synergies between leadership and flows of social energies within the context of organizational knowledge management. As described by Lash (2006), the notion of life favors the idea of flow and flux, emphasizing becoming as opposed to being, of movement versus stasis, of action over structure (echoing the title of Prigogine's 1980 book "From Being to Becoming"). This idea is consistent with the concept of living systems portrayed in complexity theory.

The LIFE Model emphasizes the dynamism of the KPS that exists in organizations and shows the different feedback systems created and influenced by social processes, knowledge activities, and flows of social energies within the organization. The model has a strong focus on flows of social energies and leadership. These important aspects are not included in previous models (such as Senge's (1990) Deep Learning Cycle, Nonaka and Takeuchi's (1995) SECI model, McElroy's (2000) Knowledge Life Cycle, or Trott's (2002) model), while in the LIFE Model they are presented at the core of the understanding of knowledge processing in organizations. Furthermore, the model emphasizes the importance of interactions between the Organizational Knowledge Base and the different stages of what is called the Knowledge Processing Cycle.

The following section provides an introduction to the components and processes constituting the LIFE Model.

6.3.2. The Organizational Knowledge Base (OKB)

The OKB is at the same time the foundation of the KPS and the repository of all its outcomes. The OKB is the aggregate of all knowledge possessed and shared within the organization, through all its members, experiences, and facilities. In the context of this model, knowledge is defined in a broad way as a collection of interrelated skills, experiences, know-how, and perspectives (Styhre, Ingelgård & Roth, 2000),

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encompassing all constituents of the knowledge taxonomy as portrayed in the E2E (existence to enlightenment) model presented in Section 6.2. Hence, the OKB contains both tacit and explicit knowledge, as well as the DIKW components included in the E2E model. However, in order not to overcomplicate the model itself, knowledge is understood in the broader sense stated above. For a more complete view of how the E2E and LIFE models interact, readers should refer to Figure 8.2 in Section 8.3.

The OKB is a social knowledge base that interacts, through flows of knowledge and energies, with all of the processes of the Knowledge Processing Cycle. It is the center of positive and negative feedback, allowing for incremental accumulation of knowledge as well as selective forgetting mechanisms. Such a feedback system is the basis of the emergence of complex adaptive systems, indicating that the OKB is a social CAS with emergent properties, arising from its self-organization capacities. It forms part of a scale-free representation of the KPS present in both individuals and organizations. Every organization has an OKB; its role is fundamental in all of the processes that occur in the Knowledge Processing Cycle.

6.3.3. The Knowledge Processing Cycle

The Knowledge Processing Cycle is a self-organizing social process expressing emergent patterns of knowledge flows. Knowledge processes are natural and exist on their own; they do not need to be created, but they can be formalized and guided in order to improve performance. The organizational Knowledge Processing Cycle is a core constituent of the organizational social network, which is the knowledge processing environment supporting the self-organization of the KPS. Hence, the objective of knowledge management is not to create the KPS but to enhance and strengthen its behavior. If this is ignored, organizational rules or policies will work against these natural processes, making them inefficient. Furthermore, managerial interventions should not go against this behavior, as it would result in a situation where the KPS is no longer sustainable through time, thereby disrupting the functioning of innovation and learning.

As shown in Figure 6.5, the Knowledge Processing Cycle is divided into eight inter-dependent activities, interacting with the OKB, external knowledge, and the organizational social network. This set of activities represents a synthesis of all models found in the literature (see chapter 4), reconciling them within a new framework derived from complexity theory. The Knowledge Processing Cycle is characterized by an on-

going mechanism, without a start or finish. Therefore, the eight activities described below interact with each other at the same time through the knowledge feedback system shown by the model. These activities can occur concurrently or consecutively, and in any sequence, depending on the circumstances, indicating that this model is not as linear as traditional models.

Figure 6.5: The LIFE Model
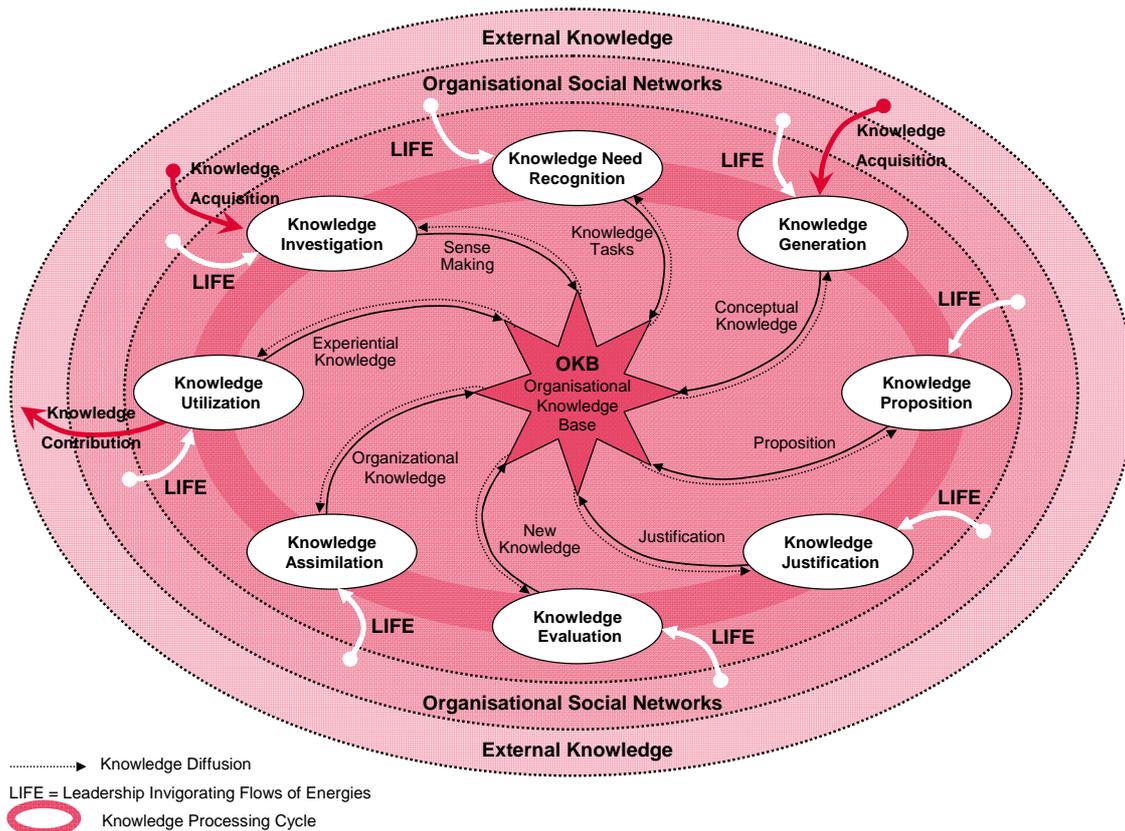
This is a general model, and it is apparent that all knowledge will follow its own way through the processes of the model. Depending on the organization in which it occurs, the frequency and types of feedback, as well as the relative importance given to processes, may vary (this will be exemplified in the next chapter with the case of Wikipedia). The LIFE Model is built on the assumption that both tacit and explicit knowledge (at all levels of the traditional Data, Information, Knowledge, Wisdom taxonomy) can occur and be processed by the model. The following presentation of the eight activities in the diagram of the LIFE Model is ordered to match the commonly-perceived sequence described in a variety of partial published models (e.g. Argyris, 1993; Awad & Ghaziri, 2004; Luo, 2000; McElroy, 2000; Nonaka & Takeuchi, 1995; Trott, 2002; Wiig, 2004; Zollo & Winter, 2002), although this is not the only possible

sequence. A fixed cyclicality is not essential and the activities can occur in any order depending upon the type of organizational learning taking place.

The Knowledge Investigation activity refers to the process of monitoring and scanning the knowledge being used inside and outside the organization. It involves comparing objectives and results, as well as checking the alignment between the organization and its environment. Knowledge Investigation includes what Argyris (1993) refers to as the detection of a mismatch between the real and expected outcomes of the organization's activities or objectives. At this stage of the Knowledge Processing Cycle, individuals analyze knowledge within all boundaries to which they have access, trying to make sense of it. During the process, external knowledge is acquired and added to the OKB. This activity is part of the strategic intelligence activities of the organization as it helps to organize and make sense of the content of the OKB for future development. Important positive feedback takes place at this stage; managers should look closely at this activity to discover emergent patterns that occur in the KPS.

The Knowledge Need Recognition activity is the formulation of knowledge needs and their related knowledge tasks. These tasks interact with the OKB, through which they are expressed and allocated. When possible, allocation of knowledge tasks should be governed by self-organizing processes and individual willingness. The idea here is to let individuals come forward themselves within the organizational social network, rather than forcing them to do so. The advantage of this approach is that it fosters the motivation of individuals, helping them to feel at ease within the organization as they receive responsibilities for tasks they have chosen. This also invigorates flows of social energy and positive feedback which will support learning and innovation within the organization. However, this implies a diversity of individuals within the organization, in terms of skills, ambitions, and topics of interest, as well as sufficient transparency for members of the organization to see what is currently being accomplished and what else is needed.

The Knowledge Generation activity occurs when new knowledge is created as the product of individual and group learning processes. This can be an outcome of a new way of combining prior knowledge held by the organization, a combination of completely new ideas, the combination of external knowledge acquired by some individuals, or a mix of these. This process by which groups and individuals challenge existing mental models combines both positive and negative feedback. Furthermore, the

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Knowledge Generation activity interacts with the OKB, as any conceptual knowledge should be retained by the system to help trace the history of the KPS, which facilitates pattern recognition. As suggested by Buchanan (2000), CAS evolve when they attain a critical state built up by a history of irreversible and unexpected events. Therefore, better knowledge about the history of the system can greatly improve the understanding and management of that system.

The Knowledge Proposition activity addresses recognized knowledge needs of the organization, arising explicitly from the Knowledge Need Recognition or tacitly from other activities in the Knowledge Processing Cycle. Furthermore, every proposition should be historically stored in the OKB and open to the view of other members of the organization, allowing for future feedback and iterations. As suggested by McElroy (2003), to facilitate formulation of knowledge claims, organizations should be organized as open enterprises, which implies that the organizational KPS stays politically open. This is a more democratic way of organizing, giving to every agent of the organization the ability to propose knowledge, as well as access to proposed knowledge and the opportunity to criticize it. Additionally, hindering relationships between individuals could lead to less efficient self-organization within the KPS.

The Knowledge Justification process includes discussion and argumentation of both proposed and current knowledge to demonstrate how the knowledge addresses a need of the organization. It also refers to the search for approval by the appropriate authority within the organization (Ballantyne, 2003). This activity can be influenced by any member of the organization. Hence, to be fully effective, the Knowledge Justification process implies openness and transparency within the organization and the OKB, as well as sufficient diffusion of knowledge among the members of the organization through positive and negative feedback. People must recognize their capacity to influence as well as accept being affected by others. These necessary rich connections lead to a more robust, adaptive, and creative system (Regine & Lewin, 2000). Finally, a history of the Knowledge Justification process should be stored in the OKB, thereby being visible to the members of the organization; this permits future examination and provides historical data to explain organizational developments.

The Knowledge Evaluation activity concerns the testing and evaluating of knowledge, including authorizing or denying the Knowledge Proposition. This consequently leads to the accreditation of the proposition (positive feedback emphasizing the original

deviation) or to the refutation of the proposition (negative feedback countering the original deviation), in which case it is sent back to the Knowledge Generation or Knowledge Need Recognition activity. This process is usually the role of managers; however, as suggested by McElroy (2003) among others, representatives of employees from throughout the organization should be able to participate during the Knowledge Evaluation process in order to create more fruitful interactions. This stage interacts with the OKB, as any result of the Knowledge Evaluation process should be retained for historical reference, allowing current knowledge as well as previous evaluations to be consulted in reaching a decision. The principal outcome and interaction of this process with the OKB is the provision of validated new knowledge complemented by records of knowledge propositions that could not be validated.

The Knowledge Assimilation activity is the process whereby members of the organization gradually adopt and incorporate new knowledge from the OKB into their personal knowledge bases. This activity includes – but is not limited to – what Nonaka et al. (2001) refer to as internalization, when explicit knowledge is converted into tacit knowledge. The Knowledge Assimilation process also includes the direct transfer of tacit knowledge and of explicit knowledge, such as the amalgamation of newly perceived experiences into the existing cognitive structure. Socialization plays an important role in the assimilation process and continuously creates feedback from the Knowledge Utilization activity. Socialization is a learning stage during which tacit knowledge is transferred from one organizational member to another through shared experience (Nonaka et al., 2001). This shared experience can involve assimilating knowledge or the experience from using it. The Knowledge Assimilation activity's interactions with the OKB should be monitored and shared among members via the OKB through tools such as story telling, interviews, meetings, etc., hence increasing the likelihood of innovativeness in the organization.

The Knowledge Utilization activity consists of the application of tacit and explicit knowledge to guide organizational activities, including decision making, information gathering, or any of the activities of the Knowledge Processing Cycle. Important feedback loops intervene at this stage, linking to such activities as Knowledge Need Recognition (recognition by doing), Knowledge Justification (illustration of a need), and Knowledge Evaluation (trial based). Additionally, performance monitoring processes direct feedback from the Knowledge Utilization activity into the OKB. The organization interacts with its environment through contributions such as publications,

patents, or new products; such contributions help the development of links with other organizations, which can promote the process of knowledge acquisition from them.

The whole organizational Knowledge Processing Cycle is essentially a series of feedback mechanisms within the organizational network. The LIFE Model, illustrated in Figure 6.5, represents an open system, with interactions among the OKB, the Knowledge Processing Cycle, and their environment. Organizations continuously try to channel and manage flows of knowledge and energies within their organizational boundaries. However, complexity theory implies that control is an illusion, and that it is more important to understand (and foster) the natural course of evolution of a system rather than trying to control it. The LIFE Model focuses on the role of leadership in relation to the flows of social energies that trigger the evolution of the KPS. Leadership in a social CAS, such as an organization, needs to ensure that the feedback mechanisms are working towards amplifying the performance of the system relative to its objectives. The next section focuses on the flows of energies and explains why leadership plays an important role in them.

6.3.4. The Leadership Invigorating Flows of Energies

In the context of this model, it is important to note that the term "leaders" does not mean the same as "managers." The term "leaders" here means emergent leaders, those who arise from within the KPS to enable and/or enhance it – essentially equating to organizational knowledge intrapreneurs. Derived from the seminal work of Burgelman (1983), it is proposed that ideas regarding entrepreneurship and intrapreneurship are equally applicable to the knowledge management processes and systems of an organization as they are to a whole enterprise. Knowledge intrapreneurship consists of the development and application of new knowledge within an organization, while knowledge entrepreneurship refers to the ability of the organization to garner externally-derived gains from application of its knowledge in the marketplace. Although this aligns to a large degree with Nonaka et al.'s statement that "leadership is about enabling knowledge creation, – not controlling and directing it" (2006: 1192), it extends beyond their position that leaders are managers (top and middle managers being referred to specifically). Emergent leaders are defined by the relationships that they hold within the organization and the elements of the Knowledge Processing Cycle. They can be any member of the organizational social network (individual, team, or group), which is an extended view of the organization. They are defined as a leader not by their position but by their relationship to the whole organization, which includes creating, enhancing, and

influencing flows of social energies. As suggested by Griffin (2002), leadership emerges through the recognition by others. This perspective differentiating leaders from managers is in accord with that advocated by Alvesson (1992), Kotter (1985), and Zaleznik (1977), wherein managers rely on their formal position while leaders utilize non-coercive power. It also concurs with Griffin's work on the emergence of leadership as arising from the "on-going process of group interactions in which personal and collective identities are iterated and potentially transformed" (Griffin, 2002, p.217).

Emergent leaders are the initiators, enablers, and enhancers of self-organization processes that take place in the KPS. These processes require and involve flows of energies, invigorated by emergent leaders, who are at the core of the negentropic activities (i.e., producing negative entropy) underlying self-organizing mechanisms. However, the production of negative entropy does not mean creation of energy, as that would be a direct violation of the first law of thermodynamics (i.e., conservation of energy). Emergent leaders do not create energy, but invigorate flows of existing energies – directing them toward accomplishment of organizational goals with respect to knowledge management. Consequently, the organization will dissipate entropy into its environment, implying that a systemic perspective is required due to the scale-free aspect of CAS. Because any flow of entropy may have repercussions at various levels of the system, the system's boundaries remain crucial. Activities at all organizational levels can have system-wide repercussions.

Although there are some similarities with the notions of self-leadership and shared-leadership expressed by Pearce and Manz (2005), emergent leadership does not refer to the same understanding. Just as an organization can not always be considered a team, neither can LIFE be compared to individual flow of energies. LIFE is broader than the notions of self-leadership and shared-leadership; in fact, they are both contained within LIFE, and describe part of the flows of energies included in it. Relationships in organizations are sources that can release enormous amounts of social energy that eventually enable the organizations to evolve (Regine & Lewin, 2000). As part of the system, emergent leaders influence and are influenced by the activities of the Knowledge Processing Cycle. Therefore, feedback can occur at any time, anywhere within the KPS, reinforcing or depressing its operation.

Emergent leaders play a crucial role in the KPS, invigorating its emergence and self-organization by providing, enabling, or fostering the vital energies that are needed for

its functioning. A feature of systems approaches is the identification of flows of energies to sustain the system. Energy manifests itself in multiple forms in a social system, including mental energy (knowledge, motivation, ambition), with filters and catalysts (e.g., policies, meetings, recruitment providing fresh inputs, etc.). One essential role of managers is to understand what type of energy is needed to create a favorable environment that supports the Knowledge Processing Cycle and the emergence of the OKB. However, it is not the role of managers to provide all the flows of energies, nor (as it is a self-organizing system) can they control them. They can only help prepare and maintain the environment. Managers are able to serve as emergent leaders for some of the processes taking place in the Knowledge Processing Cycle, but this is a role that can be filled by any other organizational member and in efficient systems this will be encouraged.

6.4. Implications and Discussion

Complexity theory leads to the understanding that all organizational members should possess what Ward (1963) refers to as "negative capabilities." This means they need the capacity to live with and tolerate ambiguity and paradox, the willingness to accept change, and the ability to learn and allow their mind to be changed by others (French, 2001). As argued by Regine and Lewin (2000), managers have to be "paradoxical leaders"; they must be leaders by not leading. What Regine and Lewin (2000) suggest is that managers need to overcome three main paradoxes. First, their power rests not so much in controlling others but in their ability to allow others to achieve their goals. Second, managers don't have to be omniscient but accessible. Finally, they are not autonomous but rather interdependent with all the others agents of the organization of which they are part. Hence, managers have to understand, accept, and adapt to the flows of social energies that take place in an organization.

An implication of complexity theory for the business world is that senior managers need to facilitate the organization's evolution at the edge of chaos so that it may self-organize creatively (Nonaka et al., 2001). Managers should stop thinking in terms of control and rigid structures, which are illusions of power and stability. Hence, senior managers should show enough flexibility to allocate trust and some autonomy to the members of the organization and liberate the creative interactions among flows of social energies. Good communication and trust among employees enhance socialization, which is vital to organizational innovation (Rhodes, Hung, Lok, Lien, & Wu, 2008) as well as for knowledge diffusion (Štrach & Everett, 2006).

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Giving autonomy to organization members involves letting them create knowledge on their own and providing their opinion on the current and proposed knowledge within the organization. This means that the organization needs to make its knowledge accessible to its members, such that its knowledge is subject to constant visibility and therefore open to improvement. Nonaka et al. (2001) suggested that, in order for an organization to create knowledge, senior managers need to ensure that there exists an appropriate atmosphere, or culture, inside the organization. They suggest that love, care, trust, and commitment among members of the organization are the basis for knowledge creation and knowledge sharing processes. These key factors (among others such as job rotation, rewards, and flatter structure) have also been identified by Al-Alawi, Al-Marzooqi, and Mohammed (2007) as prerequisites for the success of knowledge sharing. Recent research has shown that strategies based on centered leadership (Barsh, Cranston, Craske 2008) could help individuals to develop more efficient leadership capabilities through the use of shared purposes, management of energy flows, and positive framing. Therefore, the key implication for managers is that they need to provide a purpose to the system and create a supportive environment; self-organization will follow.

Although general patterns of a CAS may often be quite predictable, complexity theory stipulates the impossibility of predicting or controlling the future outcomes of an organization (Stacey, 1992). Therefore, managers need to prepare themselves to adapt to the unexpected. Organizations require structures that allow self-organization, which is obtained by navigating a path at the edge of chaos (Firestone & McElroy, 2003; Stacey, 1992). Self-organization implies allowing the structure of the whole organization to evolve constantly. This can be done by developing a flat and flexible organizational structure in which different units are intertwined by a knowledge network nurturing the flows of social energies within the organization (as depicted in the LIFE Model). Self-organization relies on the presence in the organization of a sufficient variety of people and diversity of ideas, facilitating change. Indeed, the survival of an organization in a changing environment lies in flexibility and adaptation (Kourdi, 2003; Lindgren & Bandhold, 2003; Stacey, 1992; Watson, 1994). Hence, managers need to introduce some mechanism to generate sufficient instability and variety, as well as a system of selection in order to stimulate novelty and emergent adaptation (Stacey, 1992). They need to trust and support all organizational members, permitting the rise of change champions (McWilliam & Ward-Griffin, 2006), i.e., the emergent leaders. Senior managers need to focus on strategic recognition rather than planning (Burgelman,

1983). They also have to provide policies that enhance the rotation of personnel and enable employees to develop interdisciplinary skills in order to deal with the complexity of the environment (Nonaka et al., 2001).

In an unpredictable, rapidly changing environment it becomes obvious that adapting faster than the competition is a competitive advantage (Phelan, 1995). Hence, some organizational learning and transformational change management programs such as the LIFE Model can help managers to handle complexity. However, managers– no matter how powerful – must remember that they are part of the system, and are both enabled and constrained by the availability of resources (Stacey, 1992). Self-organization means that interactions between the agents of a system are made according to their own will, capability, and knowledge (Kourdi, 2003; Lindgren & Bandhold, 2003; Stacey, 1992). If each element follows a managerial blueprint, self-organization will not occur (Stacey, 1992), potentially leading to an inefficient struggle to preclude or prevent self-organization. As argued by Spender (1996) a diffuse, non-bureaucratic management style is needed to provide a context in which employees at every level become independent agents. Such independent agents would take responsibility, experiment, make mistakes, and learn as they aim for continuous improvement. This is echoed by recent research (e.g. Hasgall & Shoham, 2008) showing that the issue still needs to be addressed. As emphasized by Rutherford and Holt (2007), the manner in which a manager decides to foster organization-wide corporate entrepreneurship is a key factor in its success. In the case of the LIFE Model, this applies to the knowledge intrapreneurs who act as emergent leaders.

6.5. Summary

To progress, the concept of knowledge required a new systemic perspective matching the non-linearity of reality, as well as clearer statements of boundaries and transitional possibilities. The E2E model proposed an integrated framework based on insights from complexity theory, illustrating the different constructs of data, information, knowledge, and wisdom linked into a feedback system of increasing level of understanding, allowing multidirectional interstate transitions, bound between two states of being: existence and enlightenment. This model presents a more complete cognitive system of knowledge and shows how understanding conceptually links existence to enlightenment in a non-linear framework.

This chapter also introduced the LIFE Model, which provides a comprehensive description of the organizational knowledge processing system. The LIFE Model highlights the role of emergent leadership and flows of social energies as forces invigorating the KPS, and describes how knowledge is created, assimilated, and diffused dynamically within an organization through the Knowledge Processing Cycle in eight activities interacting with the Organizational Knowledge Base, external knowledge, and the organizational social network.

The concept of Leadership Invigorating Flows of Energies allows for a more complete description of the mechanisms underlying the KPS and its self-organization. Managers should understand, accept, and adapt to the flows of social energies taking place in an organization by focusing on strategic recognition rather than planning. They should provide a purpose to the KPS and create a supportive environment enabling the knowledge flows within the organization and fostering the emergence of knowledge intrapreneurs. They are the facilitators of the self-organization of the KPS that can liberate creative interactions among flows of social energies.

Together, the E2E Model and the LIFE Model provide a sound foundation for a reconceptualization of knowledge management. They open the path to the creation of an integrative theory of knowledge management, which will be further discussed in Chapter 8. In preparation for the summary discussion provided in that concluding chapter, the potential of the LIFE Model will be demonstrated in Chapter 7, where it will be applied to the case of Wikipedia, the free online encyclopedia.

Chapter 7. Applying the LIFE Model: The Case of Wikipedia

The purpose of this chapter is to provide an initial justification of the LIFE model, and to explore knowledge processing in a social complex adaptive organization, using Wikipedia, the free online encyclopedia, as a case study[*]. As shown in Chapters 4, 5, and 6, the existing models of organizations, and in particular of knowledge processing systems, fail to address the nonlinearity and self-evolving characteristics of organizational processes. This chapter examines Wikipedia through the lens of the LIFE model as an attempt to remedy that situation. Apart from being one of the most successful organizations of the early 21st century, Wikipedia has been chosen as a case study for the remarkable similitude between its attributes and those of complex adaptive systems, as well as the easiness of accessibility to its internal components and processes.

Complexity theory provides insight into how simple patterns can emerge from complex relationships among a great number of individual elements comprising a CAS. In the context of this chapter, complexity theory provides a framework to understand how knowledge forms at the level of individuals and then influences knowledge intrapreneurship at the collective level of the organization. Stacey (1995) claimed that rather than trying to yield predictors of or prescriptions for long-term innovative success, research into complexity theory and organization studies needed to focus on explaining whole systems and their dynamics, and link this analysis to their innovative success. Following that claim, this case study illustrates why Wikipedia should be considered as a social CAS. To analyze Wikipedia as a CAS, the Leadership Invigorating Flows of Energies (LIFE) model is used in order to reflect the important dynamic systems aspect of energy, which can only be examined by considering its flows and sources.

This chapter includes five sections.

- Section 1 outlines the methodology underlying the case study presented in this chapter.

- Section 2 provides a brief description of relevant aspects of Wikipedia and its historical development.

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[*] Note that this case was last updated in November 2008. Much has happen since then and some facts may not be accurate anymore (See Lih, 2009). However, changes that occured since November 2008 do not change the conclusion and analysis made which are not focused on a 'current' state of Wikipedia.

- Section 3 presents a detailed analysis illustrating how the LIFE model can be used to understand the knowledge processing cycle that takes place within Wikipedia. Wikipedia's LIFE are identified and examined.

- Section 4 discusses several implications drawn from the case study, before suggesting areas for further research.

- Section 5 is a summary of this chapter, and provides discussion links to the concluding chapter of this thesis.

7.1. Case Methodology

As suggested by Yin (2003, p.13), a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. This situation is particularly manifest in the case of Wikipedia. In order to provide some justification of the LIFE model and show its usefulness, the next sections provide an exploratory case study of Wikipedia, based on the model's framework. This approach has been facilitated by two major facts: First, due to its openness, most if not all aspects of Wikipedia processes are fully accessible online. Second, the researcher is an active contributor to Wikipedia, and therefore has personal knowledge of its functioning. Following Yin's (2003) case study design principles, Table 7.1 provides a summary of the case study design used in this chapter.

Table 7.1: Case Study Design

Research component	Application
Study's question	How does a social CAS process knowledge at the organizational level?
Propositions	(1) Wikipedia is a social CAS (2) Wikipedia processes knowledge following patterns depicted by the LIFE model
Units of analysis	Knowledge activities at both editorial and administrative levels of Wikipedia
Logic linking the data to the proposition	Pattern matching and explanation building
Criteria for interpreting the findings	Systemic coherence between the data and the LIFE model

*: adapted from Yin (2003)

Note that Yin acknowledged that "the current state of the art does not provide detailed guidance on the last two" components of this research design (2003, p. 28). Therefore, the present design follows the epistemic position of this thesis as described in Chapter 1.

This case study is, however, by no means an exhaustive analysis of Wikipedia or application of the LIFE model. In that regard, Section 7.4 provides some discussion of what is still needed to complete such a task, which is beyond the scope of this thesis. This case study presents only preliminary research into the social complex adaptive organization that is Wikipedia. It is based on the researcher's observations, personal experience as a Wikipedian, and collection of data directly available online on the Wikipedia website or in the literature from previous research. This approach is consistent with Yin's supporting principles, which are: the use of multiple sources of evidence, the creation of a case study database, and maintaining a chain of evidence (2003, p. 85).

Table 7.2 provides a summary of the strengths and weaknesses of each source of evidence.

In the context of this case study, the sources of evidence comprise five out of the six possible enumerated by Yin's methodology (i.e., documentation, archival records, direct observations, participant observations, and physical artifacts). The only source of evidence that was not used is interviews. Furthermore, due to the structure and openness of Wikipedia, the weakness aspects such as 'access', 'retrievability', and 'availability' were mostly waived. It should also be noted that because of the nature of Wikipedia, direct and participant observations had no influence whatsoever on the data, as it could be said that Wikipedia is always under direct and participative observation by all editors, the researcher being just one among many. Because Wikipedia and all Wikipedians (excluding the researcher) were entirely unaware that this research was being conducted, the research could not have affected the system it was investigating.

Table 7.2: Six Sources of Evidence: Strengths and Weaknesses

Sources of evidence	Strengths	Weaknesses
Documentation	• Stable, can be reviewed repeatedly • Unobtrusive, not created as a result of the case study • Exact, containing exact names, references, and details of an event • Broad coverage, long span of time, many events, and many settings	• Retrievability, can be low • Biased selectivity, if collection is incomplete • Reporting bias, reflecting (unknown) bias of author • Access, may be deliberately blocked
Archival records	• Same as for 'documentation' • Precise and quantitative	• Same as for ''documentation' • Accessibility due to privacy reasons
Interviews	• Targeted, focusing directly on case study topic • Insightful, providing perceived causal inferences	• Bias due to poorly constructed questions • Response bias • Inaccuracies due to poor recall • Reflexivity, interviewee gives • What interviewer wants to hear
Direct observation	• Reality, covering events in real time • Contextual, covering context of event	• Time-consuming • Selectivity, unless broad coverage • Reflexivity, event may proceed differently because it is being observed • Cost, hours needed by human observers
Participant observation	• Same as above for 'direct observation' • Insightful into interpersonal behavior and motives	• Same as above for 'direct observation' • Bias due to investigator's manipulation of events
Physical artifacts	• Insightful into cultural features • Insightful into technical operations	• Selectivity • Availability

*: Adapted from Yin (2003, p. 80)

The case study database is summarized in the next section in a narrated format. Data collection was conducted to match the activities of the knowledge processing cycle of the LIFE model summarized in Table 7.3: The Knowledge Processing Cycle.

7.2. Wikipedia: The Free Encyclopedia

The Read and Write Web, also called Web 2.0, offers powerful tools to create collaborative online strategic communities such as the one underlying Wikipedia.

Applications such as wikis[ω] allow users who have little or no knowledge of programming languages to modify the content of a web page instantaneously. Based on the software Wikimedia, the Wikipedia project, also known as the Free Encyclopedia, is an organic, loosely structured process to produce encyclopedia-type content (Achterman and Loertscher, 2006).

Wikipedia is the registered trademark of the non-profit Wikimedia Foundation, which is the initiator of many free content projects on the Internet. All these projects are subject to self-editing conducted in collaborative ways (Wikipedia, 2008c). Since its creation in 2001, Wikipedia has grown rapidly into one of the largest reference sites on the World Wide Web. Wikipedia's internationalization has been extremely rapid, overcoming many different national policies and creating a global virtual community without precedent. Wikipedia contains more than 11,000,000 articles with more than 75,000 active contributors in more than 260 languages (Wikipedia, 2008c). According to Alexa.com (2008), Wikipedia attracts about 9% of all Internet users, and is the eighth most visited website worldwide (Internetworldstats.com, 2008).

7.2.1. The Free Encyclopedia

According to its own definition, Wikipedia is a multilingual, web-based, free content encyclopedia project (Wikipedia, 2008c). Wikipedia is written by volunteer editors who collaborate with each other from all over the world in an open way by using a wiki-based platform. Many wiki applications feature a back page used for discussion, reflection, and feedback (Achterman and Loertscher, 2006). Users employ this space to explain their contributions, to evaluate the current content, or to disagree with other contributors. Nearly all of the content of Wikipedia can be edited, without permission, by anyone who has access to the Internet.

Wikipedia is founded on five rules: a free license, the wiki process, the ability of anyone to edit, a neutral point of view, and the ultimate authority of Jimmy Wales ('Jimbo') and the Wikipedia board on process matters (Wales, 2008). Therefore, anyone is welcome to contribute to Wikipedia as long as their contribution abides by Wikipedia's editing policies (Wikipedia, 2008h). These rules demonstrate how managers can influence and direct energy towards the organization's overall goals while not exercising direct control. Additionally, Wikipedia uses software known as MediaWiki which allows easy

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[ω] Wiki (jargon): A wiki is a website that uses wiki software, allowing the easy creation and editing of any number of interlinked Web pages, using a text editor within the browser.

reversal of editorial changes, whether they are mistakes or deliberate vandalism (Wikipedia, 2008b, 2008i).

7.2.2. Wikipedia Policies and Guidelines

Despite lacking clear managerial directives, Wikipedia does feature a small number of overall policies and guidelines intended to maintain the open and voluntary nature of the project. All of Wikipedia's official policies and guidelines can be summarized as the five pillars that define its character (Wikipedia, 2008i): It is a *free* content *encyclopedia* using a *neutral point of view* and following a *code of conduct*, but with *no firm rules*. Wikipedia also provides a set of rules of thumb, but common sense is always called upon to interpret them (Wikipedia, 2008r). The following is a synthesized list of general policies in use on Wikipedia for contributors:

- Be bold in updating;
- Be civil, gracious, and tolerant to other users;
- Discuss changes thoroughly;
- Edit summaries with decency and clarity;
- Assume good faith of authors;
- Sign-in for traceability and readability;
- Use the preview function;
- Do not infringe copyright;
- Agree with the five rules of the foundation of Wikipedia; and
- Ignore all rules if necessary for improvement.

These policies are designed to encourage change, avoid destructive criticism, keep people networking, and track changes.

Wikipedia organizes all its current policies under five categories to address Wikipedia standards: behavioral, content and style, deletion, enforcement, and legal and copyright (Wikipedia, 2008L, 2008o). In order to assess and understand the relationships among the Knowledge Processing Cycle activities in Wikipedia, a brief summary of these policies is given.

Behavioral policies emphasize the need for users to stay respectful of others, and to keep a good and neutral atmosphere within the community by preventing personal attacks or user-centered conflicts. These policies emphasize discussion of the content rather than the authors, and encourage honesty to prevent faked consensus and learning to prevent repeats of problematic behavior.

Content policies consist mainly of three policies: No original research (NOR), Neutral point of view (NPOV), and Verifiability (V). Wikipedia is not a publisher of original thought. Therefore, articles are required to contain only verifiable content from reliable sources without further analysis. Wikipedia users are also requested not to synthesize content in order to advance a position.

Deletion policies are based on consensus. Even if articles still require the authority of an Administrator in order to be deleted or un-deleted, deletions or un-deletions pass through a consensus-forming process before any administrative action is taken. Controversial articles require a three-step process and a waiting period of a week before being deleted or un-deleted in order to give time to users to discuss the issue at hand. The Wikimedia Foundation office reserves the right to speedily delete an article temporarily in cases of exceptional controversy (Wikipedia, 2008b).

Enforcing policies deal with bans, arbitration, and protection issues. Wikipedia is consensus driven and therefore emphasizes discussion and interaction among its members. Most editing decisions are made by an ongoing consensus process among editors. In the case of a controversy or dispute, it is possible for an Administrator to temporarily protect a page against editing by a lower level of users. Furthermore, users violating the welfare of Wikipedia by exhibiting disruptive behavior such as vandalism can be banned (Wikipedia, 2008s). Internet Protocol (IP) addresses are read constantly by Wikipedia and a history of them is kept for security checks and assistance in banning processes. As a last resort, an Arbitration Committee exists to impose binding solutions to Wikipedia disputes that have failed to be resolved in any other way (Wikipedia, 2008g, 2008e).

Legal and copyright policies emphasize the fact that Wikipedia has no tolerance for copyright violation and that Wikipedia content can be used under the GNU Free Documentation License (GFDL$^{\infty}$).

Most importantly, policies can be changed or new ones added. Again, consensus is the main principle in altering or extending policies and it is interesting to note that voting is not considered useful in this process. Indeed, it is commonly viewed on Wikipedia that a vote can never create consensus, but rather only indicate whether or not one may already exist (Wikipedia, 2008g).

$^{\infty}$ GFDL: Copy left license for free documentation, designed by the Free Software Foundation for the GNU Project. It is similar to the GNU General Public License, giving readers the rights to copy, redistribute, and modify a work and requires all copies and derivatives to be available under the same license.

This set of policies provides Wikipedia with loose and flexible yet organized guidance for editors, allowing natural interactions to take place. As will be discussed in further detail in the next sections, this flexibility is one of the foundations underlying the self-organization of the Wikipedia project, which is also supported by an atypical structure and management.

7.2.3. Wikipedia Structure and Management

Wikipedia possesses a shallow organizational structure. Anyone can join Wikipedia at the lowest level as an *Editor*. As of the 5th of October 2008, there were 7,978,268 registered Wikipedians, all of whom are Editors (all data in this section from Wikipedia, 2008m). On that day, the second level consisted of 1,598 *Administrators*, also called *Sysops*, with duties, responsibilities, and authority relative to the creation and maintenance of both Wikipedia content and user accounts (Wikipedia, 2008d, 2008i).

As Administrators are often perceived as the "official face" of Wikipedia, they are held to high standards of conduct. The community grants Administrator status only to trusted users who show a deep understanding of policies (Wikipedia, 2008h). Following a thorough seven-day community consensus-based assessment, the candidate is reviewed by Administrators carrying special rights, called *Bureaucrats* (31) or *Stewards* (36), and a decision is taken according to whether or not a consensus has been reached. Generally, a consensus is assessed as being 75% support. Candidate Bureaucrats are evaluated in a similar fashion and promoted by the Stewards, who are elected from and by the global community of the Wikimedia Foundation's projects. A small group of Administrators holds special rights known as *Oversight* (29), which permits hiding revisions of pages from all users, and *Check Users* (28), which allows retrieval of contributors' unique IP that identify individual users. More recently, on 9 January 2008, a status called *rollback* was added, giving the 1,958 *Rollbackers* a method of rapidly undoing nonproductive edits (usually vandalism).

Wikipedia is guided by the *Board of Trustees* of the Wikimedia Foundation, composed of 7 members (Wikipedia, 2008b). The board is assisted by the *Arbitration Committee*, currently consisting of 13 members, in cases of last resort regarding editing disputes among users (Wikipedia, 2008e), and at least 4 known *Developers*, who have the highest technical level of access and can make direct changes to the MediaWiki software and Wikipedia databases, but do not carry any administrative responsibilities. All these people are appointed by the Board of Wikimedia or sometimes elected from the pool of trusted Wikipedians.

The next section presents a detailed analysis illustrating how the LIFE model can be used to understand the knowledge processing cycle that takes place within Wikipedia. It also identifies and examines Wikipedia's LIFE.

7.3. Wikipedia through the Lens of the LIFE Model's Knowledge Processing Cycle

In the case of Wikipedia, the Organizational Knowledge Base is at the same time the publicly-accessible Wikipedia repository and the sum of all the energy flows contributing to the Knowledge Processing Cycle, linking all contributors (Editors and Administrators alike) through the Organizational Social Networks. As such, it is also the main enabler of feedback within the Wikipedia organization. Editors and Administrators contribute according to their own views, with ongoing interactions creating a dynamic consensus, which emphasizes that knowledge in Wikipedia is socially constructed.

The following analysis describes the organizational knowledge processing cycle of Wikipedia, highlighting the flows of knowledge and energies within the operations of Wikipedia. Due to the openness of Wikipedia, the management of the organization and its editorial operations are structured in a parallel fashion. It has been proposed on Wikipedia (2008q) that *product*, *processes*, and *policies* partly explain the dynamics of the project (or, as Le Moigne (1990) would term it, the teleology of the system; see Chapter 2 Section 5). The Editors (who follow the policies and use the processes to create the product) and Administrators (who create the policies to guide the processes used to develop the product) provide the basis for the relationships among these three elements. The processes are the principal focus of this article. Each of the following sections briefly summarizes the processes occurring at the administrative and editorial levels in light of this organizational management analysis. This systemic approach illustrates the scale-free aspect of the LIFE model, while providing a deeper analysis of Wikipedia. Table 7.3 provides a summary of the knowledge processing cycle developed in Chapter 6.

Table 7.3: The Knowledge Processing Cycle

Process	Function
Knowledge Investigation	monitoring and scanning of knowledge being used inside and outside the organization; involves comparing objectives and results, as well as checking the alignment between the organization and its environment
Knowledge Need Recognition	formulation of knowledge needs and related tasks
Knowledge Generation	creation of new knowledge by individual and group learning processes
Knowledge Proposition	formulation of knowledge claims in response to a recognized knowledge need
Knowledge Justification	discussion and argumentation of knowledge claims, including maintenance of existing knowledge as well as verification of proposed new knowledge
Knowledge Evaluation	testing and assessing the value of the knowledge proposed, generated, or in use in the organization; includes authorizing or denying knowledge propositions
Knowledge Assimilation	adoption and incorporation of knowledge
Knowledge Utilization	application and dissemination of knowledge

To help manage Wikipedia, five different types of pages are used at the administrative level (Wikipedia, 2008p): process pages (to outline organized ways of operating), wiki project pages (for specific project related discussions), community pages (for centralized discussion), help pages (to explain how to do things), and essay pages (to propose personal or group views to gather consensus). At the editorial level, every entry in Wikipedia receives four pages: one for the actual article, one to edit it (with a preview function), one for discussion, and one to display its history (to follow changes). Various tags are given to articles to indicate their editing status, including development needs, e.g. 'Featured article' 'Stub', 'Disambiguation and redirection', and 'Requesting sources and verification' (Wikipedia, 2008a). Wikipedia keeps track of any changes made to the actual entries and it is always possible to revert (or *rollback*) to any previous version.

7.3.1. Knowledge Investigation

At the administrative level, knowledge investigation is normally performed by Wikipedia's Administrators according to either their own interest, or according to lists of recognized needs. As Wikipedia is fully open, every contributor can investigate anything or propose new investigations. This exemplifies the absence of management in the traditional sense, replaced by intrapreneurship and emergent leadership. Thanks to the breadth and diversity of users, and the openness of Wikipedia (all characteristics of CAS), it is only a matter of time before feedback (from the knowledge evaluation process in particular) identifies missing or deficient practices in the community (Wikipedia, 2008t). Knowledge acquisition is therefore done by the contributors through sense-making processes and integrated into Wikipedia's OKB as needed. This permits proposals for future developments, typically indicated in specialized discussion pages or by creation of a new page – constituting feedback from other processes in the Knowledge Processing Cycle, specifically knowledge need recognition.

At the editorial level, knowledge investigation is performed by Editors. Missing or deficient entries are rapidly identified and edited by contributors, often organized in patrols sharing specific tasks (Wikipedia, 2008o). Knowledge acquisition performed by Editors provides content for current or future entries. Different Editors will hold different assumptions and epistemic stances, consequently leading to further discussion, investigation, and interactions, which primarily occur on discussion pages of the relevant entries or activities.

7.3.2. Knowledge Need Recognition

At both the administrative and editorial levels, knowledge need recognition is accomplished by any contributor, individually or in a group, who identifies an area that needs to be improved or created. Each contributor will proceed according to his or her own knowledge, interests, and experiences, or following lists of recognized needs created to promote this process. Contributors voluntarily emerge to take on any task that interests them; consequently, only motivated contributors are working on tasks that they have chosen. Communication with other users working on the same task occurs through web forums dedicated to Wikipedia, as well as discussion pages. The great diversity of web users makes it possible to have people from all levels and backgrounds interacting and developing the organizational, operational, and technical aspects of Wikipedia. Because contributors may identify potential duties they are not eager to undertake or

with which they lack familiarity, they can tag a task that they believe requires attention. Interested Administrators or Editors will then volunteer to perform the relevant actions.

7.3.3. Knowledge Generation

At the administrative level, knowledge generation is both formal and informal. Informal knowledge generation occurs through social interactions among contributors through forums and discussion pages, with the variety of contributors providing many opportunities for creative feedback. Formal knowledge generation takes place within special task groups that employ specific forums and communication means to direct their effort on particular tasks (Wikipedia, 2008u).

At the editorial level, Wikipedia serves as a repository of knowledge; its intended purpose is not to generate new knowledge, but to store and make available established knowledge. Hence, knowledge generation in Wikipedia does not rely on original research, which is avoided as part of their editorial policy ('No original research' policy). Rather, knowledge is generated through the addition of secondary material and its integration into the OKB. In this sense, knowledge is generated not by formal hypothesis testing and application of the scientific method to original experiments, but through a process transforming data and information into higher levels of understanding. At the editorial level, knowledge generation equates with the knowledge contribution made by Editors.

7.3.4. Knowledge Proposition

In Wikipedia, the knowledge proposition activity follows an identical process at both administrative and editorial levels. Propositions are made by contributors in special discussion pages or forums (Wikipedia, 2008p). The knowledge proposition process is ongoing, exhibiting active feedback systems between the Knowledge Processing Cycle and the OKB. Every contributor can make knowledge propositions at both administrative and editorial levels. These correspond to the strong feedback loops in Wikipedia among knowledge assimilation, knowledge need recognition, and knowledge proposition, as deficiencies noticed during knowledge assimilation lead to direct adoptions or suggestions for new (or needed) knowledge. Tension among different users and groups with alternative perspectives and opinions lead to debate, which constitutes ongoing interaction through feedback loops linking knowledge proposition and knowledge justification. However, at the editorial level, this process of proposition and

peer review through knowledge justification (see below) is not followed by every Editor, and some make changes without asking or notifying the community.

7.3.5. Knowledge Justification

Wikipedia emphasizes constructive justification at both administrative and editorial levels, which is accomplished through discussion pages available for each article, proposition, or official process within Wikipedia. Contributors defend their ideas and try to convince the majority that the proposed changes are appropriate. Propositions are then reviewed by interested Editors and Administrators and subjected to a consensus-based decision. As these discussions are open to everyone, the critique of any proposition is democratic and based on peer review. Justification also occurs when contributors challenge existing content or processes. The history of the justification process is kept in the discussion page of each article or in special archives for future reference. However, many contributions at the editorial level are made without justifications (Goldspink, 2008).

At the editorial level, the use of references and reviewers is intended to help maintain the neutrality and robustness of entries, but the choice of supports is left to the contributors, thereby allowing personal bias to enter the frame (Goldspink, 2008). Although the process is not precisely anonymous (given that every edit or contribution is associated with a screen name or IP address), politics and self-promotion are minimized due to the inherent multitude of Editors and the structure of the organization.

7.3.6. Knowledge Evaluation

Every user can participate in knowledge evaluation as the process in Wikipedia is transparent. However, Administrators have special rights and duties regarding that process. Wikipedians are encouraged to treat anyone's complaint with the utmost respect, as long as complaints are presented in a constructive way. A fairly recent evaluation tool is the 'Wikipedia Scanner' (also called 'Wikiscanner'). This publicly searchable database links Wikipedia edits to the organizations where the edits originated. Since its release on 14 August 2007, it has provoked a number of scandals by showing that some organizations were editing criticisms about themselves. Although the Wikiscanner is the work of an independent Wikipedian, the Wikimedia foundation and Jimmy Wales have endorsed it (Wikipedia, 2008v); a Wikipedia spokesperson stated that "Wikipedia Scanner may prevent an organisation or individuals from editing articles that they're really not supposed to" (Fildes, 2007).

At the editorial level, a status indicator at the top of every entry in Wikipedia informs readers of the quality and nature of the entry. One of the tasks of Editors is to check for changes involving poor editing or vandalism (as not all knowledge generated goes through either a proposition or justification phase). Bots are used for making repetitive edits that would be extremely tedious to undertake manually, such as cleaning and control activities related to vandalism (Wikipedia, 2008f). A history of all evaluations is kept either in the discussion pages or in the history pages. As a last resort, arbitration is available through the Administrators, or if no solution can be found, by the Arbitration Committee.

7.3.7. Knowledge Assimilation

At the administrative level, knowledge assimilation occurs as contributors learn about and familiarize themselves with Wikipedia's mechanisms and policies, impacting on both individual awareness and the way people use and modify the content and organization. This is accomplished through formal and informal feedback among Wikipedians at the individual level, connecting knowledge generation with the other processes in the Knowledge Processing Cycle and reflecting the openness of the organization. This is not imposed on any contributor; it is just assumed they will familiarize themselves in order to fit in. Different guidelines and tools are available to them such as 'the New Admin School' where they can learn how to become a more efficient Administrator (Wikipedia, 2008n).

At the editorial level, assimilation commences when a user edits a page. As the change is instantaneous, it is immediately incorporated in the Wikipedia OKB (providing a form of immediate positive feedback) and other users can see the change right away. Of course, because some changes may not have gone through a justification process, this process is in a close feedback system with the evaluation process. The evolution of every article though a succession of iterations and changes demonstrates self-organization at work.

7.3.8. Knowledge Utilization

At the editorial level, the intention behind Wikipedia is to make knowledge accessible to everyone. This is accomplished by exposing the physical part of the organizational knowledge base to the public via the Internet. Wikipedia's actual contribution is difficult to assess, but statistics can help to understand the scale of its importance. Wikipedia is the eighth most visited site worldwide, attracting more than 9% of the total

number of users of the Internet (Alexa.com, 2008). The 11,410,179 articles available (in all languages combined, as of 5 October 2008) provide one of the biggest repositories of human knowledge today. (See Wikipedia, 2008k and 2008r, for a discussion, statistics, and summary table.)

Analyzing the extent of the knowledge utilization at the administrative level is almost impossible in the context of this case study. However, the success and rapid expansion of Wikipedia permits the belief that knowledge utilization has occurred among administrators in efficient ways, exemplified by the rapid implementation of tools such as rollback and Wikiscanner (Wikipedia, 2008m, 2008v).

The preceding analysis shows how the Wikipedia OKB is a social knowledge base which has interactions demonstrating all elements of the Knowledge Processing Cycle. Clear feedback loops have been identified, and it can be said that the competitive advantage of Wikipedia resides in its policies to improve its content. However, one of the most interesting features of Wikipedia is its leadership.

7.3.9. LIFE of Wikipedia

One of the main types of leadership invigorating flows of energies in Wikipedia corresponds to 'recruitment' in a corporate organization. Wikipedia is an open community into which anyone can enter. In Wikipedia, emergent leaders are the ones becoming Editors or Administrators. As anyone can become a contributor, the possible sources of LIFE and their amounts are endless. Similar to a meritocracy, it is up to the Editors to show their abilities to serve well the community in order to access the role of Administrator (Wikipedia, 2008d). Therefore, the principal sources of LIFE are provided by the users, drawing on their motivation, spare time, and donations that help to pay for the maintenance of Wikimedia databases and their five employees. It is clear that these contributions stimulate each other and constitute a far greater force together than the sum of the individual inputs. This point emphasizes the need to further develop the concept of social energy in the context of describing organizations as social CAS.

Policies in Wikipedia are a strong catalyst of LIFE. As stated by Jimmy Wales in October 2001, the Wikipedia community will continue to grow and survive only as long as contributors carry on doing the right things. By 'doing the right thing', he mostly meant the preservation of Wikipedia's shared vision for the NPOV and for a culture of thoughtful, diplomatic honesty (Wales, 2008). Wikipedia's content policies create an energizing feedback system that affects all contributions and demonstrate how leaders

can help the system towards achieving its goals without trying to exercise strong control. As suggested by Nonaka et al., "leadership is about enabling knowledge creation, – not controlling and directing it" (2006: 1192).

7.4. Implications and Discussion

The most striking aspect of Wikipedia is that it changes continuously. Change is an inherent constituent of the free encyclopedia's organization and content. The organization of Wikipedia emerges from social interaction among Wikipedians in order to channel the intrinsic flux of human action towards a common goal, through the generalization and institutionalization of specific meanings and rules within the community, matching the criteria described by Tsoukas and Chua (2002). Wikipedia embeds the notion of change in its organizational mechanisms.

7.4.1. Wikipedia: An Example of a Social Complex Adaptive System Embracing Change

As illustrated in the preceding analysis, Wikipedia exhibits the key characteristics of social CAS. There are continuous flows of positive and negative feedback among users and the processes of the Knowledge Processing Cycle, which leads to the emergence of a complex feedback system that nurtures the self-organization of the Wikipedia community and its outputs. Aligning with Bak (1996), this self-organization process is supported by the memory of the system. Wikipedia has many processes to store the history of the system and make it available to all users.

Wikipedia is rooted in the concept of flows, as depicted by the notion of *becoming* as opposed to *being*. This is consistent with the claims made by many scholars throughout history from Heraclitus (500 BC) through to scholars such as Bergson (1913), Whitehead (1929), Prigogine (1980) and more recently in the management literature by Chia (1997). In essence, Wikipedia embraces change as a core value, which leads to the support and fostering of intra- and entrepreneurial behaviors within the community. Policies calling for contributors to edit as much as they wish, while being 'bold' in editing, are just one example. However, as suggested by Bouchikhi (1993), although individuals may be fully competent and purposeful actors making a difference, they hardly ever make it alone.

This case study supports three principles underlying complexity theory. First, managers should stop thinking about control and rigid structures, which are illusions of power and

stability. If one acknowledges the complexity of an organization, its growth and survival in a changing environment lie in flexibility and adaptation (Levy, 1994; Lindgren and Bandhold, 2003; Stacey, 1992). Second, organizations require structures that allow self-organization (McElroy, 2000; Stacey, 1992). Self-organization implies allowing the structure of the whole organization to evolve continuously. In Wikipedia, this is achieved through a flat, flexible organizational structure in which different units are interlinked via a knowledge network subject to constant visibility and change. While control is impossible, it is possible to create guidelines and decision rules to help cope with complexity in order to achieve organizational goals indirectly (Levy, 1994). In Wikipedia, a simple set of principles provides a unifying philosophy and specifies the overall goal of the system.

A third common claim regarding self-organization in human organizations is that enough variety of people and ideas must be present in the organization (Byrne, 1998; Firestone and McElroy, 2003). Hence, managers need to introduce mechanisms to maintain sufficient instability and variety, as well as a system of selection to stimulate novelty and emergent adaptation (Stacey, 1992). They need to trust and support organizational members, permitting the rise of change champions (McWilliam and Ward-Griffin, 2006), i.e., the emergent leaders. In Wikipedia, this is done by allowing everyone to edit content and propose change, guided by strong and clear policies that lead the Knowledge Processing Cycle processes.

7.4.2. Who and What Are the Managers of Wikipedia?

It is difficult to say whether there are 'managers' in Wikipedia. The open structure of Wikipedia does not emphasize the traditional aspect of 'command and control' found in many organizations. Administrators appear to be managers since they have special rights over other Wikipedians and they are entitled to provide administrative support and foster a flourishing environment for the project. However, it appears that in the case of Wikipedia, these 'managers' share a lot of the characteristics of the emergent leaders featured in the LIFE model. In fact, unless they are able to demonstrate the aptitudes required as an emergent leader they are unlikely to be promoted through the meritocratic mechanisms that underpin Wikipedia processes.

Nonaka et al. (2001) suggest that, in order for an organization to create knowledge, top managers need to ensure that there exists an appropriate atmosphere inside the organization. They suggest that love, care, trust, and commitment among members of the organization are the basis for knowledge creation and knowledge sharing processes.

It is uncertain whether Wikipedia managers provide love to their users; however, they do provide a supportive environment for Wikipedia to grow harmoniously. Jimmy Wales provided a vision, and then allowed the community to self-organize (Wales, 2008). As emphasized by Rutherford and Holt (2007), how a manager chooses to foster organization-wide corporate entrepreneurship is a key factor in its success. In the case of Wikipedia, this applies to knowledge intrapreneurs – those who edit the encyclopedia. Managers can have a devastating influence if they don't understand the dynamism underlying their organization; as suggested by Thiétart and Forgues (1997), power struggles can push an organization into counterproductive dynamics.

Regine and Lewin (2000) suggested that managers need to overcome three main paradoxes. First, their power lies not so much in *controlling* others but in their ability to *allow* others to achieve their goals. This follows the claim that managers are inclined to the 'illusion of control' (Stacey, 1992). In the case of Wikipedia, there are many examples. One is that no one can choose or predict what page will be edited or created; Wikipedians are free to act as they wish. Another involves the past actions of one of the cofounders, as many Wikipedians spotted that Jimmy Wales was editing his own Wikipedia page, trying to minimize part of its content (Wikipedia, 2008j). Although considered the head of the organization, he was forced to acknowledge his inappropriate behavior and change. The second paradox is that managers don't have to be omniscient but accessible. In Wikipedia, every user can communicate with every Administrator. In order to foster that kind of communication, the current status of the Administrators is available to let the user know who is active. The high number of Administrators makes it easier to obtain an answer quickly. Finally, the third paradox that managers have to deal with is that they are not autonomous but rather interdependent with all the other agents of the organization. This is clearly shown in Wikipedia by the fact that all major changes are governed by consensus-based processes.

The flexibility of this managerial structure raises the question of whether it is sufficient to facilitate the continued rapid growth of Wikipedia. As pointed out by Espedal (2007, p. 105), " 'emotions and impulsive behaviour' and 'conflict and opportunistic behaviour' can be detrimental to executive decision making; therefore, it is important to provide constraints or guidelines on executive actions." His advice is that such constraints should be enacted as rules, which are more effective in achieving transformation through leadership than managerial discretion would be.

7.4.3. Does Self-Organization Result in a Lack of Quality Control?

The primary control in Wikipedia is that all Editors, good or bad, can edit its content. Indeed, with so much openness, bad editing or even vandalism will be spotted in a very short period of time, and then reversed. This is of course different from traditional knowledge storage and publishing, which limit the number of approved Editors, imposing a strong hierarchical control over any proposed content. A 2002 study by IBM (Viégas et al., 2004) found that as a result of this process, most vandalism on the English-language Wikipedia was reverted within five minutes. Recent examples such as the collapse of Barings Bank, Enron's bankruptcy, and massive trading fraud at Société Générale illustrate the importance of openness and transparency within organizations.

McElroy (2003) suggested that organizations should be structured as open enterprises, implying that their knowledge processing systems should stay politically open to allow qualified agents to access and criticize knowledge produced by other agents. Organizational knowledge would then be subject to constant visibility and improvement. This is clearly the kind of structure possessed by Wikipedia, with flexible rules, openness for editing by members, and open scrutiny processes that are tailored to members' needs instead of being driven by an attempt to 'control'. As suggested by McElroy (2003) and the LIFE model, openness in the Knowledge Processing Cycle processes does not mean undermining the authority of any management team of the organization; rather, it implies more transparency of the organization's decisions and activities for the agents of the organization.

The quality of the content of Wikipedia also needs to be considered. It is growing much faster than any traditional knowledge and publishing repository. Indeed, as of 5 October 2008, Wikipedia featured 2,201,515 articles in its English edition. In contrast, the largest traditional English-language encyclopedia, Encyclopædia Britannica (online version), only contains an estimated 120,000 articles (Wikipedia, 2008k). An investigation published in the journal *Nature* (Giles, 2005) indicated that quality in Wikipedia is generally comparable to that in other, more established reputable sources. This research project, which involved experts comparing Wikipedia and Britannica articles, found that the average science article in Wikipedia had only one inaccuracy more than Britannica's average of three per article.

The self-organization mechanisms in Wikipedia do not appear to negatively affect its overall quality. It is suggested that Wikipedia represents a new type of organizational model that fits Spender's (1996) call for a diffuse, non-bureaucratic management style

in which employees at every level become independent agents. Hence, they would take responsibilities, experiment, make mistakes, and learn as they aim for continuous improvement. Spender proposed a shift from the resource-based to the knowledge-based view of the firm. Instead of treating managers as rule-makers, employees as rule-followers, and firms as a collection of tangible resources, he suggested that what is needed is a knowledge-based theory in which organizations are a venue for alliances among independent knowledge creating entities. According to him, entities can be individuals, teams, or organizations. In terms of the LIFE model, achieving Spender's proposition requires emergent leaders who foster the intrapreneurial spirit of the whole company. In the case of Wikipedia, contributors to the organization are volunteers assisted by extremely few employees. It is striking that Wikipedia, successful as an organization, seems to empirically follow Spender's framework. This leads to the question of whether a new model of employment is needed, or if the Wikipedia structure is somehow applicable to other organizations.

7.4.4. Further Research

In order to advance ecological understanding in organization studies, and provide an enlightening example of a social complex adaptive organization, this chapter presented one case study supporting the usefulness of the LIFE model. More case analyses are required to further justify the model. Other forms of research are also necessary to complement this case study. Interviews of Wikipedians and historical analysis of Wikipedia pages would provide further insights into the dynamics of Wikipedia's self-organization and intrapreneurial behaviors. The case study presented focused on the English application of Wikipedia; although it is assumed that these results can be generalized to most language applications of Wikipedia, it is possible that different Wikipedia applications could exhibit cultural differences. Further research is needed to assess this possibility as it could be a fruitful source of cross- and inter-cultural studies. As shown by Lam (1997), and echoed by Collinson and Wilson (2006), societal and cultural factors linked to knowledge embeddedness influence its transference. Hence, the understanding of Wikipedia itself and transfer of organizational knowledge among different language applications of the 'free encyclopedia' may be hindered.

The nature of Wikipedia questions many academic assumptions. Editors of Wikipedia write articles for free, with almost no recognition (official or otherwise) for their work, while still being loyal and coordinating and leading the whole project. This leads to questions about the concepts of entrepreneurship and intrapreneurship, the first as

Wikipedia is not technically an enterprise but still the outcome of entrepreneurial behaviors, and the latter because the motivations of the members of the organization (intrapreneurs in this case) seem quite different than in most business organizations, or even in non-profit organizations. Wikipedia therefore raises interesting questions about organizational agency and the forms of social interactions required by an organization to innovate or simply operate. This relates to the role and source of flows of social energies, some of which have been illustrated by the LIFE model and the preceding analysis of Wikipedia. More research is needed to show the repercussions of this systemic and ecological concept, and illustrate how it underlies many aspects of organizational dynamics. In this context, a longitudinal approach with an analysis of Wikipedia at different points in time could prove to be very fruitful.

Complexity theory leads to the understanding that all organizational members should possess the capacity to live with and tolerate ambiguity and paradox, the willingness to accept change, and the ability to learn and allow one's mind to be changed by others (French, 2001). Because change is inherent to self-organization, as illustrated within the Wikipedia context, managers need to understand, accept, and adapt to the flows of energies that take place. As suggested by Tsoukas and Chua (2002), organization is a pattern that is constituted, shaped, and emerging from change.

7.5. Summary

This chapter has provided a brief description of the key relevant aspects of Wikipedia, and a presentation of the case research methodology. This led to a case analysis of Wikipedia based on the LIFE model framework. This case study has illustrated why Wikipedia could be considered as a social CAS and how the LIFE model enabled its analysis. It has been shown how continuous flows of positive and negative feedback among users and the processes of the Knowledge Processing Cycle lead to the emergence of a complex feedback system that nurtures the self-organization of the Wikipedia community and its outputs. As a result, a first justification of the LIFE model has been presented, and showed its usefulness in analyzing the knowledge processing system of a social CAS. This case study also emphasized the validity of previous claims made by researchers in the field of complexity theory such as the illusion of control, the need for flexibility and adaptation, and the need for diversity within organizations. It has also demonstrated the value of the LIFE model to uncover new areas of uncertainty, providing ground for further research in different fields.

This chapter completes a sequence of conceptual thinking, providing the basis for the concluding chapter, which will summarize this thesis and reflects on its achievements, as well as the future avenues for research that have been opened.

Chapter 8. Towards an Integrated Theory of Knowledge Management

This chapter concludes this thesis and retraces the key contributions made in the preceding seven chapters. The aim of this chapter is not to close the different discussions opened throughout this research, but to provide a reflective discussion of what might come next. The various discussions in this dissertation are at the core of the reconceptualization of the field of knowledge management called for by this thesis and should therefore stay open to further arguments. This chapter highlights what has been achieved up to this point, what still needs to be done, and how it could be done.

This chapter includes four sections.

- Section 1 provides a brief linear summary of this thesis, highlighting the key elements discussed in the first seven chapters.

- Section 2 summarizes the main contributions made in this thesis, constituting a non linear summary of this thesis.

- Section 3 proposes an integrative framework of the knowledge processing system based on the contributions of this thesis.

- Section 4 reflects on latent limitations, and outlines potential opportunities for further research.

8.1. Thesis Summary

This section provides a summary of the first seven chapters of this thesis. This will be useful to contextualize the main contributions made by this research in the next section.

Chapter 1 outlined the literature underlying this thesis. Three main areas of literature were presented: the concept of knowledge, knowledge processing systems, and complex adaptive systems. Gaps in the literature were highlighted and briefly discussed to supply the background for this study. Research objectives were presented and the chapter explained how gaps found in the literature would be addressed and what intended outcomes they would bring about. Chapter 1 also presented the philosophical position of the researcher and discussed briefly the approach undertaken during this research. It outlined the *agnostic existentialist* ontology underlying the research as, followed by a

description of the *radical socio-cultural constructivist* epistemology used in this thesis. A first account of the methodology employed in this thesis was also given.

The second chapter provided a brief historical description of the origins and developments of complexity theory, describing how this emerging theory tries to move away from the classical assumptions of scientific management. It described and discussed the key relevant concepts of simple, complicated, and complex, as well as the characteristics of complex adaptive systems (CAS), setting the theoretical basis for the analysis conducted in the following chapters. This chapter introduced the concept of social energy and discussed its importance for the study of social complex adaptive systems. Finally, the different methodological implications of using complexity theory as a theoretical lens to study social systems were reviewed. Several conclusions were reached on this issue. First, a model of a CAS needs to take into account four major issues: the different active environments surrounding the system, the functions of the system, the transformations occurring within the system through time, and the purpose of the system. Second in order to extract and convey insightful understanding from CAS, meaningfulness of such models needs to be favored as opposed to their precision. It has been demonstrated that this required using a conjunctive logic associated with systemic concepts as opposed to the traditional disjunctive logic associated with analytical concepts. Third, a systemic terminology needs to be employed. All these considerations when modeling complex systems provided the basis for developing the research tools exploited in the following chapters.

Chapter 3 discussed the historical development of the concept of knowledge. It provided an understanding of how a reductionist perspective entered the debate between philosophers in the West, playing an important role in the development of the theory of knowledge. It described how, from the idealism of Plato and the deductive empiricism of Aristotle, the debate of the concept of knowledge has been subject to many influences, including the whirlpool of reductionism induced by rationalists such as Descartes, and the work of the inductive empiricists, such as Bacon and Locke, attempting to pursue the conceptual development of the self. Modern philosophers representing varying epistemologies (e.g. logical positivists and falsificationists) were included to illustrate how the concept of knowledge eventually progressed towards systems thinking, intending to create more epistemological cohesiveness. This chapter described how idealists such as Kant and Hegel helped to create dialectical logic, whereas Kuhn and Lakatos proposed the premises of holistic accounts of science in the

West, and how this move towards holism bridged a gap between the East and the West with the foundation of constructivism and the consequent appearance of systems theory and complexity theory; the latter sharing numerous ideas featured in established Eastern philosophies (e.g. refutation of causation, self-organization, and flows of energies).

Chapter 3 also presented many definitions of taxonomies of knowledge (such as know-how, know-what, know-who, and know-why; or tacit and explicit) from the literature, along with a wide variety of definitions of the constructs constituting them (typically data, information, knowledge, and wisdom, commonly known as DIKW). Although the field of knowledge management had been created with intentions of holism, this chapter showed how it entered a reductionist phase, leading to the birth of the traditional DIKW pyramid, a model which, based on linear thinking, slowed the evolution of the field. Several recent models were presented and their attempts to move away from the traditional pyramid to provide a more systemic approach discussed. It was determined that none achieved sufficient improvements in regards to the reconceptualization needed by the field. To progress towards a systemic and integrative theory of knowledge management, it was concluded that the concept of knowledge required a new systemic perspective matching the non-linearity of reality, as well as clearer statements of boundaries and transitional possibilities.

Chapter 4 provided a review of the knowledge management literature to convey the dimension of the changes involved in establishing a systemic and integrative theory of knowledge management. It provided an account of the main current theories of organizational learning and knowledge processing systems, and analyzed the prominent models found in the literature for these research areas. A comparison of these models highlighted the lack of systemic considerations among these models, and, most importantly, the oversight of the concept of social energy.

Chapter 5 commenced by briefly discussing the Delphi method, its origins, and its field of application. This chapter presented a Delphi study utilizing a panel of experts to explore existing consensus and dissension within the field of knowledge management. The purpose of this study was to examine the current state of knowledge management, and to assess issues related to questions raised in previous chapters, such as the validity of the DIKW framework and the potential need for reconceptualization of the field. Results indicated that knowledge management is a field in flux, demanding improved conceptualizations and a developed consensus among academics and practitioners. As a

step in this direction, experts hinted that complexity theory could open a suitable avenue to reach a new integrative paradigm. Additionally, this chapter showed how the Delphi method can be adapted for use in mapping consensus among a group of experts, and how it can serve as a key research tool to study a complex issue. This chapter confirmed the need for a reconceptualization of the field of knowledge management, which was the focus of the next chapter.

Chapter 6 presented the E2E Model, an integrated framework based on insights from complexity theory, illustrating the different constructs of data, information, knowledge, and wisdom linked into a feedback system of increasing level of understanding, allowing multidirectional interstate transitions, bound between two states of being: existence and enlightenment (hence "E2E"). This model therefore presented a more complete cognitive system of knowledge and showed how understanding conceptually links existence to enlightenment in a non-linear framework. This model answered the need for a new systemic perspective matching the non-linearity of reality with clearer statements of boundaries and transitional possibilities. Chapter 6 also introduced the LIFE Model (Leadership Invigorating Flows of Energies) to provide a more useful description of the organizational knowledge processing system. It showed how the LIFE Model highlighted the role of emergent leadership and flows of social energies as forces invigorating the KPS, and described how knowledge is created, assimilated, and diffused dynamically within an organization through the Knowledge Processing Cycle in eight activities interacting with the Organizational Knowledge Base, external knowledge, and the organizational social network. Furthermore, this chapter illustrated how the concept of Leadership Invigorating Flows of Energies allowed for a more comprehensive description of the mechanisms underlying the KPS and its self-organization. It was suggested that managers should understand, accept, and adapt to the flows of social energies taking place in an organization by focusing on strategic recognition rather than planning. They should provide a purpose to the KPS and create a supportive environment enabling the knowledge flows within the organization and fostering the emergence of knowledge intrapreneurs. Managers were described as the facilitators of the self-organization of the KPS that can liberate creative interactions among flows of social energies.

Chapter 7 provided a brief description of the key relevant aspects of Wikipedia, and a presentation of the case research methodology. This led to a case analysis of Wikipedia based on the LIFE Model. This case study illustrated why Wikipedia could be

considered as a social CAS and how the LIFE model enabled its analysis. It was shown how continuous flows of positive and negative feedback among users and the processes of the Knowledge Processing Cycle led to the emergence of a complex feedback system that nurtures the self-organization of the Wikipedia community and its outputs. As a result, this chapter presented a first justification of the LIFE model, and showed its usefulness in analyzing the knowledge processing system of a social CAS. This case study also emphasized the validity of previous claims made by researchers in the field of complexity theory such as the illusion of control, the need for flexibility and adaptation, and the need for diversity within organizations. It also demonstrated the value of the LIFE model to uncover new areas of uncertainty, providing ground for further research in different fields.

Together, the E2E Model and the LIFE Model provided a sound foundation for a reconceptualization of knowledge management. They opened the path to the creation of an integrative theory of knowledge management. A first integration of these two models is presented in Section 8.3, after the following section which highlights the main contributions of this thesis.

8.2. Main Contributions

The five main contributions of this thesis, described in this section, are:

(1) The design of an adapted Delphi method, and its application to map the current state of the field of knowledge management,

(2) The development of a comprehensive concept of social energy,

(3) The creation of a new model of the concept of knowledge (E2E Model),

(4) The conception of a new model of knowledge processing system (the LIFE Model), and

(5) The foundation for an integrative theory of knowledge management.

In order to examine constructs related to knowledge management, an adapted Delphi technique was developed. This technique is a hybrid between the policy and classical approaches, with adaptations that allowed for consensus mapping and theory building. This modified Delphi approach proved useful in focusing on the tensions and patterns

arising within the panel, and helped uncover the need for a major re-conceptualization of the field of knowledge management. It also highlighted that no single existing framework garnered significant support to provide the core of such a new foundation. Supporting the conclusions that emerged through the literature review, this Delphi study suggested that knowledge management will need to advance to a new paradigmatic stage to truly bridge the gap between theory and practice. Further supporting the underlying approach of this thesis, systems thinking and complexity theory emerged as the most appropriate theories to support such a shift.

The concept of social energy was introduced; while not constituting a novel concept, it has been essentially ignored by the literature in all fields. It was shown that energy flows were typically missing from knowledge management frameworks. The survival of an organization (avoidance of entropy, or recovery from it) requires sufficient inputs of social energy to sustain its normal activities as well as to create new ones. These flows are important elements of organizational evolution; they intervene across all organizational levels (individual, group, inter-group) by creating vital positive and negative feedback systems within organizational processes. This concept of social energy is prominent in the conception of the LIFE Model, itself based on the E2E Model, two new knowledge management frameworks introduced in this thesis.

The E2E Model is an integrated framework based on insights from complexity theory. The model illustrates how the different constructs of data, information, knowledge, and wisdom are linked into a complex feedback system of increasing levels of understanding. The E2E Model allows for multidirectional interstate transitions, bound between two states of being: existence and enlightenment. This new extension of the traditional DIKW framework echoes the findings of this research and answers the need to replace the traditional pyramid, as strongly suggested by a majority of the panel of experts during the Delphi study. This model presents a more comprehensive cognitive system of knowledge and shows how understanding conceptually links existence to enlightenment in a non-linear framework.

The LIFE Model provides a comprehensive description of the organizational Knowledge Processing System based on insights from complexity theory, especially the ones of complex adaptive systems. The LIFE Model stresses the role of emergent leadership and flows of social energies as forces invigorating the KPS. It describes how knowledge is created, assimilated, and diffused dynamically within an organization

through the Knowledge Processing Cycle in eight activities interacting with the Organizational Knowledge Base, external knowledge from the environment, and the organizational social network. The concept of Leadership Invigorating Flows of Energies allows for a more complete description of the mechanisms underlying the KPS and its self-organization. The model also highlights the need to create a supportive environment enabling the knowledge flows within the organization and to foster the emergence of knowledge intrapreneurs, as they are the facilitators of the KPS self-organization that can liberate creative interactions among flows of social energies.

Together, the E2E Model and the LIFE Model propose a new foundation for the knowledge management field. They provide a solid philosophical grounding based on insights from systems thinking and complexity theory. Aligned with the needs uncovered in the literature reviews, and during the Delphi study, they allow for a reconceptualization of the field from the ground up into an integrative theory of knowledge management.

The next section provides an initial illustration of what could be achieved using these two models to build an integrative framework for knowledge management, constituting the fifth of the main contributions of this research.

8.3. Towards an Integrative Framework

This section presents the two new models of, respectively, the concept of knowledge (E2E) and the knowledge processing system (LIFE) within an integrative framework, explaining how and why they relate to each other. This is a brief account of what it is possible to achieve with these two models, and this section provides only two examples drawn from a myriad of possibilities. The design and discussion of a comprehensive integrative framework for knowledge management is beyond the scope of this thesis, and is left for subsequent research.

The first example is of the use of the LIFE Model to illustrate the inter-organizational flows of energy and feedback loops that occur among related organizations. Whether in an industry cluster, a partner network, or even a competitive setting, organizations evolve in the same environment. Therefore, organizations are linked to each other, and Leadership Invigorating Flows of Energies that are created among them flow across their boundaries. Figure 8.1 illustrates this point.

Figure 8.1: Inter-organizational LIFE

Inter-organizational LIFE exchanges
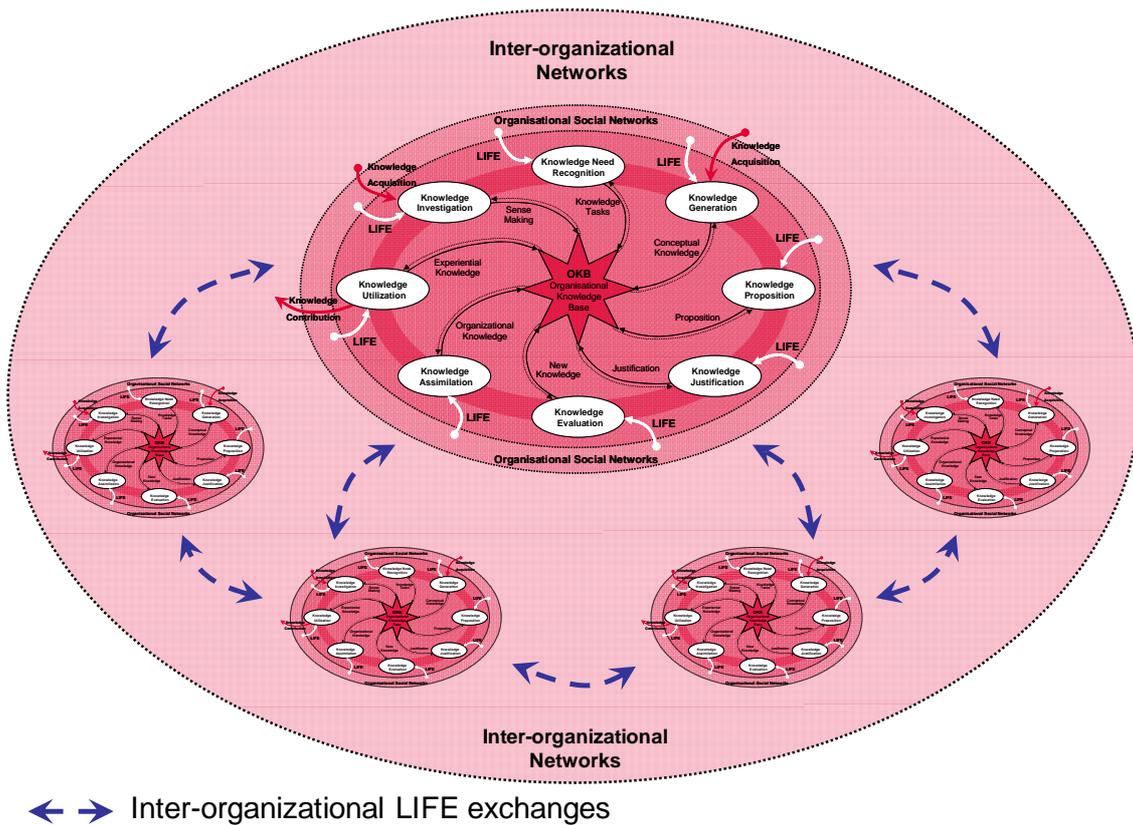
In essence, these inter-organizational LIFE exchanges exemplify the fractal aspect of knowledge processing systems. At every level – individual, group, organizational, inter-organizational – the LIFE Model can be used to show the leading flows of energies nurturing the self-organization of the knowledge processing systems at play.

The LIFE model portrays principally the 'knowledge' construct, using a broader definition of knowledge than the E2E perspective, which emphasizes the DIKW taxonomy and the tacit and explicit dimensions of these constructs, as well as experience and understanding. In essence, the LIFE model portrays knowledge as any construct within the DIKW taxonomy; it also includes understanding and experience. In fact, the term 'knowledge' in the LIFE model can be replaced by 'E2E', in the sense of 'E2E construct'. Figure 8.2 illustrates that point. The original LIFE model has been adapted to match the new perspective, and it is therefore E2E constructs that are exchanged, diffused, transformed, and created through the Knowledge Processing Cycle, which is consequently renamed in this figure as the 'E2E Processing Cycle'. All other components of the model have been renamed accordingly.

Figure 8.2: The LIFE of E2E Model
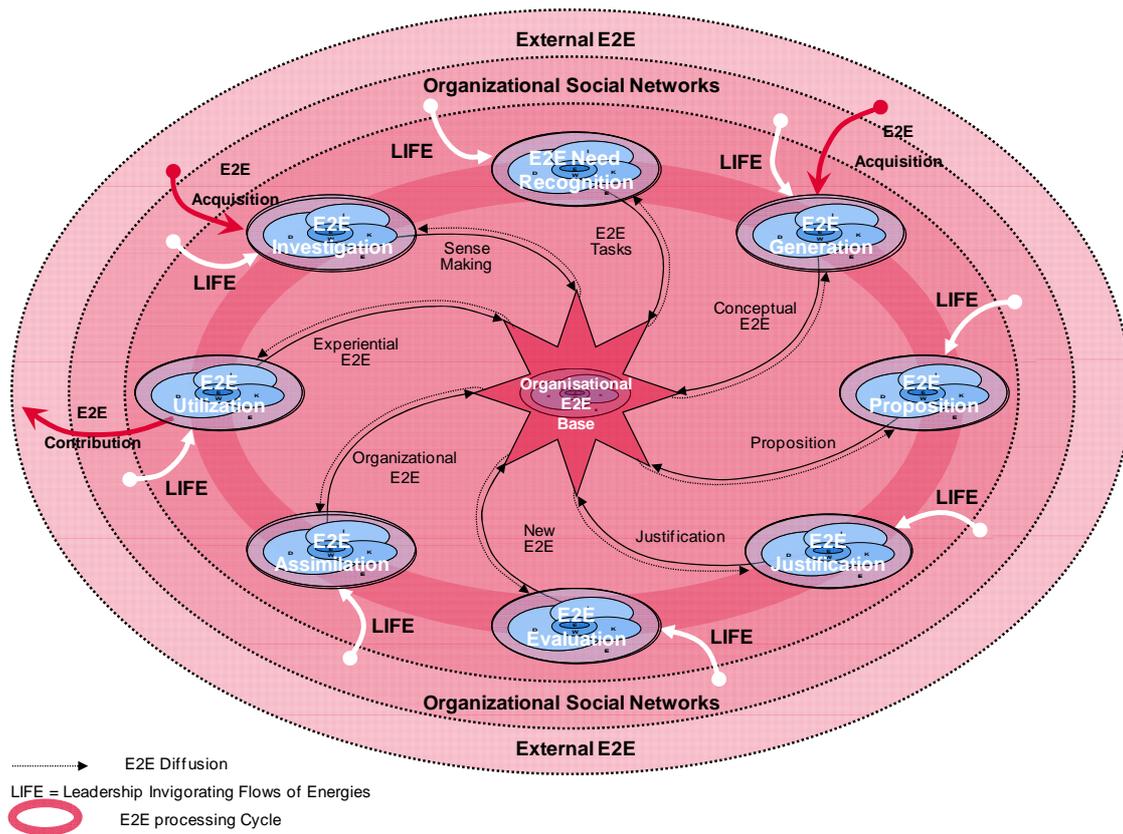
Blending the last two illustrations is also possible, showing the extent of possibilities that these two models offer to knowledge management at the conceptual level.

The next section reflects on latent limitations of this thesis, and outlines potential opportunities for further research.

8.4. The Living End

Although this thesis is reaching its conclusion, it is far from an 'end' in itself. This is the start of many new challenges to build an integrative theory of knowledge management, therefore one that can be seen as a 'living end' in reference to the never-ending self-organization of the field. This section examines the underlying limitations of this thesis and discusses prospective opportunities for further research.

This thesis has provided an overview of the LIFE Model as a basis for describing the principles of a self-organizing KPS. Individual aspects deserve further conceptual analysis and the model should be tested against specific organizational contexts. This thesis is an attempt to fill a vacuum in the current knowledge management literature –

portrayal of a knowledge management process that fits the view of an organization as a dynamic venue for interactions including the necessary flows of energies implied by such mechanisms. There are several new proposals in the LIFE model that could be the subject for further research, discussion and development.

Knowledge intrapreneurship requires a more in-depth description and integration into the LIFE Model and wider literature. Showing how knowledge intrapreneurship relates to organizational entrepreneurship would be a starting point. It will also be important to study the underlying motives and conditions that lead to knowledge intrapreneurship. Some organizations (such as Wikipedia and Google) have recently experienced seemingly incredible success, which can be seen as directly related to their knowledge intrapreneurship capabilities. However, while Google and Wikipedia share the image of being unorthodox organizations, one is profit-oriented whereas the other is based on voluntarism. It is unlikely that intrapreneurial mechanisms in both organizations are the same, although they probably share some common ground.

This relates to a property of systems that is commonly overlooked by researchers, namely equifinality (Ashmos & Huber, 1987). As argued by Shibutami (1968), open systems can reach a similar final state while having undergone different evolutions in different contexts, commencing from different starting points. Von Bertalanffy (1962) and Katz and Kahn (1966) claimed this phenomenon as a property of the openness of the system, but in the case of social CAS this may also be due to strange attractors that have not yet been identified (as described by Parker & Stacey, 1994). Ashmos and Huber (1987) argued that because of the memory of social systems, a broader concept of equifinality was required when studying human organizations. The LIFE Model could provide the basis for such a framework to analyze how organizational learning mechanisms (as in the Knowledge Processing Cycle) and memory (as in the OKB) work together in the context of social CAS.

The importance of feedback systems has been highlighted by the LIFE model at both group and individual levels. As highlighted in this thesis and by many researchers on cognition (Baron, 2008; Lazarus, 1991a, 1991b; Markus & Kitayama, 1991), mental energy strongly influences knowledge intrapreneurship. In essence, knowledge can be viewed as a form of mental energy, typically created, enhanced, and managed through flows of social energies (interactions among holders of mental energy). Hence, there is a need to further study how mental energies are triggered and how they can be nurtured at

the individual or group level. This particular point also supports further work on the relationship between levels of understanding, as described in the E2E Model, and levels of energy that are used by individuals and organizations. At the organizational level, a finer description illustrating the difference between positive and negative feedback in the different activities of the Knowledge Processing Cycle could bring deeper insights into the KPS. This could be complemented by an analysis of the influence of senior managers on the KPS, and how they can interfere with its (self-organizing) functioning. As suggested by Ling et al. (2008), CEOs' transformational inclination has a direct impact on organizational willingness to engage in corporate entrepreneurship (i.e., intrapreneurship). Consequently, factors affecting knowledge intrapreneurs at the individual level should be investigated.

Analysis of the scale-free aspect of the LIFE Model should be conducted, extending its applicability from the individual to the organizational network level, as illustrated in the previous section. In essence, the LIFE Model as a tool can be transposed to all organizational levels, but theoretical and practical limitations arise from doing this. A fractal LIFE Model exists, but this requires further examination of its applicability as different forms of knowledge intrapreneurship behaviors may exist at different organizational levels. The relationships among the E2E Model and the processes illustrated by the LIFE Model also require further attention as they may play a major role in the self-organization of the KPS. A better understanding of the Metas, introduced in Chapter 6, and their influence on the underlying functioning of the LIFE Model, seems a fertile ground for new insights into knowledge management. Extending on the scale-free characteristic of the LIFE Model, the KPS and its self-organizing mechanisms might also be useful to portray learning mechanisms at the individual level, as suggested by the work of von Glasersfeld (1987).

The Knowledge Processing Cycle and the emergence of an OKB could be examined from the perspective of organizational learning theory. Indeed, it is possible that different organizations will manifest different patterns and may not employ all aspects of the Knowledge Processing Cycle, or at least not in the same ways. Studying multiple case examples to track differences and similarities among organizational learning outcomes could lead to the discovery of patterns of organizational behavior and impacts of environmental differences, fostering understanding of the emergent properties found in social CAS. Portraying how organizational learning interacts with the self-organization of the KPS could strengthen the practical applications of the LIFE Model.

Examining interactions between organizational networks and environments should provide insight into the barriers and filters affecting flows of both knowledge and energies into and out of the organization, balancing the openness of a complex adaptive system with the self-preservation and learning goals of the social system.

The concept of organizational intelligence and its potential role in the LIFE Model will need to be examined. As shown by Akgün, Byrne, and Keskin (2006), organizational intelligence emerges from and is contained in the daily activities of the organization. Akgün et al. assert organizational intelligence to be a multidimensional and multifaceted construct, implicating the recursive interaction of the cognitive, behavioral, and emotional capabilities of organizations. This view can be directly related to the OKB of the LIFE Model, as it implies organizational intelligence. Organizational intelligence also leads to the notion of intellectual capital, which is commonly divided into three principal forms: human, organizational, and social (Subramaniam & Youndt, 2005). Following a systemic approach, considering human, organizational, and social capital as discrete entities seems reductionist; however, studying them as interrelated elements of an intellectual capital system might be fruitful. The LIFE Model could be seen as facilitating such a system. Human capital is part of the organizational social network; organizational capital is a constituent of the same network, as well as of the OKB, while social capital resides mostly in the OKB. Some limitations and overlaps are apparent from even a cursory analysis; an integrative model of intellectual capital using the LIFE framework could address these limitations.

Further developing on intellectual capital, in the LIFE Model, social energy is proposed as the basic force within the Knowledge Processing System. The relationship between social energy and social capital warrants clarification. Although equated by some (e.g. Bebbington & Perreault, 1999), social capital and social energy relate to different levels of the organization, one being a constituent of the other. Social capital is composed of social connections (Bourdieu, 1986) and social structure (Coleman, 1988), and refers to opportunities (Burt, 1997). Hence, social capital may be a source and storage of social energy. Through the lens of complexity theory, social capital may even take the form of self-organizing feedback systems, present in the LIFE Model. This raises the question of what forms social energy can take. We have suggested motivation and knowledge, but other forms of social energy such as power in organizations are relevant as well. Furthermore, this implies that social capital underlies knowledge flows in organizations,

which concurs with recent research in knowledge management (Mu, Peng, & Love, 2008; Tsai, 2006).

In conclusion, the LIFE Model provides a useful representation of the mechanisms underlying the Knowledge Processing System in organizations. Recognition of organizations as social complex adaptive systems and provision of an integrative systems model opens the path for a multitude of new research in entrepreneurship, organizational learning, intellectual and social capital, and organization studies. Most of all, it offers a possible avenue for the creation of an integrated theory of knowledge management.

"There is a theory which states that if ever anyone discovers exactly what the Universe is for and why it is here, it will instantly disappear and be replaced by something even more bizarre and inexplicable. There is another which states that this has already happened."

Douglas Adams (2002), The Ultimate Hitchhiker's Guide to the Galaxy, p. 148.

References

Achterman, D., & Loertscher, D. (2006). The wiki way: Building better collaborative library projects. *California School Librarians Association Workshop*. Retrieved on 1 April 2008, from http://www.sbhsd.k12.ca.us/sbhslib/teacherhelp/wikiwayhandouts.pdf.

Ackoff, R. (1989). From data to wisdom. *Journal of Applied Systems Analysis, 16*(1), 3-9.

Addison, T. (2003). E-commerce project development risks: Evidence from a Delphi survey. *International Journal of Information Management, 23* (1), 25-40.

Akgün, A., Byrne, J., & Keskin, H. (2007). Organizational intelligence: A structuration view. *Journal of Organizational Change Management, 20*(3), 272-289.

Al-Alawi, A., Al-Marzooqi, N., & Mohammed, Y. (2007). Organizational culture and knowledge sharing: Critical success factors. *Journal of Knowledge Management, 11*(1), 22-42.

Alavi, M. (1997). *KPMG Peat Marwick US: One Giant Brain*. Boston, MA: Harvard Business School.

Alavi, M., & Leidner, D. (1999). Knowledge management systems: Issues, challenges, and benefits. *Communications of the AIS, 1*(2es), 2-36.

Alavi, M., & Leidner, D. (2001). Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly, 25*(1), 107-136.

Alexa.com (2008). Traffic details from Alexa. Retrieved on 5 October 2008, from http://www.alexa.com/data/details/traffic_details?url=wikipedia.org

Allard, S. (2003). Knowledge creation. In C. Holsapple (Ed.), *Handbook on Knowledge Management 1: Knowledge Matters* (pp. 367-379). Berlin, Germany: Springer-Verlag.

Allee, V. (1997). *The Knowledge Evolution: Expanding Organizational Intelligence*. Boston, MA: Butterworth-Heinemann.

Allix, N. (2003). Epistemology and knowledge management concepts and practices. *Journal of Knowledge Management Practice, 4*. Retrieved on 1 April 2008 from http://www.tlainc.com/articl49.htm.

Alvesson, M. (1992). Leadership as social integrative action: A study of a computer consultancy company. *Organization Studies, 13*(2), 185-209.

Ammon, M. (2003). Psychological studies on human structural dance. *Group Analysis, 36*(2), 288-306.

Anthony, R. (1965). *Planning and Control Systems: A Framework for Analysis*. Boston, MA: Harvard University Graduate School of Business Administration.

Applehans, W., Globe, A., & Laugero, G. (1999). *Managing Knowledge: A Practical Web-Based Approach*. Reading, PA: Addison Wesley Longman.

Apte, C. (1982). *Expert Knowledge Management for Multi-Level Modeling with an Application to Well-Log Analysis.* Technical report, LCSR, Rutgers University.

Argyris, C. (1993). *On Organizational Learning*. Cambridge, MA: Blackwell.

Arrow, K. (1984). *The Economics of Information*. Cambridge, MA: Belknap Press of Harvard University.

Arthur Andersen and APQC. (1996). *The Knowledge Management Assessment Tool: External Benchmarking Version*. Chicago, IL: Arthur Andersen.

Ashmos, D., & Huber, G. (1987). The systems paradigm in organization theory: Correcting the record and suggesting the future. *The Academy of Management Review, 12*(4), 607-621.

Augier, M., & Vendelo, M. (1999). Networks, cognition and management of tacit knowledge. *Journal of Knowledge Management, 3*(4), 252-261.

Aune, B. (1970). *Rationalism, Empiricism, and Pragmatism*. New York, NY: Van Nostrand.

Awad, E., & Ghaziri, H. (2004). *Knowledge Management*. Upper Saddle River, NJ: Pearson Education, Prentice Hall.

Bak, P. (1996). *How Nature Works: The Science of Self-Organized Criticality*. New York, NY: Copernicus.

Ballantyne, D. (2003). A relationship-mediated theory of internal marketing. *European Journal of Marketing, 37*(9), 1242-1260.

Baron, J. (2008). *Thinking and Deciding* (4 ed.). Cambridge, UK: Cambridge University Press.

Baron, R. (2008). The role of affect in the entrepreneurial process. *Academy of Management Review, 33*(2), 328-340.

Barsh, J., Cranston, S., & Craske, R. (2008). Centered leadership: How talented women thrive. *McKinsey Quarterly*(4), 35-48.

Basu, S., & Schroeder, R. (1977). Incorporating judgments in sales Forecasts: Application of the Delphi method at American Hoist & Derrick. *Interfaces, 7*(3), 18-27.

Bateson, G. (1979). *Mind and Nature: A Necessary Unity*. New York, NY: Bantam Books.

Bebbington, A., & Perreault, T. (1999). Social capital, development, and access to resources in highland Ecuador. *Economic Geography, 75*(4), 395-418.

Bellinger, G., Castro, D., & Mills, A. (2004). Data, information, knowledge, and wisdom. *Systems Thinking*. Retrieved on 1 March 2006, from http://www.systems-thinking.org/dikw/dikw.htm

Bennet, A., & Bennet, D. (2004). *Organizational Survival in the New World: The Intelligent Complex Adaptive System*. Boston, MA: Elsevier.

Bennett, D., & Bennett, A. (2003). The rise of the knowledge organization. In C. Holsapple (Ed.), *Handbook on Knowledge Management 1: Knowledge Matters* (pp. 5-20). Berlin, Germany: Springer-Verlag.

Berger, P., & Luckmann, T. (1966). *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*. Garden City, NY: Anchor Books.

Bergson, H. (1913). *Creative Evolution*. London: Macmillan.

Best, S., & Kellner, D. (1997). *The Postmodern Turn*. New York, NY: Guilford Publications, Inc.

Boisot, M., & Canals, A. (2004). Data, information and knowledge: Have we got it right? *Journal of Evolutionary Economics, 14*(1), 43-67.

Boisot, M., MacMillan, I., & Han, K. (2007). Property rights and information flows: A simulation approach. *Journal of Evolutionary Economics, 17*(1), 63-93.

Boland, R., Singh, J., Salipante, P., Aram, J., Fay, S., & Kanawattanachai, P. (2001). Knowledge representations and knowledge transfer. *Academy of Management Journal, 44*(2), 393-417.

Bonczek, R., Holsapple, C., & Whinston, A. (1981). *Foundations of Decision Support Systems*. New York, NY: Academic Press.

BonJour, L. (1985). *The Structure of Empirical Knowledge*. Cambridge, MA: Harvard University Press.

Bouchikhi, H. (1993). A constructivist framework for understanding entrepreneurship performance. *Organization Studies 14*(4), 549-570.

Bourdieu, P. (1977). *Outline of a Theory of Practice*. Cambridge, UK: Cambridge University Press.

Bourdieu, P. (1986). The forms of capital. In E. Richardson (Ed.), *Handbook of Theory of Research for the Sociology of Education* (pp. 241-258). London: Greenword Press.

Bourdreau, A., & Couillard, G. (1999). Systems integration and knowledge management. *Information Systems Management, 16*(4), 24-32.

Box, G. (1979). Robustness in the strategy of scientific model building. In R. Launer & G. Wilkinson (Eds.), *Robustness in Statistics*. New York, NY: Academic Press.

Bradley, L., & Stewart, K. (2003). A Delphi study of Internet banking. *Marketing Intelligence & Planning, 21* (5), 272-281.

Buchanan, M. (2000). *Ubiquity: Why Catastrophes Happen*. New York, NY: Three River Press.

Burgelman, R. (1983). Corporate entrepreneurship and strategic management: Insights from a process study. *Management Science, 29*(12), 1349-1364.

Burt, R. (1997). The contingent value of social capital. *Administrative Science Quarterly, 42*(2), 339-365.

Byrne, D. (1998). *Complexity Theory and the Social Sciences: An Introduction*. London: Routledge.

Capra, F. (1996). *The Web of Life: A New Scientific Understanding of Living Systems*. New York, NY: Anchor.

Capra, F. (2005). Complexity and life. *Theory, Culture & Society, 22*(5), 33.

Chalmers, A. (1999). *What Is This Thing Called Science* (3 ed.). St. Lucia, Queensland, Australia: University of Queensland.

Chia, R. (1997). Thirty years on: From organizational structures to the organization of thought. *Organization Studies, 18*(4), 685-707.

Ciborra, C. (2002). *The Labyrinths of Information: Challenging theWisdom of Systems*. Oxford, UK: Oxford University Press.

Cilliers, P. (1998). *Complexity and Postmodernism: Understanding Complex Systems*. London: Routledge.

Cilliers, P. (2005). Knowing complex systems. In K. Richardson (Ed.), *Managing Organizational Complexity: Philosophy, Theory, and Application* (pp. 7-19). Charlotte, NC: Information Age Publishing.

Cohen, M. (1999). Commentary on the Organization Science special issue on complexity. *Organization Science, 10*(3), 373-376.

Colander, D. (2000). *Complexity and the History of Economic Thought*. London: Routledge.

Colander, D. (2000). *The Complexity Vision and the Teaching of Economics*. Cheltenham, UK: Edward Elgar.

Coleman, J. (1988). Social capital in the creation of human capital. *The American Journal of Sociology, 94*(Supplement), S95-S120.

Collinson, S., & DC, W. (2006). Inertia in Japanese organizations: Knowledge management routines and failure to innovate. *Organization Studies 27*, 1359-1387.

Crowell, S. (2004). Existentialism. *Stanford Encyclopedia of Philosophy*. Retrieved on 2 October 2009, from http://plato.stanford.edu/entries/existentialism.

Czinkota, M., & Ronkainen, I. (1997). International business and trade in the next decade: Report from a Delphi study. *Journal of International Business Studies, 28*(4), 827-844.

Czinkota, M., & Ronkainen, I. (2005). A forecast of globalization, international business and trade: Report from a Delphi study. *Journal of World Business, 40*(2), 111-123.

Dalkey, N. (1968). *Experiments in Group Prediction*. Santa Monica, CA: RAND Corporation.

Dalkey, N. (1968). *Predicting the Future*. Santa Monica, CA: RAND Corporation.

Dalkey, N. (1969). *The Delphi Method: An Experimental Study of Group Opinion*. Santa Monica, CA: RAND Corporation.

Dalkey, N., & Helmer, O. (1963). An experimental application of the Delphi method to the use of experts. *Management Science, 9*(3), 458-467.

Davenport, T., & Prusak, L. (1997). *Information Ecology: Mastering the Information and Knowledge Environment*. New York, NY: Oxford University Press.

Davenport, T., & Prusak, L. (1998). *Working Knowledge: Managing What Your Organization Knows*. Boston, MA: Harvard Business School Press.

Day, R. (2005). Clearing up implicit knowledge: Implications for knowledge management, information science, psychology, and social epistemology. *Journal of the American Society for Information Science and Technology, 56*(6), 630-635.

Denning, S. (1998). What is knowledge management? Retrieved on 26 August 2009, from http://www.stevedenning.com/knowledge.htm.

Dent, E. (1999). Complexity science: A worldview shift. *Emergence, 1*(4), 5-19.

Desouza, K. (2005). *New Frontiers of Knowledge Management*. New York, NY: Palgrave Macmillan.

Dimitrov, V. (2003). Fuzziology: A study of fuzziness of human knowing and being. *Kybernetes, 32*(4), 491-510.

Dixon, N. (2000). *Common Knowledge: How Companies Thrive by Sharing What They Know*. Boston, MA: Harvard Business School Press.

Dodge, B., & Clark, R. (1977). Research on the Delphi technique. *Educational Technology, 17*(4), 58-60.

Dos Santos, B., & Holsapple, C. (1989). A framework for designing adaptive DSS interfaces. *Decision Support Systems, 5*(1), 1-11.

Drucker, P. (1995). *Managing in a Time of Great Change*. New York, NY: Truman Talley Books.

Durkheim, E. (1912). *The Elementary Forms of Religious Life*. (J. Swain, trans. (1915)). London: Allen & Unwin.

Edvinsson, L., Dvir, R., Roth, N., & Pasher, E. (2004). Innovations: The new unit of analysis in the knowledge era. *Journal of Intellectual Capital, 6*(1), 40-58.

Erffmeyer, R., Erffmeyer, E., & Lane, I. (1986). The Delphi technique: An empirical evaluation of the optimal number of rounds. *Group & Organization Studies, 11*(1-2), 120-128.

Erffmeyer, R., & Lane, I. (1984). Quality and acceptance of an evaluative task: The effects of four group decision-making formats. *Group & Organization Studies, 9*(4), 509-529.

Espedal, B. (2007). Why rules rather than discretion: When the leadership intends to transform a desired policy into reality. *Journal of Organizational Change Management, 20*(1), 95-108.

Faucher, J., Everett, A., & Lawson, R. (2008). Reconstituting knowledge management. *Journal of Knowledge Management, 12*(3), 3-16.

Faucher, J., Everett, A., & Lawson, R. (2008). What do we know about knowledge? In A. Koohang, K. Harman & B. Johannes (Eds.), *Knowledge Management: Theoretical Foundations* (pp. 41-78). Santa Rosa, CA: Informing Science Press.

Fildes, J. (Producer). (2007) Wikipedia shows CIA page edits. BBC News, August 15. Retrieved on 31 January 2008, from http://news.bbc.co.uk/2/hi/technology/6947532.stm.

Firestone, J., & McElroy, M. (2003). *Key Issues in the New Knowledge Management.* Boston, MA: Butterworth-Heinemann.

Ford, D. (2003). Trust and knowledge management: The seeds of success. In C. Holsapple (Ed.), *Handbook on Knowledge Management 1: Knowledge Matters* (pp. 553-575). Berlin, Germany: Springer-Verlag.

Foster, J. (2005). From simplistic to complex systems in economics. *Cambridge Journal of Economics, 29*(6), 873-892.

French, R. (2001). Negative capability: Managing the confusing uncertainties of change. *Journal of Organizational Change Management, 14*(5), 480-492.

Galup, S., Dattero, R., & Hicks, R. (2002). Knowledge management systems: An architecture for active and passive knowledge. *Information Resources Management Journal, 15*(1), 22-28.

Gell-Mann, M. (1994). *The Quark and the Jaguar.* New York, NY: Freeman

Giles, J. (2005). Special report: Internet encyclopedias go head to head. *Nature, 438*(15), 900-901.

Gladwell, M. (2000). *The Tipping Point: How Little Things Can Make a Big Difference.* Boston, MA: Little, Brown.

Gleick, J. (1987). *Chaos. Making a New Science.* London: Heinemann.

Goldman, A. (1991). *Empirical Knowledge.* Berkeley, CA: University of California.

Goldspink, C. (2009). Social self regulation in on-line communities: The case of Wikipedia. *International Journal of Agent Technologies and Systems, 1*(1), (in press).

Gordon, T., & Helmer, O. (1964). *Report on a Long-Range Forecasting Study*. Santa Monica, CA: RAND Corporation.

Gordon, T., & Pease, A. (2006). RT Delphi: An efficient, "round-less" almost real time Delphi method. *Technological Forecasting & Social Change, 73*(4), 321-333.

Gore, C., & Gore, E. (1999). Knowledge management: The way forward. *Total Quality Management, 10*(4/5), 554-560.

Greenblatt, S. (1988). *Shakespearean Negotiations: The Circulation of Social Energy in Renaissance England*. Berkeley, CA: University of California Press.

Group, V. H. S. (2003). *The Seeker's Glossary of Buddhism*. Taipei, Taiwan: The Corporate Body of the Buddha Educational Foundation.

Gupta, U., & Clarke, R. (1996). Theory and applications of the Delphi technique: A bibliography (1975-1994). *Technological Forecasting & Social Change, 53*(2), 185-211.

Hasgall, A., & Shoham, S. (2008). Knowledge processes: From managing people to managing processes. *Journal of Knowledge Management, 12*(1), 51-62.

Hawes, C. (2005). *The Social Circulation of Poetry in the Mid-Northern Song; Emotional Energy and Literati Self-Cultivation*. New York, NY: State University of New York Press.

Hegel, G. (1929). *Science of Logic* (Vol. 2). London: G. Allen & Unwin.

Heidegger, M. (1962). *Being and Time*. New York, NY: Harper & Row

Heisenberg, W. (1930). *The Physical Principles of the Quantum Theory*. New York, NY: Dover Publications.

Heisig, P. (2005). *Integration von Wissensmanagement in Geschäftsprozesse*. Unpublished Dissertation, TU Berlin, Berlin, Germany.

Heisig, P. (2009). Harmonisation of knowledge management - Comparing 160 KM frameworks around the globe. *Journal of Knowledge Management, 13*(4), 4-31.

Heisig, P., & Orth, R. (2005). *Wissensmanagement Frameworks aus Forschung und Praxis*. Berlin, Germany: Eureki.

Helmer, O., & Quade, E. (1963). *An Application to the Study of a Developing Economy by Operational Gaming*. Santa Monica, CA: RAND Corporation.

Heskett, J. (2002). What's best for the corporate brain. *Harvard Business School Working Knowledge*. Retrieved 30 August 2006, from http://hbswk.hbs.edu/item/3163.html

Hicks, R., Dattero, R., & Galup, S. (2006). The five-tier knowledge management hierarchy. *Journal of Knowledge Management, 10*(1), 19-31.

Hill, K., & Fowles, J. (1975). Methodological worth of Delphi forecasting technique. *Technological Forecasting and Social Change, 7*(2), 179-192.

Hirschman, A. (1983). The principle of conservation and mutation of social energy. *Grassroots Development Journal, 7*(2), 3-9.

Holsapple, C. (2003). Knowledge and its attributes. In C. Holsapple (Ed.), *Handbook on Knowledge Management 1: Knowledge Matters* (pp. 165-188). Berlin, Germany: Springer-Verlag.

Holsapple, C., & Joshi, K. (1999). Description and analysis of existing knowledge management frameworks. Paper presented at the Thirty-Second Annual Hawaii International Conference on System Sciences, Maui, HI.

Holsapple, C., & Joshi, K. (2003). A knowledge management ontology. In C. Holsapple (Ed.), *Handbook on Knowledge Management 1: Knowledge Matters* (pp. 89-124). Berlin, Germany: Springer-Verlag.

Holsapple, C., & Whinston, A. (1987). *Business Expert Systems*. Homewood, IL: McGraw-Hill Professional.

Holsapple, C., & Whinston, A. (1987). Knowledge-based organizations. *Information Society, 5*(2), 77-90.

Holsapple, C., & Whinston, A. (1996). *Decision Support Systems: A Knowledge-Based Approach*. St. Paul, MN: West Publishing.

Horgan, J. (1995). From complexity to perplexity. *Scientific American, 272*(6), 74-79.

Huckfeldt, V., & Judd, R. (1974). Issues in large scale Delphi studies. *Technological Forecasting & Social Change, 6*, 175-184.

Hume, D. (1777). An enquiry concerning human understanding. In P. Nidditch (Ed.), *Essays and Treatises on Several Subjects* (3 ed.). Oxford, UK: Clarendon Press.

Hunt, S. (2003). *Controversy in Marketing Theory: For Reason, Realism, Truth, and Objectivity*. London: ME Sharpe Inc.

Internetworldstats.com (2008). Internet World Stats: Usage and Population Statistics. Retrieved on 5 October 2008, from http://www.internetworldstats.com/stats.htm

Jasimuddin, S. (2006). Disciplinary roots of knowledge management: A theoretical review. *Organizational Analysis, 14*(2), 171-180.

Jayaraman, S. (1984). *Knowledge Management and Problem Solving in Textiles.* Unpublished Doctoral dissertation, North Carolina State University, Raleigh, NC.

Jilson, I. (1979). The National Drug-abuse Policy Delphi: Progress Report and Findings to Date. In H. Linstone & M. Turoff (Eds.), *The Delphi Method* (pp. 124-159). Reading, MA: Addisons-Wesley.

Jones, D., & Culliney, J. (1998). Confucian order at the edge of chaos: The science of complexity and ancient wisdom. *Journal of Religion & Science, 33*(3), 395-404.

Jones, D., & Culliney, J. (1999). The fractal self and the organization of nature: The Daoist sage and chaos theory. *Journal of Religion & Science, 34*(4), 643-654.

Jullien, F. (2000). *Detour and Access: Strategies of Meaning in China and Greece* (S. Hawkes, Trans.). New York, NY: Zone Books.

Kakabadse, N., Kakabadse, A., & Kouzmin, A. (2003). Reviewing the knowledge management literature: Towards a taxonomy. *Journal of Knowledge Management, 7*(4), 75-91.

Katz, D., & Khan, R. (1966). *The Social Psychology of Organizations*. New York, NY: Wiley.

Kauffman, S. (1993). *The Origins of Order: Self Organization and Selection in Evolution*. New York, NY: Oxford University Press.

Kauffman, S. (1995). *At Home in the Universe: The Search for Laws of Self-Organization and Complexity*. New York, NY: Oxford University Press.

Kawalek, J. (2004). Systems thinking and knowledge management: Positional assertions and preliminary observations. *Systems Research and Behavioral Science, 21*(1), 17-36.

Kaynak, E., Bloom, J., & Leibold, M. (1994). Using the Delphi technique to predict future tourism potential. *Marketing Intelligence & Planning, 12*(7), 18-29.

Keene, A. (2000). Complexity theory: The changing role of leadership. *Industrial and Commercial Training, 32*(1), 15-18.

Kellogg, C. (1986). From data management to knowledge management. *Computer, 19*(1), 75-84.

Kelly, G. (1955). *A Theory of Personality: The Psychology of Personal Constructs*. New York, NY: Norton.

Khun, T. (1962). *Paradigm Shift*. Cambridge, MA: Harvard University Press.

King, J. (1993). Editorial notes. *Information Systems Research, 4*(4), 291-298.

Koenig, M. (2000). The evolution of knowledge management. In M. Koenig & K. Srikantaiah (Eds.), *Knowledge Management for the Information Professional*. Medford, NJ: Information Today, 37-61.

Kontzer, T. (2001). Management legend: Trust never goes out of style. *Call Center Magazine*. Retrieved on 26 August 2009, from http://www.callcentermagazine.com/article/IWK20010604S0011

Korsgaard, C. (2003). Realism and constructivism in twentieth-century moral philosophy. *Journal of Philosophical Research, 28*, 99–122.

Kotter, J. (1985). *The Leadership Factor*. New York, NY: The Free Press.

Kourdi, J. (2003). *Business Strategy: A Guide to Effective Decision-Making*. London: W. W. Norton & Company.

Kupers, W. (2005). Phenomenology of embodied implicit and narrative knowing. *Journal of Knowledge Management, 9*(6), 114-133.

Lai, H., & Chu, T. (2000). Knowledge management: A review of theoretical frameworks and industrial cases. Paper presented at the 33rd Hawaii International Conference on System Sciences, Maui, HI.

Laihonen, H. (2006). Knowledge flows in self-organizing processes. *Journal of Knowledge Management, 10*(4), 127-135.

Lakatos, I. (1978). *The Methodology of Scientific Research Programmes: Philosophical Papers* (Vol. 1). Cambridge, UK: Cambridge University Press.

Lam, A. (1997). Embedded firms, embedded knowledge: Problems of collaboration and knowledge transfer in global cooperative ventures. *Organization Studies 18*, 973-996.

Landeta, J. (2006). Current validity of the Delphi method in social sciences. *Technological Forecasting & Social Change, 73*(5), 467-482.

Lash, S. (2006). Life (vitalism). *Theory, Culture & Society, 23*(2-3), 323-349.

Lawrence, T., Mauws, M., Dick, B., & Kleysen, R. (2005). The politics of organizational learning: Integrating power into the 4I framework. *Academy of Management Review, 30*(1), 180-191.

Lazarus, R. (1991). Cognition and motivation in emotion. *American Psychologist, 46*, 352-367.

Lazarus, R. (1991). Progress on a cognitive-motivational-relational theory of emotion. *American Psychologist, 46*, 819-834.

Le Moigne, J. (1990). *La Modélisation des Systèmes Complexes*. Paris: Dunod.

Leonard-Barton, D. (1995). *Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation*. Boston, MA: Harvard Business School Press.

Leong, S. (1985). Metatheory and metamethodology in marketing: A Lakatosian reconstruction. *The Journal of Marketing, 49*(4), 23-40.

Levine, M. (2003). Can the concept of enlightenment evolve? *Asian Philosophy, 13*(2-3), 115-129.

Levy, D. (1994). Chaos theory and strategy: Theory, application and managerial implications. *Strategic Management Journal, 15*(Summer), 167-178.

Liebeskind, J. P. (1996). Knowledge, strategy, and the theory of the firm. *Strategic Management Journal, 17* (Special Issue, Winter), 93-117.

Liebowitz, J., & Wilcox, L. (1997). *Knowledge Management*. Ft. Lauderdale, FL: CRS Press.

Lih, A. (2009). *The Wikipedia Revolution*. New York: Hyperion.

Lindgren, M., & Bandhold, H. (2003). *Scenario Planning: The Link between Future and Strategy*. Hampshire, UK: Palgrave Macmillan.

Ling, Y., Simsek, Z., Lubatkin, M., & Veiga, J. (2008). Transformational leadership's role in promoting corporate entrepreneurship: Examining the CEO-TMT interface. *Academy of Management Journal, 51*(3), 557-576.

Linstone, H. (1975). Eight basic pitfalls: A checklist. In H. Linstone & M. Turoff (Eds.), *The Delphi Method. Techniques and Applications*. Reading, MA: Addison-Wesley, 573-586.

Linstone, H., & Turoff, M. (1975). *The Delphi Method: Techniques and Applications*. Reading, MA: Addison-Wesley.

Lueg, C. (2001). Information, knowledge, and networked minds. *Journal of Knowledge Management, 5*(2), 151-159.

Lundvall, B., & Johnson, B. (1994). The learning economy. *Journal of Industry Studies, 1*(2), 23-41.

Luo, Y. (2000). Dynamic capabilities in international expansion. *Journal of World Business, 35*(4), 355-378.

Machlup, F. (1982). *The Branches of Learning* (Vol. 2). Princeton, NJ: Princeton University Press.

Markus, H., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review, 98*, 224-253.

Matthews, P. (1998). What lies beyond knowledge management: Wisdom creation and versatility. *Journal of Knowledge Management, 1*(3), 207-214.

McElroy, M. (1999). Second-generation knowledge management. *Knowledge Management, 10*, 86-88.

McElroy, M. (2000). Integrating complexity theory, knowledge management and organizational learning. *Journal of Knowledge Management, 4*(3), 195-203.

McElroy, M. (2003). *The New Knowledge Management: Complexity, Learning, and Sustainable Innovation*. Boston, MA: Butterworth-Heinemann, KMCI Press.

McWilliam, C., & Ward-Griffin, C. (2006). Implementing organizational change in health and social services. *Journal of Organizational Change Management, 19*(2), 119-135.

Meso, P., & Smith, R. (2000). A resource-based view of organizational knowledge management systems. *Journal of Knowledge Management, 4*(3), 224-234.

Midgley, G. (2008). Personal conversations at the University of Otago, Dunedin, New Zealand.

Miller, J., & Page, S. (2007). *Complex Adaptive Systems: An Introduction to Computational Models of Social Life*. Princeton, NJ: Princeton University Press.

Mitchell, V. (1991). The Delphi technique: An exposition and application. *Technology Analysis & Strategic Management, 3*(4), 333-358.

Mitchell, V., & McGoldrick, P. (1994). The role of geodemographics in segmenting and targeting consumer markets: A Delphi study. *European Journal of Marketing, 28*(5), 54-72.

Monroe, K., & Lee, A. (1999). Remembering versus knowing: Issues in buyers' processing of price information. *Journal of the Academy of Marketing Science, 27*(2), 207-225.

Mu, J., Peng, G., & Love, E. (2008). Interfirm networks, social capital, and knowledge flow. *Journal of Knowledge Management, 12*(4), 57-66.

Neisser, U. (1967). *Cognitive Psychology*. New York, NY: Appleton-Century-Crofts.

Nelms, K., & Porter, A. (1985). EFTE: An interactive Delphi method. *Technological Forecasting and Social Change, 28*, 43-61.

Nelson, R., & Winter, S. (1982). *An Evolutionary Theory of Economic Change*. Cambridge, MA: Belknap Press.

Nissen, M. (2002). An extended model of knowledge-flow dynamics. *Communications of the Association for Information Systems, 8*(1), 251-266.

Nonaka, I. (1991). The knowledge creating company. *Harvard Business Review, 69*(6), 96-104.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, 5*(1), 14-37.

Nonaka, I., & Kono, N. (1998). The concept of "ba": Building a foundation for knowledge creation. *California Management Review, 40*(3), 40-54.

Nonaka, I., & Takeuchi, H. (1995). *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*. New York, NY: Oxford University Press.

Nonaka, I., Toyama, R., & Byosière, P. (2001). A theory of organizational knowledge creation: Understanding the dynamic process of creating knowledge. In Dierkes, M., Antal-Berthoin, A., Child, J., & Nonaka, I. (Eds), *Handbook of Organizational Learning and Knowledge Creation* (pp. 491-517). Oxford, UK: Oxford University Press.

Nonaka, I., Toyama, R., & Konno, N. (2001). Emergence of ba: A conceptual framework for the continuous and self-transcending process of knowledge creation. In I. Nonaka & T. Nishiguchi (Eds.), *Knowledge Emergence, Social, Technical, and*

Evolutionary Dimensions of Knowledge Creation (pp. 13-29). New York, NY: Oxford University Press.

Nonaka, I., von Krogh, G., & Voelpel, S. (2006). Organizational knowledge creation theory: Evolutionary paths and future advances. *Organization Studies, 27*(8), 1179-1208.

Novins, P., & Armstrong, R. (1998). Choosing your spots for knowledge management. *Perspectives on Business Innovation, 1*, 45-54.

O'Dell, C., & Grayson, C. J. (1998). *If Only We Knew What We Know: The Transfer of Integral Kknowledge and Best Practice*. New York, NY: The Free Press.

Oreskes, N., Shrader-Frechette, K., & Belitz, K. (1994). Verification, validation, and confirmation of numerical models in the earth sciences. *Science, 263*(5147), 641-646

Oulasvirta, A., Tamminen, S., & Höök, K. (2005). Comparing two approaches to context: Realism and constructivism. Paper presented at the Proceedings of the 4th Decennial Conference on Critical Computing: Between Sense and Sensibility, Aarhus, Denmark.

Oxford English Dictionary. (2008) (Online 2nd ed. under revision). Retrieved on 24 April 2008, from http://dictionary.oed.com/

Pareto, V. (1916). *The Mind and Society* (A. Bongiorno & A. Livingston, Trans.). London: J. Cape.

Pareto, V. (1935). *The Mind and Society* (A. Bongiorno & A. Livingston, Trans.). New York, NY: Harcourt, Brace and Company.

Parker, D., & Stacey, R. (1994). *Chaos, Management and Economics: The Implications of Non-linear Thinking*. London: Institute of Economic Affairs.

Pearce, J., & Manz, C. (2005). The new silver bullets of leadership: The importance of self- and shared leadership in knowledge work. *Organizational Dynamics, 34*(2), 130-140.

Phelan, S. (1995). From chaos to complexity in strategic planning. Paper presented at the 55th Annual Meeting of the Academy of Management.

Phelan, S. (2001). What is complexity science, really? *Emergence, 3*(1), 120-136.

Piaget, J. (1967). *Logique et Connaissance Scientifique [Logic and Scientific Knowledge]*. Dijon, France: Gallimard.

Piaget, J. (1969). *The Mechanisms of Perception* (G. Seagrim, Trans.). New York, NY: Basic Books.

Polanyi, M. (1958). *Personal Knowledge: Towards a Post-Critical Philosophy*. London: Routledge Kegan & Paul.

Polanyi, M. (1966). *The Tacit Dimension*. New York, NY: Doubleday.

Polanyi, M. (1969). *Knowing and Being*. Chicago, IL: The University of Chicago Press.

Popper, K. (1959). *The Logic of Scientific Discovery*. New York: NY: Routledge.

Prange, C. (1999). Organizational learning: Desperately seeking theory. In M. Easterby-Smith, L. Araujo & J. Burgoyne (Eds.), *Organizational Learning and the Learning Organization: Developments in Theory and Practice* (pp. 23-43). London: Sage Publications.

Prigogine, I. (1969). Structure, dissipation and life. In M. Marois (Ed.), *Theoretical Physics and Biology* (pp. 23-52). Amsterdam, The Netherlands: North-Holland Publishing Company.

Prigogine, I. (1980). *From Being to Becoming: Time and Complexity in the Physical Sciences*. San Francisco: Freeman.

Prigogine, I. (1997). *The End of Certainty*. New York, NY: The Free Press.

Prigogine, I. (2002). Dynamics of correlations. A formalism for both integrable and nonintegrable dynamical systems. *Advances in Chemical Physics*, *122*, 261-275.

Prigogine, I. (2003). *Is Future Given?* Singapore: World Scientific.

Prigogine, I., & Stengers, I. (1984). *Order Out of Chaos*. New York, NY: Bantam Books.

Pritchard, P. (1999). The three kinds of knowledge in the context of evidence-based medicine and decision support. Paper presented at the Annual Conference of the Primary Health Care Specialists Group of the British Computer Society, Cambridge, United Kingdom.

Raghuram, S. (1996). Knowledge creation in the telework context. *International Journal of Technology Management, 11*(7/8), 859-870.

Rauch, W. (1991). The Decision Delphi. *Technological Forecasting & Social Change, 15*(3), 159-169.

Regine, B., & Roger, L. (2000). Leading at the edge: How leaders influence complex systems. *Emergence, 2*(2), 5-23.

Rhodes, J., Hung, R., Lok, P., Lien, B., & Wu, C. (2008). Factors influencing organizational knowledge transfer: Implication for corporate performance. *Journal of Knowledge Management, 12*(3), 84-100.

Richardson, K. (2008). Managing complex organizations: Complexity thinking and the science and art of management. *Emergence, 10*(2), 13-26.

Richardson, K., & Cilliers, P. (2001). What is complexity science? A view from different directions. *Emergence, 3*(1), 5-22.

Rowe, G., & Wright, G. (1999). The Delphi technique as a forecasting tool: issues and analysis. *International journal of forecasting, 15*(4), 353-375.

Rubenstein-Montano, B., Liebowitz, J., Buchwalter, J., McCaw, D., Newman, B., & Rebeck, K. (2001). A systems thinking framework for knowledge management. *Decision support systems, 31*(1), 5-16.

Rutherford, M., & Holt, D. (2007). Corporate entrepreneurship: An empirical look at the innovativeness dimension and its antecedents. *Journal of Organizational Change Management, 20*(3), 429-446.

Sackman, H. (1974). *Delphi Assessment: Expert Opinion, Forecasting and Group Process*. Santa Monica, CA: Rand Corporation.

Saint-Onge, H. (1996). Tacit knowledge: The key to the strategic alignment of intellectual capital. *Strategy & Leadership, 24* (2), 10-14.

Sartre, J. (1956). *Being and Nothingness.* (H. Barnes, trans.). New York, NY: Philosophical Library.

Scaruffi, P. (2003). A history of knowledge. Retrieved on 19 July 2007, from http://www.thymos.com/know/history.html.

Scholl, W., König, C., Meyer, B., & Heisig, P. (2004). The future of knowledge management: An international Delphi study. *Journal of Knowledge Management, 8*(2), 19-35.

Schrödinger, E. (1944). *What is Life? The Physical Aspect of the Living Cell. (Reprint 1962).* Cambridge: Cambridge University Press.

Selamat, M., & Choudrie, J. (2004). The diffusion of tacit knowledge and its implications on information systems: The role of meta-abilities. *Journal of Knowledge Management, 4*(3), 195-203.

Senge, P. (1990). The leader's new work: Building learning organizations. *Sloan Management Review, 32*(1), 7-23.

Shibutani, T. (1968). *A Cybernetic Approach to Motivation*. Chicago, IL: Aldine.

Shibutani, T., & Buckley, W. (1968). *Modern Systems Research for the Behavioral Scientist*. Chicago, IL: Adeline.

Simon, H. (1996). *The Sciences of the Artificial* (3 ed.). Cambridge, MA: MIT Press.

Simon, H. (1997). *Administrative Behavior: A Study of Decision-Making Processes in Administrative Organizations* (4 ed.). New York, NY: The Free Press.

Skyrme, D. (1999). *Knowledge Networking: Creating the Collaborative Enterprise*. Burlington, MA: Butterworth-Heinemann.

Smith, A., & Humphries, C. (2004). Complexity theory as a practical management tool: A critical evaluation. *Organization Management Journal, 1*(2), 91-106.

Smith, E. (2001). The role of tacit and explicit knowledge in the workplace. *Journal of Knowledge Management, 5*(4), 311-321.

Snowden, D. (2002). Complex acts of knowing: Paradox and descriptive self awareness. *Journal of Knowledge Management, 6*(2), 100-111.

Spender, J. (1995). The science of complexity: An alternative perspective for strategic change processes. *Strategic Management Journal, 16*(6), 477-495.

Spender, J. (1996). Making knowledge the basis of a dynamic theory of the firm. *Strategic Management Journal, 17*(Winter Special), 45-62.

Stacey, R. (1992). *Managing the Unknowable: Strategic Boundaries Between Order and Chaos in Organizations*. San Francisco, CA: Jossey-Bass.

Stacey, R. (1996). *Complexity and Creativity in Organizations*. San Francisco, CA: Berrett-Koehler Publishers.

Stacey, R. (2001). *Complex Responsive Processes in Organizations: Learning and Knowledge Creation*. London: Routledge.

Stacey, R. D. (1995). The science of complexity: An alternative perspective for strategic change processes. *Strategic Management Journal, 16*(6), 477-495.

Stenmark, D. (2001). Leveraging tacit organizational knowledge. *Journal of Management Information Systems, 17*(3), 9-24.

Stewart, T. (2002). *The Wealth of Knowledge: Intellectual Capital and the 21st Century Organization*. New York, NY: Currency Doubleday.

Štrach, P., & Everett, A. (2006). Knowledge transfer within Japanese multinationals: Building a theory. *Journal of Knowledge Management, 10*(1), 55-68.

Styhre, A., Ingelgård, A., & Roth, J. (2000). A nonreductionist view of knowledge: Product development in the pharmaceutical industry. *Emergence, 2*(3), 51-67.

Subramaniam, M., & Youndt, M. (2005). The influence of intellectual capital on the types of innovative capabilities. *Academy of Management Journal, 48*(3), 450-463.

Suppe, F. (1996). *Middle-range theory: Role in nursing theory and knowledge development.* Paper presented at the Sixth Rosemary Ellis scholars retreat. Nursing Science: Implications for the 21st Century, Cleveland, OH.

Suppe, F. (1998). The structure of a scientific paper. *Philosophy of Science, 65*(3), 381-405.

Sveiby, K. (1997). *The New Organizational Wealth: Managing and Measuring Knowledge-Based Assets*. San Francisco, CA: Berrett-Koehler.

Sveiby, K. (2001a). What is knowledge management? Retrieved on 11 August 2003, from http://www.sveiby.com/faq.html#Whatis.

Sveiby, K. (2001b). Frequently asked questions. Retrieved on 16 July 2001, from http://www.sveiby.com.au/faq.html.

Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal, 17*(Winter Special Issue), 27-43.

Tetenbaum, T. (1998). Shifting paradigms: From Newton to chaos. *Organizational Dynamics, 26*(4), 21-32.

Thierauf, R., & Hoctor, J. (2006). *Optimal Knowledge Management*. Hershey, PA: Idea Group.

Thiétart, R.-A., & Forgues, B. (1997). Action, structure and chaos. *Organization Studies, 18*(1), 119-143.

Trott, P. (2002). *Innovation Management and New Product Development* (2 ed.). Harlow, England: Prentice Hall, Pearson Education.

Tsai, Y. (2006). Effect of social capital and absorptive capability on innovation in internet marketing. *International Journal of Management, 23*(1), 157-168.

Tsoukas, H. (1996). The firm as a distributed knowledge system: A constructionist approach. *Strategic Management Journal, 17*, 11-25.

Tsoukas, H. (2003). Do we really understand tacit knowledge? In M. Easterby-Smith & M. Lyles (Eds.), *The Blackwell Handbook of Organizational Learning and Knowledge Management* (pp. 410-427). Malden, MA: Blackwell.

Tsoukas, H., & Chia, R. (2002). On organizational becoming: Rethinking organizational change. *Organization Science 13*, 567-582.

Tuomi, I. (1999). Data is more than knowledge: Implications of the reversed knowledge hierarchy for knowledge management and organizational memory. *Journal of Management Information Systems, 16*(3), 103-117.

Van de Ven, A., & Delbecq, A. (1974). The effectiveness of nominal, Delphi, and interacting group decision making processes. *Academy of Management Journal, 17*(4), 605-621.

van der Spek, R., & Spijkervet, A. (1997). Knowledge management: Dealing intelligently with knowledge. In J. Liebowitz & L. Wilcox (Eds.), *Knowledge Management and Its Integrative Elements*. New York, NY: CRC Press.

Van Doren, C. (1991). *A History of Knowledge: Past, Present, and Future*. New York, NY: Ballantine Books.

van Zolingen, S., & Klaassen, C. (2003). Selection processes in a Delphi study about key qualifications in senior secondary vocational education. *Technological Forecasting & Social Change, 70*(4), 317-340.

Vance, D. (1997). Information, knowledge and wisdom: The epistemic hierarchy and computer-based information systems. Paper presented at the America's Conference on Information Systems. Retrieved on 30 March 2006, from http://aisel.isworld.org/Publications/AMCIS/1997/vance2.htm.

Varela, F. (1992). Whence perceptual meaning? A cartography of current ideas. In F. Varela & J. Dupuy (Eds.), *Understanding Origins: Contemporary Views on the Origin of Life, Mind, and Society* (pp. 235-264). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Varela, F., Thompson, E., & Rosch, E. (1992). *The Embodied Mind*. Cambridge, MA: MIT Press.

Viégas, F., Wattenberg, M., & Kushal, D. (2004). Studying cooperation and conflict between authors with history flow visualizations. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 575-582), Vienna, Austria.

Vincenti, W. (1990). *What Engineers Know and How They Know It: Analytical Studies from Aeronautical History*. Baltimore, MD: Johns Hopkins University Press.

von Bertalanffy, L. (1950). An outline of general systems theory. *British Journal for the Philosophy of Science, 1*(2), 134-165.

von Bertalanffy, L. (1962). General system theory: A critical review. *General Systems, 7*, 1-20.

von Bertalanffy, L. (1968). *General System Theory: Foundations, Development, Applications*. New York, NY: George Braziller.

von Foerster, H. (1962). *Principles of Self-Organization*. New York, NY: Pergamon Press.

von Foerster, H. (1981). *Observing Systems*. Seaside, CA: Intersystems Publications.

von Glasersfeld, E. (1984). An introduction to radical constructivism. In P. Watzlawick (Ed.), *The Invented Reality: How Do We Know What We Believe We Know?* (pp. 17-40). New York, NY: Norton.

von Glasersfeld, E. (1987). *The Construction of Knowledge: Contributions to Conceptual Semantics*. Salinas, CA: Intersystems Publications.

von Glasersfeld, E. (1990). An exposition of constructivism: Why some like it radical. In R. Davis, C. Maher & N. Noddings (Eds.), *Constructivist Views on the Teaching and Learning of Mathematics* (Vol. 4, pp. 19-30). Reston, VA: National Council of Teachers of Mathematics.

von Glasersfeld, E. (1995). *Radical Constructivism: A Way of Learning*. London: Routledge Falmer Press.

von Hayek, F. (1989). The pretense of knowledge [1974 Nobel Prize Memorial Lecture]. *American Economic Review, 79*(6), 3-7.

von Krogh, G., & Roos, J. (1995). *Organizational Epistemology*. New York, NY: St. Martin's Press.

Wagner, R., & Sternberg, R. (1985). Practical intelligence in real-world pursuits: The role of tacit knowledge. *Journal of Personality and Social Psychology, 49*(2), 436-458.

Waldrop, M. (1992). *Complexity: The Emerging Science at the Edge of Order and Chaos*. New York, NY: Simon & Schuster.

Wales, J. (2008). Statement of principles. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/User:Jimbo_Wales/Statement_of_principles

Ward, A. (1963). *John Keats: The Making of a Poet*. London: Secker and Warburg.

Watson, T. (1994). *In Search of Management: Culture, Chaos and Control in Managerial Work*. London: Routledge.

Wei, C., Piramuthu, S., & Shaw, M. (2003). Knowledge discovery and data mining. In C. Holsapple (Ed.), *Handbook on Knowledge Management 2:Knowledge Directions* (pp. 157-188). Berlin, Germany Springer-Verlag.

Weick, K., & Roberts, K. (1993). Collective mind in organizations: Heedful interrelating on flights decks. *Administrative Science Quarterly, 38*(3), 357-381.

Werlin, H. (2004). Political power as social energy: Why are MDCs more efficient than LDCs? *The Journal of Social, Political, and Economic Studies, 29*(4), 433-453.

Whitehead, A. (1929). *Process and Reality*. New York, NY: The Free Press.

Whitehead, A., & Russell, B. (1910). *Principia Mathematica*. Cambridge: Cambridge University Press.

Wiig, K. (1993). *Knowledge Management Foundations: Thinking about Thinking: How People and Organizations Create, Represent, and Use Knowledge*. Arlington, TX: Schema Press

Wiig, K. (1995). *Knowledge Management Methods: Practical Approaches to Managing Knowledge*. Arlington, TX: Schema Press.

Wiig, K. (1997). Knowledge management: An introduction and perspective. *Journal of Knowledge Management, 1*(1), 6-14.

Wiig, K. (2004). *People-Focused Knowledge Management: How Effective Decision Making Leads to Corporate Success*. Oxford, UK: Elsevier Butterworth-Heinemann.

Wikipedia (2008a). Template: Grading scheme. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Template:Grading_scheme.

Wikipedia (2008b). Wikimedia Foundation. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikimedia_Foundation.

Wikipedia (2008c). Wikipedia: About. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:About.

Wikipedia (2008d). Wikipedia: Administrators. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:Administrators.

Wikipedia (2008e). Wikipedia: Arbitration Committee. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:Arbitration_committee.

Wikipedia (2008f). Wikipedia: Bot Policy. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:Bot_policy.

Wikipedia (2008g). Wikipedia: Dispute Resolution. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:Dispute_resolution.

Wikipedia (2008h). Wikipedia: Editorial Oversight and Control. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:Editorial_oversight_and_control.

Wikipedia (2008i). Wikipedia: Five Pillars. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:Five_pillars.

Wikipedia (2008j). Wikipedia: Jimmy Wales. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Jimmy_Wales.

Wikipedia (2008k). Wikipedia: Largest Encyclopedia. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:Largest_encyclopedia.

Wikipedia (2008L). Wikipedia: List of Policies. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:List_of_policies.

Wikipedia (2008m). Wikipedia: List of Sysops. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Special:Listusers/sysop.

Wikipedia (2008n). Wikipedia: New Admin School. Retrieved on 24 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:New_admin_school.

Wikipedia (2008o). Wikipedia: Patrols. Retrieved on 24 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:Patrols.

Wikipedia (2008p). Wikipedia: Policies and Guidelines. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:Policies_and_guidelines.

Wikipedia (2008q). Wikipedia: Product, process, policy. Retrieved on 24 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:PPP.

Wikipedia (2008r). Wikipedia: Statistics. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:Statistics.

Wikipedia (2008s). Wikipedia: What Wikipedia Is Not. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:What_Wikipedia_is_not.

Wikipedia (2008t). Wikipedia: Why Wikipedia Is Not So Great. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:Why_Wikipedia_is_not_so_great.

Wikipedia (2008u). Wikipedia: WikiProject. Retrieved on 23 October 2008, from http://en.wikipedia.org/wiki/Wikipedia:WikiProject.

Wikipedia (2008v). Wikiscanner. Retrieved on 5 October 2008, from http://en.wikipedia.org/wiki/Wikiscanner.

Williams, M. (2008). Representation = Grounded information. Paper presented at the Trends in Artificial Intelligence: 10th Pacific Rim International Conference on Artificial Intelligence, Hanoi, Vietnam.

Williams, R. (2006). Narratives of knowledge and intelligence... Beyond the tacit and explicit. *Journal of Knowledge Management, 10* (4), 81-99.

Wilson, T. (2002). The nonsense of knowledge management. *Information Research, 8*(1), paper 144. Retrieved on 9 January 2009, from http://informationr.net/ir/8-1/paper144.html.

Yin, R. (2003). *Case Study Research: Design and Methods* (3 ed.). Thousand Oaks, CA: Sage Publishing.

Zadeh, L. (1973). Outline of a new approach to the analysis of complex systems and decision processes. *IEEE Transactions on Systems, Man and Cybernetics, 3*(1), 28-44.

Zaleznik, A. (1977). Managers and leaders: Are they different? *Harvard Business Review, 55*(3), 67-78.

Zeleny, M. (1987). Management support systems: Towards integrated knowledge management. *Human Systems Management, 7*(1), 59-70.

Zeleny, M. (2006). From knowledge to wisdom: On being informed and knowledgeable, becoming wise and ethical. *International Journal of Information Technology & Decision Making, 5*(4), 751-762.

Zipfinger, S. (2007). *Computer Aided Delphi: An Experimental Study of Comparing Round Based with Real Time Implementation of the Method*. Linz, Austria: Trauner Verlag.

Zollo, M., & Winter, S. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization Science, 13*(3), 339-351.

Appendix 1. Delphi Round 1 Questionnaire

Delphi Study on the Concept of Knowledge

This questionnaire is part of a doctoral research project, being conducted as a Delphi study in three rounds (with feedback to participants after each round). It aims to examine definitions of constructs related to the concept of knowledge and gather information on how these constructs relate to each other, in order to test new models of knowledge. We are interested in your understanding of the concept of knowledge and related ideas.

The individuals selected for this Delphi study are all experts in fields relevant to the concept of knowledge. Familiarity with the terminology is therefore expected - although with different interpretations and orientations (that's part of the focus of this research project) due to the diverse backgrounds of the invitees. Please feel free to comment on any aspect of the questionnaire, terminology, or approach, anywhere within this document (or in a separate email).

We hope to receive your completed questionnaire before Wednesday the 10th of October by email sent to jb.faucher@gmail.com.

How to answer this questionnaire:

Please type your answers directly into this Word document. Take as much time as you like to respond as thoughtfully and comprehensively as you can. We recognize that some people will have previously contemplated some of these issues and relationships, and thus can reply quite quickly, while for others particular aspects will invoke thinking pauses. We do hope that the questions are somewhat provocative!

A list of FAQ is provided at the end of the questionnaire. If you have further questions, please email Jean-Baptiste at jb.faucher@gmail.com.

QUESTIONS

1) Is it possible to manage knowledge?

Never – Hardly ever – Sometimes – Most of the time – Always

2) Do you believe that the "knowledge pyramid" represents the standard or most common view of the concept of knowledge in the field of knowledge management? If not, what does it represent?
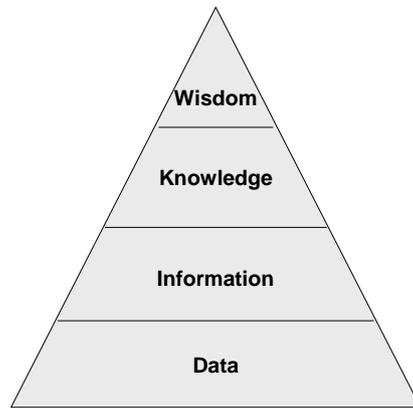
Wisdom

Knowledge

Information

Data

3.a) Do you know of any other models or representations of the concept of knowledge? If yes, please briefly identify them.

3.b) Which of the above is your preferred model or representation of the concept of knowledge? Why?

4) What, or who, has most influenced your thinking about the concept of knowledge?

5.a) Do we need new models or representations of the concept of knowledge?

5.b) Why (why not)?

5.c) If yes, what theory or approach has the best potential to achieve this?

6) Please complete the following sentences (briefly):

Data is …

Information is …

Knowledge is …

Wisdom is …

7.a) Please rate how strongly you associate each construct in the left hand column with the construct in each of the other columns. Choose a number between 0 and 10, where 0 means there is no association, and 10 means there is a 100% (complete) association between the two constructs. (If you think any other word should be added to the list, please feel free to write it in at the end of the table.) The list of constructs is given in alphabetical order.

Please attempt to complete the entire table. Some association possibilities may appear illogical or strange to you - in which case low values are probably appropriate. This doesn't indicate that you should leave them blank, as "missing data" will cloud the analysis.

	Data	Information	Knowledge	Wisdom
Cognition				
Data				
Enlightenment				
Existence				
Experience				
Explicit				
Fact				
Information				
Intelligence				
Judgement				
Knowledge				
Learning				
Memory				
Organisation				
Perception				
Process				
Relationship				
Reality				
Structure				
System				
Tacit				
Theory				
Truth				
Understanding				
Wisdom				

7.b) Should any of the following constructs be included in the list?
- Conversion
- Environment
- Mind
- Schema
- Threshold

8) What is your main field of research interest?

9) Would you know anyone else who you believe we should include in this project? (Although we believe we have a nearly complete list of qualified individuals, we would appreciate any recommendations to help identify suitable additional participants. We are seeking authors of knowledge management related research publications in academic journals during the past five years, whether they be academics or practitioners.)

10) Finally, please confirm your preferred email address (and if it differs from the one to which this document was sent, please include your name so we can ensure an appropriate match).

Thank you for your participation! The next Delphi round will start approximately one week after the deadline of the first round (10th of October), and will include feedback on this round.

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FAQ – General

1. You can format your answers any way you like - bold, italics, red, or nothing at all. Don't worry about page boundaries or any other formatting issues.

2. If a question seems irrelevant to you, feel free to say so!

3. You can type comments anywhere in this questionnaire - we have not made it a "form" or converted it to PDF for that reason. We are happy to receive any explanations, comments, criticisms, etc.

4. On the table (question 7.a), you may use any value repeatedly within any row or column. The approach most people use to answer this question is to respond by row (across the table). Of course you are free to approach it any way you like. If you have any comments or suggestions regarding your approach, please write them.

5. In this project, "Delphi study" is defined as a social research technique of structuring communication which aims at constructing a reliable group opinion among experts assembled into a panel, involving multiple rounds of exchange and feedback through a central coordinator.

Appendix 2. Delphi Round 2 Questionnaire

Delphi Study on the Concept of Knowledge

<<< Round 2 >>>

This questionnaire is part of a doctoral research project, being conducted as a Delphi study in three rounds (with feedback to participants after each round). *You have already completed the first round; this is the second.* The project examines definitions of constructs related to the concept of knowledge and gathers information on how these constructs relate to each other, in order to test new models of knowledge. We are interested in your understanding of the concept of knowledge and related ideas.

Familiarity with the typical terminology used in the field of "knowledge management" is expected – although with different interpretations and orientations (that's part of the focus of this research project) due to the diverse backgrounds of the participants. Please feel free to comment on any aspect of the questionnaire, terminology, or approach, anywhere within this document (or in a separate email).

We hope to receive your completed questionnaire before Tuesday the 30th of October by email sent to jb.faucher@gmail.com. *(Should we receive responses from all 62 confirmed participants before then, we will proceed to the next phase earlier.)*

What differs in this second round?

Feedback from the first round has been included, highlighted with a vertical line at the left edge. In some cases, we provide feedback on a previously asked question, and ask you to respond to the same question again, as your opinion may have changed or been influenced by the feedback *(that's a fundamental aspect of the Delphi process)*. In other cases, feedback is given on a question, serving as the basis for a new question. In all cases, you can revise your previous answers if you wish.

Naturally, given the nature of this field, we anticipated respondents analysing the questions. Some people objected to specific questions, or terminology, or the lack of "given" definitions – *but that's part of the research focus of this project*. Some questions were interpreted quite differently by a few respondents. The questions asked here build on the comments received in the first round.

For logistics reasons, we did not include your previous personal answers in this questionnaire. We assume that you kept a copy, but if you would like us to send it to you, please ask Jean-Baptiste at jb.faucher@gmail.com.

[REPEAT] How to answer this questionnaire:

Please type your answers directly into this Word document. Take as much time as you like to respond as thoughtfully and comprehensively as you can. We do hope that the questions are somewhat provocative! A list of FAQ is provided at the end of the questionnaire. If you have further questions, please email Jean-Baptiste at jb.faucher@gmail.com.

QUESTIONS – ROUND 2

1) Is it possible to manage knowledge?

Proposed scale during round 1:
Never – Hardly ever – Sometimes – Most of the time – Always

Feedback: It has been pointed out by the results of the first round that it is not always possible to manage knowledge, but we will try our best to do so in this study. The results from round 1 are provided below:

Never	Hardly ever	Sometimes	Most of the time	Always	"Yes"	Other (off the scale)
5%	7%	40%	24%	13%	3%	8%

23% of the panel objected to the question format, noting that the answer depended on the definitions given to Knowledge, Management, or Knowledge Management. *Most of these people did answer the question, however. You may have noted that this question was intended to provoke thought about the nature of the name of the field we call "knowledge management."*

10% asserted it was only possible to manage knowledge indirectly.

1.a) Following these results, it is assumed that it is at least sometimes possible to manage knowledge (or else, why would the field be called knowledge management?). Do you agree?

1.b) Under what kinds of conditions is it possible to manage knowledge?

1.c) What is the purpose of knowledge management?

2) The "knowledge pyramid"

Feedback: Apart from the fact that a few members of the panel were not familiar with the pyramid including wisdom, the majority of the panel agreed that the knowledge pyramid was indeed the common view of the concept of knowledge (as show in the results below).

Do you believe that the "knowledge pyramid" represents the standard or most common view of the concept of knowledge in the field of knowledge management?

Yes	No	Other
61%	13%	26%

16% of the panel mentioned the usefulness of the pyramid *(to various degrees – particularly for educational purposes)*; however, 40% of the panel also protested about numerous perceived flaws in that model.

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2.a) Following these results, it is assumed that the knowledge pyramid is the most common view of the concept of knowledge, but that it also lacks some key features. According to you, what are the main flaws of the knowledge pyramid?

2.b) About 5% mentioned that the pyramid did not represent the concept of knowledge. Do you agree, and why?

3) Other models or representations of the concept of knowledge

Feedback: The following other models or representations of the concept of knowledge were nominated by two or more respondents. *(Some definitions and ways of representing knowledge were also named.)*

		(Identifier, used in Q3b below)
21%	SECI (Nonaka & Takeuchi)	(A)
9%	Tacit/Explicit knowledge	(B)
5%	Blackler's model of knowledge	(C)
5%	Static/Dynamic knowledge	(D)
3%	Boisot's I-space	(E)
3%	Tuomi's reversed pyramid	(F)
3%	Firestone & McElroy's cycle model	(G)
3%	Cynefin sense-making framework	(H)

Which of the above is your preferred model or representation of the concept of knowledge?

No preferred model	Pyramid model preferred	Other model(s) preferred	Depends on the context
14%	11%	61%	14%

The most preferred model is Nonaka's SECI model (12%), with the knowledge pyramid being the second most preferred. *(However, recall that 40% of respondents indicated that the pyramid was flawed in question 2; that exceeds the number of people preferring it.)* Panel members nominated a total of 47 different models or frameworks.

3.a) According to you, what is the main contribution of the SECI model? What are its main flaws?

3.b) Consider how the utility of the models above has changed over time. Please position the models on the brief timeline table below by writing their identifying letter *(you can position a model in one, two, or all three of the time columns). You may also write in any additional models you wish.*

	Past	Present	Future
Extremely important			
Very important			
Important			
Somewhat important			
Not important			

3.c) If you would like to comment about the contributions and/or flaws of any others among the models listed above, please do so. *(Note that you don't need to repeat responses you gave in the first round.)*

3.d) A couple of experts asserted that a distinction should be made between the understanding of "knowledge" in academia and that in business practice. Do you agree, and why?

4) What, or who, has most influenced your thinking about the concept of knowledge?

Feedback: Responses over 5%:

%	Who/What
26%	I. Nonaka
16%	M. Polanyi
10%	I. Nonaka and H. Takeuchi *(in addition to the result for Nonaka above)*
8%	K. Popper J.C. Spender H. Tsoukas Complexity Theory
6%	Aristotle T.H. Davenport and L. Prusak R.M. Grant K. Wiig H. Maturana and F. Varela Philosophy of Science Plato

4.a) What is your main comment/criticism about this result?

5) Do we need new models or representations of the concept of knowledge?

Feedback:

Yes	No	Maybe	Don't know	Other
36%	34%	9%	5%	17%

The main reasons given to support the need for new models were *(in order of frequency)*:
- To develop our understanding of the concept of knowledge
- To refine the current models of the concept of knowledge
- To create more descriptive models of the concept of knowledge
- To create more complex models that illustrates the complexity of knowledge
- To provide more analytical tools
- To provide different conceptualizations

- To prevent stagnation of the field of knowledge management

Here are the main theories/frameworks seen as having the best potential to achieve this *(in order of frequency)*:
- Multiple theories *(i.e., we need a combination of several theories)*
- System thinking
- Complexity theory
- Dynamic capabilities approach

The main reasons given to support the view that we do **not** need new models were *(in order of frequency)*:
- The current models are sufficient
- Creating new models of the concept of knowledge is not the focus of knowledge
  management
- We need to see how existing views complement each other
- Knowledge is too subjective to be conceptualised

5.a) Responses to the first round showed not just a great diversity of perspectives, and adhesion to a wide range of models, but an undercurrent of dissatisfaction with the state of research in the field, as well as its application to practice. Why?

5.b) Would it be a good idea to try to unify the field of knowledge management, particularly through the creation of models or frameworks acceptable to the vast majority of academics and practitioners in this field?

5.c) What should be the main characteristics of a model of the concept of knowledge for it to be relevant for knowledge management?

6) Definitions of Data, Information, Knowledge, and Wisdom

Feedback: The definitions given by panel members covered most of the wide range found in the literature, fairly well adhering to standard definitions, with some variation. We believe that a reasonable consensus has been reached. For the moment, our overall working definitions of these four concepts are as follows:

Data are unprocessed raw representations of reality.

Information is data that has been processed in some meaningful ways.

Knowledge is information that has been processed in some meaningful ways.

Wisdom is knowledge that has been processed in some meaningful ways.

6.a) There appears to be a hierarchy indicated by these definitions. Your thoughts on this?

6.b) If this is a hierarchy, is it complete? In other words, could there be something "above" or "below" this list – or perhaps somewhere in between some of the elements?

6.c) What connects these definitions? (Is there a transitional mechanism of some sort?)

7) Association among constructs

Feedback: There were a variety of reactions to this question… with many guesses as to what we were "up to" with it. *(Well, keep guessing! Maybe the following feedback will enlighten you and induce further contemplation…)* For those of you convinced we're just playing with numbers, please bear with us! We still appreciate any responses to any parts of this questionnaire, including from those who may object to this particular approach for any reason.

Colour Key

	Identity (same term)	
	8-10	Orange
	6-7.9	Light orange
	4-5.9	Gold
	2-3.9	Yellow
	0-1.9	Light yellow

Average	Data	Information	Knowledge	Wisdom
Cognition	2.2	4.1	7.5	6.7
Data	10.0	5.4	3.3	2.0
Enlightenment	1.2	2.8	6.2	8.3
Existence	4.9	4.8	5.4	5.7
Experience	2.1	3.9	7.6	7.9
Explicit	7.3	7.0	5.8	3.2
Fact	7.9	6.0	4.7	3.2
Information	4.8	9.9	5.2	3.2
Intelligence	2.1	4.5	7.2	7.3
Judgement	1.9	4.0	6.9	8.3
Knowledge	2.5	4.3	9.9	6.7
Learning	2.4	4.8	8.1	7.2
Memory	4.5	5.9	7.3	6.0
Organisation	4.4	5.8	6.6	5.4
Perception	3.4	4.6	6.4	6.0
Process	3.5	5.7	6.2	5.1
Relationship	2.3	5.1	6.9	6.7
Reality	5.7	5.6	6.2	5.9
Structure	4.9	6.0	5.4	4.3
System	4.4	5.7	5.9	4.5
Tacit	1.0	2.4	7.5	7.9
Theory	1.7	3.6	7.0	6.2
Truth	4.3	4.8	6.4	6.6
Understanding	2.3	4.4	7.8	7.9
Wisdom	1.2	2.6	5.8	9.9
Average	3.7	4.9	6.5	6.1

7.a) What patterns can you identify in the above table? What do you believe they indicate?

The following quick summary table ranks these concepts by the difference going across the table from left to right (i.e., from data to wisdom). *(For example, for the concept ranked second – enlightenment – the slope is positive from "data" to "wisdom," and the response for association with wisdom is 7.1 higher than that for data, on average.)*

<u>*Colour Key*</u>

	>= - 3	Red
	-2.9 to -1	Rose
	-0.9 to 0	Tan
	0 to +0.9	Light turquoise
	+1 to +2.9	Middle blue
	>= +3	Light blue
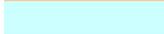
<u>Rank</u>	<u>Concept</u>	Difference			
		I - D	K - I	W - K	Total
1	Wisdom	1.4	3.2	4.1	8.6
2	Enlightenment	1.6	3.4	2.1	7.1
3	Tacit	1.4	5.1	0.5	7.0
4	Judgement	2.1	2.9	1.4	6.5
5	Experience	1.8	3.7	0.2	5.8
6	Understanding	2.1	3.4	0.1	5.6
7	Intelligence	2.4	2.7	0.1	5.2
8	Learning	2.4	3.3	-0.9	4.8
9	Theory	1.9	3.3	-0.7	4.5
10	Cognition	2.0	3.4	-0.9	4.5
11	Relationship	2.9	1.8	-0.2	4.4
12	Knowledge	1.8	5.6	-3.2	4.2
13	Perception	1.3	1.8	-0.4	2.6
14	Truth	0.5	1.6	0.2	2.3
15	Process	2.2	0.5	-1.1	1.6
16	Memory	1.4	1.4	-1.2	1.6
17	Organisation	1.3	0.8	-1.2	0.9
18	Existence	-0.1	0.6	0.3	0.8
19	Reality	-0.1	0.6	-0.3	0.2
20	System	1.3	0.2	-1.4	0.1
21	Structure	1.1	-0.7	-1.1	-0.6
22	Information	5.1	-4.6	-2.1	-1.6
23	Explicit	-0.3	-1.2	-2.7	-4.1
24	Fact	-1.8	-1.4	-1.5	-4.7
25	Data	-4.6	-2.1	-1.3	-7.9

7.b) What patterns can you identify in the above table? What do you believe they indicate?

7.c) If you'd like to comment on any patterns involving both tables, or any other considerations about the associations described here, please do so!

7.d) <<< Repeat of previous table but with a very few new terms as suggested by the panel in the first round. *These three terms each received over one-third of the panel's recommendation for inclusion. No new term outside our suggested list was mentioned*

by more than one panel member. >>> **[REPEAT of instructions]** Please rate how strongly you associate each construct in the left hand column with the construct in each of the other columns. Choose a number between 0 and 10, where 0 means there is no association, and 10 means there is a 100% (complete) association between the two constructs. (If you think any other word should be added to the list, please feel free to write it in at the end of the table.) The list of constructs is given in alphabetical order. Please attempt to complete the entire table. Some association possibilities may appear illogical or strange to you - in which case low values are probably appropriate. This doesn't indicate that you should leave them blank, as "missing data" will cloud the analysis.

	Data	Information	Knowledge	Wisdom
Environment				
Mind				
Schema				

8) What is your main field of research interest?

8.a) 39% of the panel members specifically included "knowledge management" (or KM) as within their main field of research interest. However, the areas of nearly all respondents can be considered within the broader domain of knowledge management. A simple tabulation of responses to this question isn't quite workable. To further explore this, we'd like for you to indicate the degree of relationship you perceive between selected respondents' fields and knowledge management, by marking one cell for each research interest in the following table:

Most frequent responses that are not clearly part of KM; in alphabetical order	Core	Partial overlap	Peripheral	Unrelated
Complexity theory				
Decision making/support				
Entrepreneurship				
Human resource management (HRM)				
Innovation management				
Intellectual capital				
Leadership				
Organisational learning				
Organisational behaviour				
Strategy				
System thinking				

Thank you for your participation! The next and last Delphi round will start approximately one week after the deadline of the second round (30th of October), and will include feedback on this round.

= =

FAQ – General

1. You can format your answers any way you like - bold, italics, red, or nothing at all. Don't worry about page boundaries or any other formatting issues. We have kept the format as open and free-flowing as possible.

2. If a question seems irrelevant to you, feel free to say so!

3. You can type comments anywhere in this questionnaire - we have not made it a "form" or converted it to PDF for that reason. We are happy to receive any explanations, comments, criticisms, etc.

4. On the table (question 7.a), you may use any value repeatedly within any row or column. The approach most people use to answer this question is to respond by row (across the table). Of course you are free to approach it any way you like. If you have any comments or suggestions regarding your approach, please write them.

5. In this project, "Delphi study" is defined as a social research technique of structuring communication which aims at constructing a reliable group opinion among experts assembled into a panel, involving multiple rounds of exchange and feedback through a central coordinator.

6. We limited the amount of feedback given in this round to prevent overload. Our intention is not to swamp you with feedback, but to indicate some relevant patterns found in the results of the first round. More detailed results will be available to any participant who desires them, after the study is completed (in order to avoid clouding the intent of the Delphi approach being used).

Appendix 3. Delphi Round 3 Questionnaire

Delphi Study on the Concept of Knowledge

<<< Round 3 >>>

This questionnaire is part of a doctoral research project, being conducted as a Delphi study in three rounds (with feedback to participants after each round). *You have already completed the first and second rounds; this is the third (final) round. Yes, feedback will be sent after the third round – as a quick summary in early December and then in a more extensive form, taking longer to develop, probably at the end of January.*

We hope to receive your completed questionnaire before Wednesday the 28th of November by email sent to jb.faucher@gmail.com.

What differs in this third round?

Feedback from the second round has been included, highlighted with a double vertical line at the left edge (any feedback relating to the first round features a single vertical line). New questions are in **bold**.

Some respondents have been quite vocal about our omission of their exact wording or opinions in the first-round feedback. No comments are being ignored – and every response is being carefully analysed – but we also wish to avoid overloading participants, who are already being very generous with their time (for example, on one question we received two typed pages of comments – from one respondent…) *Part of the Delphi process is "seeking a managed consensus" – but our interest goes well beyond this alone, and we recognise this distinctive aspect of the Delphi approach as both an advantage and a shortcoming. For those individuals who opt out of the Delphi, we may continue to correspond directly despite the loss of the "group"-oriented Delphi input.*

[REPEAT] In some cases, we provide feedback on a previously asked question, and ask you to respond to the same question again, as your opinion may have changed or been influenced by the feedback *(that's a fundamental aspect of the Delphi process)*. In other cases, feedback is given on a question, serving as the basis for a new question. In all cases, you can revise your previous answers if you wish.

In this round, some feedback does not lead to new questions. This may be because consensus has been reached, or because going further would take us away from the objectives of this particular Delphi project. However, your comments are still welcome.

[REPEAT] For logistics reasons, we did not include your previous personal answers in this questionnaire. We assume that you kept a copy, but if you would like us to send it to you, please ask Jean-Baptiste at jb.faucher@gmail.com.

[REPEAT] How to answer this questionnaire:

[REPEAT] Please type your answers directly into this Word document. Take as much time as you like to respond as thoughtfully and comprehensively as you can. We do hope that the questions are somewhat provocative! A list of FAQ is provided at the end of the questionnaire. If you have further questions, please email Jean-Baptiste at: jb.faucher@gmail.com.

QUESTIONS – ROUND 3

1) <u>Is it possible to manage knowledge?</u>

Following [Round 1] results, it is assumed that it is at least sometimes possible to manage knowledge (or else, why would the field be called knowledge management?). Do you agree?

<u>Feedback</u>: The overwhelming perspective [all but one respondent] is that it is possible to manage knowledge – sometimes, under certain conditions, and only in certain forms. In other words, knowledge management is highly contingent. 61% stated "yes" while 36% indicated "yes, but…"

Under what kinds of conditions is it possible to manage knowledge?

<u>Feedback</u>: The most common condition noted by the panel is that explicit knowledge is easier to manage (7%) or is the only form of knowledge that can be managed (30%). About one-tenth of respondents indicated that necessary conditions include the presence of (suitable) information technology, the existence of (appropriate) processes, and the existence of an open and empowering social environment. Approximately twenty other conditions were mentioned by one or two respondents.

1.a) Can tacit knowledge be managed?

1.b) If yes, under what conditions?

What is the purpose of knowledge management?

<u>Feedback</u>: Individual choices of wording mean that although we have tried to aggregate or categorise responses, every response inherently differed and our own perceptions have flavoured the categorisations. The two prevalent answers (1/3 of the panel) are that KM should benefit the organisation and that it should improve organisational processes. To us, the first "purpose" appears to be an "end" or overall goal, while the others are "means" whereby this overall goal can be attained. Ranked from most to least:

36%	to benefit the organisation
30	to improve organisational processes
18	to organise or store knowledge
16	to improve organisational learning
16	to exploit or create competitive advantages
14	to create or acquire knowledge
14	to transfer or share knowledge
11	to create value from knowledge resources
7	to foster innovation or creativity
7	to support decision making

1.c) Considering the range of activities implied by the results, who should be "managing" knowledge at the organisational level?

2) The "knowledge pyramid"

Feedback: Apart from the fact that a few members of the panel were not familiar with the pyramid including wisdom, the majority of the panel agreed that the knowledge pyramid was indeed the common view of the concept of knowledge; however, 40% of the panel also protested about numerous perceived flaws in that model.

Following these results, it is assumed that the knowledge pyramid is the most common view of the concept of knowledge, but that it also lacks some key features. According to you, what are the main flaws of the knowledge pyramid?

The main flaw suggested is that the pyramid is a too simplistic model (19%). Over than that, the main flaws identified are (in order of prevalence):
- Linear model (16%)
- Does not address conversion processes (9%)
- Static model (7%)
- does not address the difference between knowledge and wisdom (7%)
- does not address the influence of the environment (5%)

About 5% mentioned that the pyramid did not represent the concept of knowledge. Do you agree, and why?

Feedback: Although 42% of the panel thought the pyramid <u>does</u> represent the (or "a") concept of knowledge, 17% felt it represented something else – most commonly a taxonomy of concepts related to knowledge. *The remaining responses didn't address this question as intended, providing evaluative comments instead.*

3) Other models or representations of the concept of knowledge

Feedback: The most preferred model is Nonaka's SECI model (12%), with the knowledge pyramid being the second most preferred. Panel members nominated a total of 47 different models or frameworks.

According to you, what is the main contribution of the SECI model? What are its main flaws?

Feedback: Summarising the panel, the main contributions of SECI are that it introduces the dynamic nature of knowledge creation and the conversion processes between tacit and explicit knowledge, and that it incorporates both individual and organizational levels. One panellist noted that "people regard SECI as a model of the concept of knowledge (which it isn't) or of the whole of knowledge management (which it was never intended to be)."

Although 6% mentioned that the simplicity of the SECI model was one of its strength, 24% argued that it was not detailed enough or was an over-simplified representation (this is the main flaw identified by the panel). It has also been suggested that the SECI model depicts a misleading interpretation of the distinction between tacit and explicit knowledge (21%), and that it is based on weak or erroneous philosophical assumptions (18%); the most common example cited involved "justified true belief" as the definition of knowledge. Furthermore, it has been argued to be linear or unidirectional, unpractical, too focused on a Japanese context, and unclear about the distinction

between information and knowledge (all 12%). Finally, it was noted that the SECI model has not been empirically validated (9%).

3a) What do you see as the relationship between "tacit" and "explicit" knowledge? (For example: Are they mutually exclusive alternatives? Do they overlap? Can knowledge be partially tacit and partially explicit at the same time?)

Consider how the utility of the models above has changed over time. Please position the models on the timeline table…

Feedback: We transformed the 5 point scale into values in order to obtain the following tables. We believe they show an average picture of how panellists view the evolution of the utility of the models over time.

Colour Key

from 4.5 to 5	Extremely important
from 3.5 to 4.4	Very important
from 2.5 to 3.4	Important
from 1.5 to 2.4	Somewhat important
from 0 to 1.4	Not important

Arrow Key: ↗ ➚ increase & ↘ ➘ decrease, over time (bold = 0.3 or more)

Models	Past		Present		Future
SECI (Nonaka & Takeuchi)	4.5	➘	4.0	➘	3.6
Tacit/Explicit knowledge	4.3	➘	4.0	↘	3.8
Knowledge Pyramid	3.8	➘	3.3	➘	2.7
Blackler's model of knowledge	2.8	➚	2.9	➘	2.5
Static/Dynamic knowledge	2.8	➚	3.0	➚	3.2
Cynefin sense-making framework	2.3	➚	3.0	➚	3.2
Firestone & McElroy's cycle model	2.1	➚	2.3	➚	2.4
Tuomi's reversed pyramid	1.9	➚	2.0	=	2.0
Boisot's I-space	2.4	↘	2.2	↘	2.0

One finding here could be that the only models that show increasing importance over time are the Static/Dynamic knowledge representation, the Cynefin sense-making framework, and Firestone & McElroy's cycle model *(although there was a bit of confusion about what was meant by the cycle model; some understood it as the Knowledge Life Cycle, others the Unified Theory of Knowledge)*. Both the Cynefin sense-making framework and Firestone & McElroy's cycle model are grounded in complexity theory, and the distinction between static and dynamic knowledge can be seen as conforming to complexity perspectives. Therefore, it seems that the prospects for complexity theory within the future of KM are growing.

3b) Do you see complexity theory as the common denominator of these rising models, or is there some other reason or shared factor?

3c) Do you believe complexity theory is just the next fad, or will it provide an enduring foundation for a better understanding of the concept of knowledge?

A couple of experts asserted that a distinction should be made between the understanding of "knowledge" in academia and that in business practice. Do you agree, and why?

<u>Feedback</u>: 48% of the panel strongly opposed the idea of distinguishing the understanding of "knowledge" in academia from that in business practice. The main reasons advanced were that practitioners and academics should learn from each other and use the same language, and that a distinction would make academia irrelevant to practice.

Panellists agreeing with the idea that a distinction is needed (17%) suggested that it should be done on the basis of academia being about theories, and practice about how to apply them, therefore each requiring different approaches.

The remaining responses didn't address this question as intended, providing evaluative comments instead (mostly on the reason for such a gap).

3d) The panel favoured "no gap" over "gap" by a factor of almost three to one. However, most also noted that such a gap does exist. What can be done to reduce this gap?

4) What, or who, has most influenced your thinking about the concept of knowledge?

<u>Feedback</u>: Responses over 5%:

%	Who/What
26%	I. Nonaka
16%	M. Polanyi
10%	I. Nonaka and H. Takeuchi *(in addition to the result for Nonaka above)*
8%	K. Popper J.C. Spender H. Tsoukas Complexity Theory
6%	Aristotle T.H. Davenport and L. Prusak R.M. Grant K. Wiig H. Maturana and F. Varela Philosophy of Science Plato

What is your main comment/criticism about this result?

<u>Feedback</u>: We would like to share some insights into "uncommon" answers, as these might be more informative (and/or provocative) than the general agreement about the table (48% explicitly agreed or thought it not surprising). The main criticism (10%) of the table was that people in KM are not well educated in philosophy (which they should be). A list of key philosophers could include F. Bacon, R. Descartes, J. Locke, D.

Hume, G. Berkeley, I. Kant, G.W.F. Hegel, J. Mittelstrass, L. Wittgenstein, *and many others...*

Some comments criticised the results:
- "The virtual absence of recent (last 10 years) researchers/thinkers is very striking and suggests that their work has (for whatever reason) had practically no impact on the panellists' thinking."
- "Lots of people reference Polanyi, but how many have read and understand it?"
- "I don't think it's surprising. But it is dangerous for KM, since the ideas of Nonaka, Nonaka and Takeuchi, and Polanyi are all subjectivist and authoritarian."

A "short list" of others who influenced members of the panel (surfacing in both Rounds 1 and 2): A. Bentley, J. Dewey, F. Machlup, A. Newell, G. Ryle, and T. Matsuda. This illustrates in part how broad the perspectives represented here are, and perhaps will help some respondents feel that we are not ignoring them... but we really didn't believe it appropriate to list all 105 influencers nominated by the panel.

4.a) Would you like to make any further observations about these results?

5) Do we need new models or representations of the concept of knowledge?

Responses to the first round showed not just a great diversity of perspectives, and adhesion to a wide range of models, but an undercurrent of dissatisfaction with the state of research in the field, as well as its application to practice. Why?

Feedback: There are apparently various reasons for the dissatisfaction in the field, the main reason apparently being the fact that KM is still in its infancy (23%). Consequently, it lacks a common understanding of the concept of knowledge (20%), and has too much variety of views (20%, most of which commented on the large number of origins of KM). 11% of the panellists also mentioned the gap between theory and practice as being a handicap for the field, and 9 % blamed the lack of empirical studies in KM.

Would it be a good idea to try to unify the field of knowledge management, particularly through the creation of models or frameworks acceptable to the vast majority of academics and practitioners in this field?

Feedback: 59% of the panellists agreed that it be a good idea to try to unify the field of knowledge management, particularly through the creation of models or frameworks acceptable to the vast majority of academics and practitioners in this field, as long as it is done pluralistically (meaning that there would be more than one model or representation) in an integrative way. However, 12% suggested explicitly that this would be difficult to achieve. *Only 25% opposed the idea, but some experts did not interpret the question as intended.*

5.a) The results hint that KM will need to reach the stage of a new paradigm (using a pluralistic and integrative approach) to make real progress in terms of applicability (bridging the gap between theories and practice). Do you agree?

What should be the main characteristics of a model of the concept of knowledge for it to be relevant for knowledge management?

Feedback: 52 different characteristics were suggested, ranging from purposes to components. The most frequently nominated characteristic (24%) is relevance or applicability to business. Altogether 39% of the panel honed in on the relationship between "knowledge" and reality or practice. An equal 39% focused on the social and dynamic aspects of "knowledge," emphasising characteristics such as knowledge management processes and life cycles. 30% were concerned that a model of "knowledge" should be sufficiently inclusive, flexible, and integrative. 24% indicated that the model should differentiate among forms or types of knowledge, e.g. individual/organisational, tacit/explicit, and information/knowledge. 21% stated that the model should be clear and simple. 15% suggested that a sound philosophical basis should underlie the model, and 15% emphasised that the model should be theoretically rigorous and validated.

One panellist suggested reversing the question (swapping KM and knowledge). We see this as a very different question having a different purpose, but agree that it is relevant and important. Some of our earlier questions have partially addressed this issue. Combined and modified, this suggests our next new question for this round.

5.b) What should be the main characteristics of a model of <u>knowledge processing</u> *(as opposed to a model of knowledge)* for it to be relevant to knowledge management?

<u>6) Definitions of Data, Information, Knowledge, and Wisdom</u>

Feedback: The definitions given by panel members covered most of the wide range found in the literature, fairly well adhering to standard definitions, with some variation. We believe that a reasonable consensus has been reached. For the moment, our overall working definitions of these four concepts are as follows:

Data are unprocessed raw representations of reality.

Information is data that has been processed in some meaningful ways.

Knowledge is information that has been processed in some meaningful ways.

Wisdom is knowledge that has been processed in some meaningful ways.

There appears to be a hierarchy indicated by these definitions. Your thoughts on this?

What connects these definitions? (Is there a transitional mechanism of some sort?)

Feedback: It's clear that many nerves were frayed by this question – which is in part what we were trying to accomplish. The panel as a whole is not a whole; the tensions arising from opinion consolidation in the Delphi approach are quite evident here.

Some highlighted the issue of the oxymoron "unprocessed raw representation of reality," since creating a representation involves processing; however, most interpreted this as meaning a "basic" representation of reality, with minimal processing, which matches the consensus of the panel from the first round.

While 59% of the panel agreed that there was a hierarchy, many recognizing the pyramid, 42% argued that the definitions were inadequate and confusing (although more than 20% agreed on the definitions of data and information). Furthermore, 45% of the panel again raised problems with the pyramid. Memorable quotations arose in response to the simplistic tautology presented for your comments in the second round. A sample of our "top ten" follow, in no particular order:

(1) "This is as close to a tautological quatrain as I have ever seen. Wow!"
(2) "These 'consensual definitions' are not definitions but tautologies. Information is data? Knowledge is information? Wisdom is knowledge? And 'in some meaningful ways'? What clarity, what a precision, what a mess."
(3) "First e.g. it is arguable there is no such thing as 'unprocessed raw representations' – a representation is by definition 'processed' in some cognitive/perceptual sense. It is an IT myth, convenient perhaps for referring to marks on cards, or on magnetic tape etc. (bits) to think of those as 'data' which are thus 'raw representations'."
(4) "The only vaguely defined piece here is data, all the rest is mechanically derived from it, leading to wisdom is 'representations of reality processed in some meaningful ways'. Nobody can do anything meaningful with that."
(5) "Knowledge / wisdom – we have no real idea (generally) what we mean by these, which is why we describe them in meaningless ways as 'processed X' "
(6) "All the talk about 'processing' simply avoids the hard questions while seeming to provide an answer. Since no one has said what kind of 'processing' turns 'data' into 'information' the whole 'hierarchy'(whichever way round) is just so much verbiage."
(7) "… it follows that the remaining definitions are vague and unhelpful and are only there to define an imagined Pyramid that doesn't exist."
(8) "I think the KM field needs to get past its fascinated repetition of this hierarchy as if it is somehow meaningful or beneficial. I think it holds up progress in the KM field."
(9) "Does 'has been processed' mean 'e.g. by computers'? I am afraid so."
(10) "It is mainly based on the metaphor of IT."

To briefly summarise:
1) The definitions do not define anything as somehow wisdom equals knowledge equals information equals data (tautology), and data equals nothing (oxymoron).
2) The use of 'processed X' is inadequate and incomplete.
3) KM needs to get away from the IT metaphor in general and the pyramid in particular.

6.a) The pyramid and its inherently associated definitions remain the dominant perspective in the KM literature (and were echoed in the first two rounds here). The challenges posed by panellist comments emphasise the need for a major reconceptualisation of the discipline. Do you agree?

What connects these definitions? (Is there a transitional mechanism of some sort?)

Feedback: In order to keep this as brief as possible *(yes, we know it's already too long!)*, we will provide just one quote here: "Certainly not the transition or the processes which

need to be clearly different for various elements. The connecting feature might be the 'understanding' in my view."

6.b) Do you agree that 'understanding' is the connecting factor among data, information, knowledge, and wisdom?

7) Association among constructs

In the following table (alphabetical), the three new terms are highlighted. Additionally, some of the values have been adjusted to incorporate additional (slightly late) respondents.

Colour Key

	Identity (same term)
8-10	Orange
6-7.9	Light orange
4-5.9	Gold
2-3.9	Yellow
0-1.9	Light yellow

Average	Data	Information	Knowledge	Wisdom
Cognition	2.3	4.3	7.5	6.8
Data	10.0	5.6	3.4	2.1
Enlightenment	1.3	2.9	6.3	8.3
Environment (*)	4.8	4.9	5.8	5.5
Existence	5.0	5.0	5.6	5.9
Experience	2.1	4.1	7.6	8.0
Explicit	7.6	7.1	5.8	3.3
Fact	8.0	6.1	4.8	3.3
Information	5.0	9.9	5.5	3.3
Intelligence	2.2	4.5	7.2	7.4
Judgement	1.9	4.1	7.0	8.3
Knowledge	2.6	4.4	9.9	7.0
Learning	2.5	5.0	8.1	7.4
Memory	4.6	5.9	7.4	6.3
Mind (*)	2.7	4.4	7.4	7.9
Organisation	4.5	5.8	6.6	5.6
Perception	3.5	4.7	6.4	6.1
Process	3.6	5.7	6.4	5.3
Relationship	2.3	5.2	6.9	6.8
Reality	5.8	5.7	6.4	6.0
Schema (*)	4.6	6.1	6.0	5.0
Structure	4.9	6.0	5.5	4.5
System	4.4	5.8	6.2	4.7
Tacit	1.0	2.5	7.5	8.1
Theory	1.8	3.7	7.1	6.2
Truth	4.5	4.9	6.5	6.6
Understanding	2.4	4.6	7.8	8.1
Wisdom	1.3	2.7	6.0	9.9
Average	3.8	5.1	6.6	6.2

(*) New items added as result of responses in round 2.

What patterns can you identify in the above table? What do you believe they indicate?

Feedback: Some view this line of questioning as word games (*something that occurs for a number of questions*), and some didn't reply at all. However, we believe some of their quotes are worth considering *(given that this is a Delphi study, we won't serve as advocates or critics at this point).*

One panellist wrote: "Pretty patterns :) . What do they indicate – that we are playing with words, and finding synonyms."

Another stated that "The terms refer to static states (e.g. information, memory, …), to dynamic processes (e.g. learning, perception, judgement, …) to institutions (e.g. organisation, system, …), to adjectives (e.g. tacit, explicit, …): They do not correspond with one another."

Summarising those responses that did describe patterns, most linked several concepts, with the results resembling clusters or factors. In particular, knowledge and wisdom were linked, and data and information were linked, implying at the minimum two clusters.

The following table ranks these concepts by the difference going across the table from left to right (i.e., from data to wisdom). *(For example, for the concept ranked second – enlightenment – the slope is positive from "data" to "wisdom," and the response for association with wisdom is 7.1 higher than that for data, on average.)*

Rank	Concept	I – D	K - I	W - K	Total
			Difference		
1	Wisdom	1.4	3.3	4.3	9.0
2	Enlightenment	1.7	3.4	2.2	7.3
3	Tacit	1.4	5.3	0.5	7.2
4	Judgement	2.2	3.1	1.5	6.7
5	Experience	1.9	3.9	0.2	6.1
6	Understanding	2.2	3.6	0.1	5.9
7	Intelligence	2.5	2.7	0.1	5.3
8	Mind [*]	1.8	2.9	0.5	5.2
9	Learning	2.5	3.4	-0.9	5.1
10	Cognition	2.1	3.5	-0.9	4.7
11	Theory	2.0	3.4	-0.8	4.6
12	Relationship	3.0	1.8	-0.2	4.6
13	Knowledge	1.9	5.9	-3.2	4.5
14	Perception	1.3	1.8	-0.4	2.7
15	Truth	0.5	1.6	0.2	2.4
16	Process	2.3	0.5	-1.1	1.7
17	Memory	1.4	1.4	-1.3	1.6
18	Organisation	1.4	0.8	-1.2	1.0
19	Existence	-0.1	0.7	0.3	0.9
20	Environment [*]	0.1	0.9	-0.4	0.6
21	Schema [*]	1.5	-0.1	-1.0	0.5
22	Reality	-0.1	0.7	-0.4	0.2
23	System	1.3	0.2	-1.5	0.0
24	Structure	1.1	-0.7	-1.1	-0.6
25	Information	5.3	-4.6	-2.2	-1.5
26	Explicit	-0.3	-1.2	-2.7	-4.2
27	Fact	-1.9	-1.4	-1.5	-4.8
28	Data	-4.6	-2.2	-1.3	-8.1

(*) New items added as result of responses in round 2.

What patterns can you identify in the above table? What do you believe they indicate?

Feedback: The concept with the greatest positive total difference (between data and wisdom) is wisdom, and with the greatest negative difference (between wisdom and data) is data – a near mirror that can serve to validate the responses. The sharpest single-transition rises are between information and knowledge (darkest blue cells) – which a participant stated "implies that the conversion of info into k is seriously significant."

The largest increase for each transition is between the DIKW concepts themselves (for information, knowledge, and wisdom). Likewise, the sharpest drops are between the DIKW concepts (red cells), for data, information, and knowledge. The concept with the least total change (lowest sum of absolute values of transitions) across the four DIKW concepts is existence, closely followed by reality and environment.

7.a) Some panellists suggested clustering of the concepts in the above tables could provide insights. Do you sense any clusters (within the ranked table)? If so, please comment about them.

8) What is your main field of research interest?

39% of the panel members specifically included "knowledge management" (or KM) as within their main field of research interest. However, the areas of nearly all respondents can be considered within the broader domain of knowledge management. A simple tabulation of responses to this question isn't quite workable. To further explore this, we'd like for you to indicate the degree of relationship you perceive between selected respondents' fields and knowledge management, by marking one cell for each research interest in the following table.

Feedback: The following table illustrates the results.

Colour Key

	50-100	Orange
	35-49.9	Light orange
	20-34.9	Yellow
	0-19.9	Light yellow

%	Core	Partial overlap	Peripheral	Unrelated
Complexity theory	25.0	25.0	44.4	5.6
Decision making/support	30.6	44.4	19.4	2.8
Entrepreneurship	13.9	27.8	41.7	22.2
Human resource management (HRM)	25.0	38.9	25.0	11.1
Innovation management	47.2	38.9	11.1	2.8
Intellectual capital	55.6	27.8	11.1	5.6
Leadership	19.4	33.3	38.9	13.9
Organisational learning	61.1	22.2	5.6	0.0
Organisational behaviour	30.6	47.2	22.2	0.0
Strategy	27.8	61.1	8.3	0.0
System thinking	30.6	38.9	19.4	5.6

8.a) Do you agree that KM is mainly about organisational learning, intellectual capital, and innovation management? (If not, then what?)

9) Readings

As several panel members actively questioned the reading heritage of participants in the KM field, we hope you will consider answering the following. We recognise that these are probably the most "private" questions we have asked during this project, and of course we will never release this information in anything other than aggregated (totally anonymous) form.

9.a) Have you read any of the works of the following philosophers (not summaries by someone else)?

	All or almost all	Most	Some	Very little	None
Aristotle					
F. Bacon					
L. von Bertalanffy					
G. Berkeley					
F. Capra					
A. Comte					
R. Descartes					
J. Dewey					
G.W.F. Hegel					
D. Hume					
I. Kant					
J. Locke					

	All or almost all	Most	Some	Very little	None
K. Marx					
H. Maturana (and F. Varela)					
J. Mittelstrass					
F. Nietzsche					
Plato (e.g., Socrates)					
M. Polanyi					
K. Popper					
J.J. Rousseau					
A. Turing					
J.P. Sartre					
A.F. Whitehead					
L. Wittgenstein					

9.b) Have you actually read Polanyi's "The Tacit Dimension"?

9.c) Have you actually read Nonaka and Takeuchi's "The Knowledge-Creating Company"?

10) The Delphi method

10.a) What are your thoughts on the Delphi method?

10.b) What are your comments about our application of the Delphi method?

Thank you for your participation! This is the last questioning round of this Delphi, with (more extensive) feedback coming after we've had some time to analyse your responses. We hope you enjoyed participating, and we thank you very much for your thoughts and time.

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FAQ – General

1. You can format your answers any way you like - bold, italics, red, or nothing at all. Don't worry about page boundaries or any other formatting issues. We have kept the format as open and free-flowing as possible.

2. If a question seems irrelevant to you, feel free to say so!

3. You can type comments anywhere in this questionnaire - we have not made it a "form" or converted it to PDF for that reason. We are happy to receive any explanations, comments, criticisms, etc.

4. On the table (question 7.a), you may use any value repeatedly within any row or column. The approach most people use to answer this question is to respond by row (across the table). Of course you are free to approach it any way you like. If you have any comments or suggestions regarding your approach, please write them.

5. In this project, "Delphi study" is defined as a social research technique of structuring communication which aims at constructing a reliable group opinion among experts assembled into a panel, involving multiple rounds of exchange and feedback through a central coordinator.

6. We limited the amount of feedback given in this round to prevent overload. Our intention is not to swamp you with feedback, but to indicate some relevant patterns found in the results of the first round. More detailed results will be available to any participant who desires them, after the study is completed (in order to avoid clouding the intent of the Delphi approach being used).

7. The project examines definitions of constructs related to the concept of knowledge and gathers information on how these constructs relate to each other, in order to test new models of knowledge. We are interested in your understanding of the concept of knowledge and related ideas.

8. Familiarity with the typical terminology used in the field of "knowledge management" is expected – although with different interpretations and orientations (that's part of the focus of this research project) due to the diverse backgrounds of the participants. Please feel free to comment on any aspect of the questionnaire, terminology, or approach, anywhere within this document (or in a separate email).

Appendix 4. Delphi Final Feedback

Delphi Study on the Concept of Knowledge

<<< Final Feedback – Following Round 3 >>>

This document presents the final round of feedback from the three-round Delphi study in which you participated (in at least one round). Altogether, 353 experts were invited to participate, with 88 responses received (we cannot be sure that any of the non-respondents either received or read our message). 64 questionnaires were completed in the first round, 45 in the second round, and 35 in the third round (*note: this represents retention rates of 70% and 78%, which are relatively high for a Delphi study of this nature*).

There are no further questions in this report (although, of course, we have discovered far more questions than were "answered" in the course of this project!)

A subset of questions asked in the first round and feedback from the responses are designated with a single line at the left. (This material was provided in the second round, and is repeated here.)

A subset of questions asked in the second round and feedback from the responses are designated with a double line at the left. (This material was provided in the third round, and is repeated here.)

Questions asked in the third round and feedback from the responses are not marked – material without a line is "new" in this feedback report. *(Please use caution in comparing "percentage" feedback across rounds, as the number of respondents differs – e.g., 50% in round one represents 32 respondents, while in round three 50% is about 17 respondents).*

Some respondents have been quite vocal about our omission of their exact wording or opinions in the first-round feedback. No comments are being ignored – and every response is being carefully analysed – but we also wish to avoid overloading participants, who are already being very generous with their time. *Part of the Delphi process is "seeking a managed consensus" – but our interest goes well beyond this alone, and we recognise this distinctive aspect of the Delphi approach as both an advantage and a shortcoming.*

Obviously, the topics addressed here will continue to interest us – and hopefully you – well into the future. We look forward to working with you, perhaps indirectly through reading each others' work, perhaps directly in meetings at conferences or by email, perhaps even as collaborators or coauthors – particularly if our opinions are divergent, as challenges and disagreements are more likely to lead to change and advancement of our fields of mutual interest. We would be delighted to continue discussions with any participants on any aspects of this study – just email us at jb.faucher@gmail.com

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FINAL FEEDBACK – FOLLOWING ROUND 3

1) Is it possible to manage knowledge?

Never	Hardly ever	Sometimes	Most of the time	Always	"Yes"	Other (off the scale)
5%	7%	40%	24%	13%	3%	8%

10% asserted it was only possible to manage knowledge indirectly.

Following [Round 1] results, it is assumed that it is at least sometimes possible to manage knowledge (or else, why would the field be called knowledge management?). Do you agree?

Feedback: The overwhelming perspective [all but one respondent] is that it is possible to manage knowledge – sometimes, under certain conditions, and only in certain forms. In other words, knowledge management is highly contingent. 61% stated "yes" while 36% indicated "yes, but…"

Under what kinds of conditions is it possible to manage knowledge?

Feedback: The most common condition noted by the panel is that explicit knowledge is easier to manage (7%) or is the only form of knowledge that can be managed (30%). About one-tenth of respondents indicated that necessary conditions include the presence of (suitable) information technology, the existence of (appropriate) processes, and the existence of an open and empowering social environment. Approximately twenty other conditions were mentioned by one or two respondents.

1.a) Can tacit knowledge be managed?

Feedback: Overall, 89% of the panel believes that tacit knowledge can be managed, at least sometimes and in some ways, often with some difficulties. Summary: Yes 40%, qualified yes 49%, no 9%, other 3% *(note: "due to rounding, sums may not equal 100%"…)*

1.b) If yes, under what conditions?

A supportive environment was nominated by 52%, empowerment of employees 44%, an appropriate organisational structure and leadership 30%, and by making it explicit (or manageable using information technology) 30%.

What is the purpose of knowledge management?

Feedback: Individual choices of wording mean that although we have tried to aggregate or categorise responses, every response inherently differed and our own perceptions have flavoured the categorisations. The two prevalent answers (1/3 of the panel) are that KM should benefit the organisation and that it should improve organisational processes. To us, the first "purpose" appears to be an "end" or overall goal, while the others are "means" whereby this overall goal can be attained. Ranked from most to least:

        36% to benefit the organisation
        30   to improve organisational processes
        18   to organise or store knowledge

1.c) Considering the range of activities implied by the results, who should be "managing" knowledge at the organisational level?

Responses ranged from "everyone" to specific titled positions including CKO, CIO, CLO, and general manager. The most common response was "everyone" with 35%, followed by CKO (Chief Knowledge Officer) at 24%. "All management levels" received 18%, "knowledge managers" 12%, and "leaders" 6%; all others nominated were below 5%.

2) The "knowledge pyramid"

Feedback: Apart from the fact that a few members of the panel were not familiar with the pyramid including wisdom, the majority of the panel agreed that the knowledge pyramid was indeed the common view of the concept of knowledge; however, 40% of the panel also protested about numerous perceived flaws in that model.

Following these results, it is assumed that the knowledge pyramid is the most common view of the concept of knowledge, but that it also lacks some key features. According to you, what are the main flaws of the knowledge pyramid?

The main flaw suggested is that the pyramid is a too simplistic model (19%). Other than that, the main flaws identified are (in order of prevalence):
- Linear model (16%)
- Does not address conversion processes (9%)
- Static model (7%)
- Does not address the difference between knowledge and wisdom (7%)
- Does not address the influence of the environment (5%)

3) Other models or representations of the concept of knowledge

Feedback: The most preferred model is Nonaka's SECI model (12%), with the knowledge pyramid being the second most preferred. Panel members nominated a total of 47 different models or frameworks.

According to you, what is the main contribution of the SECI model? What are its main flaws?

Feedback: Summarising the panel, the main contributions of SECI are that it introduces the dynamic nature of knowledge creation and the conversion processes between tacit and explicit knowledge, and that it incorporates both individual and organizational levels. … It has also been suggested that the SECI model depicts a misleading

interpretation of the distinction between tacit and explicit knowledge (21%), and that it is based on weak or erroneous philosophical assumptions (18%).

3a) What do you see as the relationship between "tacit" and "explicit" knowledge? (For example: Are they mutually exclusive alternatives? Do they overlap? Can knowledge be partially tacit and partially explicit at the same time?)

The majority of the panel (57%) indicated that knowledge has both tacit and explicit dimensions, and can therefore be both at the same time. A further 22% indicated that tacit and explicit knowledge are mutually exclusive, but convertible from one to the other, while 16% agreed that they are mutually exclusive but did not mention convertibility.

Consider how the utility of the models above has changed over time.

Feedback: The only models that showed increasing importance over time were the Static/Dynamic knowledge representation, the Cynefin sense-making framework, and Firestone & McElroy's cycle model. The latter two are grounded in complexity theory, and the distinction between static and dynamic knowledge can be seen as conforming to complexity perspectives. Therefore, it seems that the prospects for complexity theory within the future of KM are growing.

3b) Do you see complexity theory as the common denominator of these rising models, or is there some other reason or shared factor?

58% agreed, and 12% disagreed while 24% responded "don't know." Based on the responses, it appears that "complexity theory" is understood in a wide variety of ways (some incompatible with each other), perhaps indicating that another Delphi study is in order!

3c) Do you believe complexity theory is just the next fad, or will it provide an enduring foundation for a better understanding of the concept of knowledge?

No respondents believed that complexity theory is definitely just a fad. However, 20% thought it could be a fad – 'probably' or 'possibly' or 'don't know yet, ask me in ten years!,' with some writing that it could be fruitful even if it does turn out to be a fad. Half of the respondents – 49% – agreed that complexity theory will provide an enduring foundation, with another 6% agreeing but less certain. A further 17% "don't know."

A couple of experts asserted that a distinction should be made between the understanding of "knowledge" in academia and that in business practice. Do you agree, and why?

Feedback: 48% of the panel strongly opposed the idea of distinguishing the understanding of "knowledge" in academia from that in business practice. The main reasons advanced were that practitioners and academics should learn from each other and use the same language, and that a distinction would make academia irrelevant to practice. Panellists agreeing with the idea that a distinction is needed (17%) suggested that it should be done on the basis of academia being about theories, and practice about how to apply them, therefore each requiring different approaches.

3d) The panel favoured "no gap" over "gap" by a factor of almost three to one. However, most also noted that such a gap does exist. What can be done to reduce this gap?

Everyone who replied provided a different response, given the nature of the question. We have grouped them according to our own perceptions as best we could, resulting in the following broad results:

56% believed more collaboration, involving more interaction and mutual benefits, can reduce the gap between practice and academia. This could involve cooperative research, better communication, and corporate funding of academic investigations of organisational practices.

15% indicated that academics need to be made more aware of practice, 9% thought the opposite (that practitioners need to be made more aware of academic understandings), and 9% replied that awareness needs to be increased by both sides.

4) What, or who, has most influenced your thinking about the concept of knowledge?

Feedback: Responses over 5%:

%	Who/What
26%	I. Nonaka
16%	M. Polanyi
10%	I. Nonaka and H. Takeuchi *(in addition to the result for Nonaka above)*
8%	K. Popper J.C. Spender H. Tsoukas Complexity Theory
6%	Aristotle T.H. Davenport and L. Prusak R.M. Grant K. Wiig H. Maturana and F. Varela Philosophy of Science Plato

What is your main comment/criticism about this result?

Feedback: The main criticism (10%) of the table was that people in KM are not well educated in philosophy (which they should be). Some comments criticised the results:
- "The virtual absence of recent (last 10 years) researchers/thinkers is very striking and suggests that their work has (for whatever reason) had practically no impact on the panellists' thinking."
- "Lots of people reference Polanyi, but how many have read and understand it?"
- "I don't think it's surprising. But it is dangerous for KM, since the ideas of Nonaka, Nonaka and Takeuchi, and Polanyi are all subjectivist and authoritarian."

4.a) Would you like to make any further observations about these results?

Major issues arose about the disconnect between philosophy and knowledge management, with a few (9%) claiming that the two were incommensurate and could not be related. A fair number (19%) criticised the educational level of the panel (despite 105 different influencers being cited). This could reflect a shortcoming of our method, given that the panel members were selected for their expertise.

Two comments serve to reflect the range of thoughts represented. First, "Every researcher should remember how important it is to stand on the shoulders of giants." Second, "These results are a reflection of the profound ignorance about knowledge among KM practitioners. To have Nonaka, Nonaka and Takeuchi, and Polanyi as the three primary sources on the nature of knowledge among Knowledge Managers is enough, by itself, to suggest that the discipline badly needs reform." The choice of which giants is, clearly, a contentious issue!

5) Do we need new models or representations of the concept of knowledge?

Feedback:

Yes	No	Maybe	Don't know	Other
36%	34%	9%	5%	17%

Responses to the first round showed not just a great diversity of perspectives, and adhesion to a wide range of models, but an undercurrent of dissatisfaction with the state of research in the field, as well as its application to practice. … Would it be a good idea to try to unify the field of knowledge management, particularly through the creation of models or frameworks acceptable to the vast majority of academics and practitioners in this field?

Feedback: 59% of the panellists agreed that it be a good idea to try to unify the field of knowledge management, particularly through the creation of models or frameworks acceptable to the vast majority of academics and practitioners in this field, as long as it is done pluralistically (meaning that there would be more than one model or representation) in an integrative way. However, 12% suggested explicitly that this would be difficult to achieve. *Only 25% opposed the idea, but some experts did not interpret the question as intended.*

5.a) The results hint that KM will need to reach the stage of a new paradigm (using a pluralistic and integrative approach) to make real progress in terms of applicability (bridging the gap between theories and practice). Do you agree?

79% agreed and 21% disagreed (with a small portion of "qualified" responses on each side).

Two supportive comments are that "Some years ago everybody thought KM was a fad, but now it needs to reach the stage of a new paradigm," and that "It is not only a matter of KM reaching such a stage, but of KM researchers reaching a stage of being well-informed of the theoretical and empirical research that already exists!"

What should be the main characteristics of a model of the concept of knowledge for it to be relevant for knowledge management?

Feedback: 52 different characteristics were suggested, ranging from purposes to components. The most frequently nominated characteristic (24%) is relevance or applicability to business. Altogether 39% of the panel honed in on the relationship between "knowledge" and reality or practice. An equal 39% focused on the social and dynamic aspects of "knowledge," emphasising characteristics such as knowledge management processes and life cycles. 30% were concerned that a model of "knowledge" should be sufficiently inclusive, flexible, and integrative. 24% indicated that the model should differentiate among forms or types of knowledge, e.g. individual/organisational, tacit/explicit, and information/knowledge. 21% stated that the model should be clear and simple. 15% suggested that a sound philosophical basis should underlie the model, and 15% emphasised that the model should be theoretically rigorous and validated.

5.b) What should be the main characteristics of a model of <u>knowledge processing</u> *(as opposed to a model of knowledge)* for it to be relevant to knowledge management?

The overriding conclusion is that a model of knowledge processing should show the processes involved in managing knowledge… obviously enough! The most commonly nominated feature is that such a model should incorporate the concept of sharing or distribution among individuals within a social context. Several suggestions called for the model to differentiate between individual and group or organisational processes (sometimes linking individual processing [mental] to tacit knowledge and group processes to the management of explicit knowledge). About one-fifth of respondents suggested that taxonomies of knowledge and conversion among types of knowledge should be represented; that the model should be based on a systemic framework, e.g. complexity theory; and that such a model should be relevant to practice or link academia to practice.

Some respondents mentioned characteristics that should be considered generic for good models, e.g. epistemological consistency, clarity, and simplicity. A fair number of respondents misinterpreted the question and designated characteristics of knowledge processing itself, rather than a model thereof.

<u>6) Definitions of Data, Information, Knowledge, and Wisdom</u>

Feedback: The definitions given by panel members covered most of the wide range found in the literature, fairly well adhering to standard definitions, with some variation. We believe that a reasonable consensus has been reached. For the moment, our overall working definitions of these four concepts are as follows:

Data are unprocessed raw representations of reality.

Information is data that has been processed in some meaningful ways.

Knowledge is information that has been processed in some meaningful ways.

Wisdom is knowledge that has been processed in some meaningful ways.

There appears to be a hierarchy indicated by these definitions. Your thoughts on this?

What connects these definitions? (Is there a transitional mechanism of some sort?)

Feedback: It's clear that many nerves were frayed by this question – which is in part what we were trying to accomplish. The panel as a whole is not a whole; the tensions arising from opinion consolidation in the Delphi approach are quite evident here.

While 59% of the panel agreed that there was a hierarchy, many recognizing the pyramid, 42% argued that the definitions were inadequate and confusing (although more than 20% agreed on the definitions of data and information). Furthermore, 45% of the panel again raised problems with the pyramid.

To briefly summarise the comments of the panellists:
1) The definitions do not define anything as somehow wisdom equals knowledge equals information equals data (tautology), and data equals nothing (oxymoron).
2) The use of 'processed X' is inadequate and incomplete.
3) KM needs to get away from the IT metaphor in general and the pyramid in particular.

6.a) The pyramid and its inherently associated definitions remain the dominant perspective in the KM literature (and were echoed in the first two rounds here). The challenges posed by panellist comments emphasise the need for a major reconceptualisation of the discipline. Do you agree?

74% of the panel agreed that a major reconceptualisation of the discipline was required, many mentioning the need to get rid of the pyramid. The main reason pointed out by the disagreeing respondents was that we mostly need a better understanding of the definitions used in the field.

What connects these definitions? (Is there a transitional mechanism of some sort?)

Feedback: In order to keep this as brief as possible *(yes, we know it's already too long!)*, we will provide just one quote here: "Certainly not the transition or the processes which need to be clearly different for various elements. The connecting feature might be the 'understanding' in my view."

6.b) Do you agree that 'understanding' is the connecting factor among data, information, knowledge, and wisdom?

61% of the panel agreed that 'understanding' was the connecting factor among data, information, knowledge, and wisdom (one respondent indicated it could be a significant factor but not the only one). The most prominent answers opposing that opinion suggested that if any connecting factor existed, it was not understanding but 'categorising,' or the role played by this taxonomy in the lives of living systems, or that understanding was the bridge between knowledge and wisdom as advocated by Ackoff.

7) Association among constructs

The following table ranks these concepts by the difference going across the table from left to right (i.e., from data to wisdom). *(For example, for the concept ranked second – enlightenment – the slope is positive from "data" to "wisdom," and the response for association with wisdom is 7.1 higher than that for data, on average.)*

Rank	Concept	Difference			
		I – D	K - I	W - K	Total
1	Wisdom	1.4	3.3	4.3	9.0
2	Enlightenment	1.7	3.4	2.2	7.3
3	Tacit	1.4	5.3	0.5	7.2
4	Judgement	2.2	3.1	1.5	6.7
5	Experience	1.9	3.9	0.2	6.1
6	Understanding	2.2	3.6	0.1	5.9
7	Intelligence	2.5	2.7	0.1	5.3
8	Mind (*)	1.8	2.9	0.5	5.2
9	Learning	2.5	3.4	-0.9	5.1
10	Cognition	2.1	3.5	-0.9	4.7
11	Theory	2.0	3.4	-0.8	4.6
12	Relationship	3.0	1.8	-0.2	4.6
13	Knowledge	1.9	5.9	-3.2	4.5
14	Perception	1.3	1.8	-0.4	2.7
15	Truth	0.5	1.6	0.2	2.4
16	Process	2.3	0.5	-1.1	1.7
17	Memory	1.4	1.4	-1.3	1.6
18	Organisation	1.4	0.8	-1.2	1.0
19	Existence	-0.1	0.7	0.3	0.9
20	Environment (*)	0.1	0.9	-0.4	0.6
21	Schema (*)	1.5	-0.1	-1.0	0.5
22	Reality	-0.1	0.7	-0.4	0.2
23	System	1.3	0.2	-1.5	0.0
24	Structure	1.1	-0.7	-1.1	-0.6
25	Information	5.3	-4.6	-2.2	-1.5
26	Explicit	-0.3	-1.2	-2.7	-4.2
27	Fact	-1.9	-1.4	-1.5	-4.8
28	Data	-4.6	-2.2	-1.3	-8.1

(*) New items added as result of responses in round 2.

What patterns can you identify in the above table? What do you believe they indicate?

Feedback: The concept with the greatest positive total difference (between data and wisdom) is wisdom, and with the greatest negative difference (between wisdom and data) is data – a near mirror that can serve to validate the responses. The sharpest single-transition rises are between information and knowledge (darkest blue cells) – which a participant stated "implies that the conversion of info into k is seriously significant." The largest increase for each transition is between the DIKW concepts themselves (for information, knowledge, and wisdom). Likewise, the sharpest drops are between the DIKW concepts (red cells), for data, information, and knowledge. The concept with the least total change (lowest sum of absolute values of transitions) across the four DIKW concepts is existence, closely followed by reality and environment.

7.a) Some panellists suggested clustering of the concepts in the above tables could provide insights. Do you sense any clusters (within the ranked table)? If so, please comment about them.

Although we were hoping for a wide range of provocative or innovative clustering suggestions, instead the panel as a whole rejected this approach. Few suggested clusters, while many commented about either contingent clustering or the inappropriateness of clustering (a few comments about the "nice colours" were also received…). The most common observation regarding potential clusters was that there seems to be a continuum between tacit and explicit.

Here is a comment that, in our view, summarises the notion of concept clustering quite well: "You could group the various terms according to their neighbourhood with D-I-K-W. The terms which are on the edge may provide insights to the transitional mechanisms. The I-K border is certainly one of the most intriguing."

Among the more oppositional comments is the following, which impugns the credibility of the panel while summarising objections to the results of the clustering consensus: "Again, the respondents seem to think that Information and Data are alike, and that knowledge and wisdom are alike. They also seem to believe that knowledge and wisdom are both more subjective in the sense that they are more closely associated with judgment, understanding, tacit knowledge, experience and enlightenment, while at the same time, they are more objective, in the sense that they are more closely associated with "truth," and "intelligence" than are data and information. What I believe these patterns indicate is confused theory about the four constructs, misunderstanding about the meaning of objectivity and subjectivity, confused psychological theory, lack of a good theory for distinguishing types of knowledge, and confusion about the theory of truth. In other words, the results show a severe lack of education in epistemology, psychology, and systems theory among the panelists."

8) What is your main field of research interest?

The top three core areas of research interest were reported as organisational learning (61%), intellectual capital (56%), and innovation management (47%). (*A full table of results is provided in the third-round questionnaire – not repeated here.*)

8.a) Do you agree that KM is mainly about organisational learning, intellectual capital, and innovation management? (If not, then what?)

77% of the panel agreed with the statement. 9% of the panel also mentioned that innovation management might not be as important as organisational learning and intellectual capital, emphasising the results of round 2. 14% suggested that individual learning should also be considered.

14% of the panellists disagreed with the statement, mentioning that a better answer would be organisational learning and organisational behaviour, or all of the areas mentioned in the table (implying that knowledge management is an integrator across multiple fields).

9) Readings

As several panel members actively questioned the reading heritage of participants in the KM field, we hope you will consider answering the following. We recognise that these

are probably the most "private" questions we have asked during this project, and of course we will never release this information in anything other than aggregated (totally anonymous) form.

9.a) Have you read any of the works of the following philosophers (not summaries by someone else)?

Colour Key

	50 + %
	30-49.99 %
	20-29.99 %
	10-19.99 %
	0-9.99 %

	All or almost all	Most	Some	Very little	None
Aristotle	3.2	12.9	48.4	12.9	22.6
F. Bacon	3.2	0.0	29.0	22.6	45.2
L. von Bertalanffy	0.0	9.7	35.5	12.9	41.9
G. Berkeley	0.0	3.2	12.9	16.1	67.7
F. Capra	0.0	16.1	16.1	9.7	58.1
A. Comte	0.0	3.2	16.1	12.9	67.7
R. Descartes	0.0	6.5	38.7	22.6	32.3
J. Dewey	3.2	12.9	22.6	9.7	51.6
G.W.F. Hegel	6.5	9.7	29.0	19.4	35.5
D. Hume	3.2	6.5	22.6	22.6	45.2
I. Kant	6.5	16.1	38.7	22.6	16.1
J. Locke	6.5	16.1	38.7	3.2	35.5
K. Marx	6.5	6.5	48.4	19.4	19.4
H. Maturana (and F. Varela)	6.5	12.9	19.4	12.9	48.4
J. Mittelstrass	0.0	0.0	3.2	9.7	87.1
F. Nietzsche	6.5	16.1	22.6	32.3	22.6
Plato (e.g., Socrates)	3.2	22.6	48.4	12.9	12.9
M. Polanyi	12.9	19.4	29.0	19.4	19.4
K. Popper	6.5	32.3	9.7	29.0	22.6
J.J. Rousseau	3.2	3.2	22.6	16.1	54.8
A. Turing	0.0	6.5	12.9	16.1	64.5
J.P. Sartre	0.0	12.9	29.0	19.4	38.7
A.F. Whitehead	0.0	0.0	16.1	19.4	64.5
L. Wittgenstein	6.5	6.5	25.8	29.0	32.3

9.b) Have you actually read Polanyi's "The Tacit Dimension"?

43% of the panel indicated yes, while a further 17% had partially read it.

9.c) Have you actually read Nonaka and Takeuchi's "The Knowledge-Creating Company"?

89% of the panel responded yes, while a further 11% had partially read it. Therefore, every panel member has read at least part of the book.

10) The Delphi method

10.a) What are your thoughts on the Delphi method?

In general, panellists appreciated the use of the Delphi approach for this study. Given that those who answered this question are those who stuck with this study through the third round, this is obviously a biased observation. (Nonetheless, we chose this approach because we believed it was the most appropriate for this portion of the overall project.)

Some favourable observations:

13% of the respondents mentioned that it had been a self-reflecting exercise, as well as a challenging one.

10% said it was a good tool to obtain feedback and experts' insight, while a further 10% added that it was a good knowledge sharing tool.

6% mentioned that it was a good method to explore consensus.

Comments critical of the Delphi method:

An equal 6% argued that the emphasis on consensus was too great.

All other critiques were voiced by one respondent each. They noted that the process was too centrally driven, closed-ended questions would have been better, the process was time-consuming, and the method is inappropriate for use in an academic setting.

Three comments in particular are worth highlighting, as they reflect our perspective:

"It is a centrally-driven methodology. I find it a bit old-fashioned. In the age of the internet some more distributed and decentralized methodologies should be devised, that allow for sideways transactions and communications. Central guidance and unilateral interpretation of answers by the part of the researchers heavily influence the results. Think about what could have come out from an ongoing all-to-all internet-based conversation? You should have given us just the protocols and a web forum and we, "the experts", would have engaged in ongoing multiple conversations, a process similar to open source software development. I bet you would have obtained different results. Delphi is a very limited way of organizing a knowledge process."

"I think a good addition to the methodology (although with this crowd it may get wild) is to facilitate a chatroom discussion. When "experts" bounce off of each other, much more happens than when they simply respond to questions."

"It is still one of the best tools to explore the degree of consensus amongst a community of interest."

10.b) What are your comments about our application of the Delphi method?

First, thank you for all of your nice comments! *(We won't reproduce them here – that's too much like patting yourself on the back, but we appreciate the notes nonetheless!)*

The majority of respondents indicated that we used the Delphi approach in an appropriate situation and applied it well. Over 20% indicated they "enjoyed" it.

The most frequent neutral observation is that the process was different from what was expected.

Second, well, some of you didn't particularly appreciate some of the aspects of this study. We won't try to change your mind – that's not the point of this project – but we will summarise some of your criticisms, for the purpose of improving both our and others' use of this approach in the future.

Small numbers of respondents (one or two individuals) indicated frustration with the process, too much emphasis on consensus, too tight deadlines, that the topic was too broad, and that our tables were sometimes difficult to interpret (one person noted elsewhere that "if you color the mess, you get colourful mess").

As a closing observation:

"I enjoyed answering your questions. Being an academic, I am not easily swayed by majority or committee view (by the lowest common denominator). I have learned from the responses of others how to simplify and sharpen my own views – so I did change in the direction of sharper differentiation and distinction. I assume many others did the same. So, after the Delphi exercise, you should have more differentiation than consensus. That would be good. You want sharp, distinct views to choose from, not a consensual, tepid, quilted and colorful mess of nothing."

Thank you for your participation! This is the last feedback round of this Delphi. We hope you enjoyed participating, and we thank you very much for your thoughts and time.

We will alert you to project-related publications and working papers as they become available, and provide free access to those where we can legally do so (publisher copyright considerations). As a disclaimer, one article (in JKM) and one book chapter were already accepted prior to our conducting this Delphi project, but have not yet appeared; they reflect our thinking at that point (with apologies to those in the panel who might find our opinions critical of theirs in those papers!)

Obviously, the topics addressed here will continue to interest us – and hopefully you – well into the future. We look forward to working with you, perhaps indirectly through reading each others' work, perhaps directly in meetings at conferences or by email, perhaps even as collaborators or coauthors – particularly if our opinions are divergent, as challenges and disagreements are more likely to lead to change and advancement of our fields of mutual interest. We would be delighted to continue discussions with any participants on any aspects of this study – just email us at jb.faucher@gmail.com