Using autopoiesis theory to give knowledge management a theoretical foundation

Using Autopoiesis Theory to Give Knowledge Management a Theoretical Foundation

by

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CERTIFICATE OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this thesis, that the original work is my own except as specified in acknowledgments or in footnotes, and that neither the thesis nor the original work contained therein has been submitted to this or any other institution for a degree.

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Abstract

The purpose of this research was to give knowledge management a sound conceptual foundation; this was done in three stages. First, the current domain of autopoiesis and knowledge management was explored with a particular focus on reasons for the research and the different approaches used. There was general agreement that knowledge management does need a theoretical foundation and that, currently, knowledge management uses only certain aspects of autopoiesis along with very little empirical work.

The second phase of this research was to take an existing model, a model of organisational learning, from the literature and apply to it the principles from autopoiesis. This was done using a matching methodology: a two step process used to align the theories from two or more domains with the aim of creating a new lexis. The resulting autopoietic model of organisational learning was tested in two organisations: Prosidion and the Conservation Services Group. The third phase of this research was to create a model of knowledge that was true to an autopoietic epistemology for evaluation by a range of knowledge management experts from both academia and industry.

The main finding from this research was that autopoiesis has the potential to become the theoretical foundation for knowledge management, but further research is required to enhance the usability of the foundation. Principles from autopoiesis can be applied to existing models, with some measurable benefit, but that the true contribution from autopoiesis will be the development of the autopoietic model of knowledge into a tangible, more useable product.

This research makes several unique contributions to the field of knowledge management and autopoiesis. First, the creation of the autopoietic models of organisational learning and knowledge, and second, the development of test/evaluation instruments. Finally, the actual results and their analysis provide a new insight into the challenges of giving knowledge management a theoretical foundation.

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Chapter 1 Introduction

This chapter explores the background to knowledge management in organisations, outlining its relationship with organisational learning, and ultimately, examining how autopoiesis can be applied to knowledge management. The aim and objectives of this thesis are presented as well as an overview of the remaining chapters.

1.1 Background

The 21st century is a knowledge economy (Drucker, 2001, p. 4) and this has given rise to a new type of organisation: the knowledge intensive organisation. With knowledge being a core strategic resource in these organisations, a new approach was needed that could help manage this new resource effectively. Hence knowledge management was developed as the answer, and aimed to help employees effectively create, share and exploit knowledge to enhance the organisation's knowledge (Jashapara, 2004, p. 12). Whilst this can be taken as an introductory position, there are a number of complicating factors coming from different academic paradigms, such as strategic management, business process re-engineering, philosophy, information management and economics.

Simply considering information management, numerous problems arise: for instance whether distinctions can be made between information and knowledge, or even data. Considering also the rise in importance that computing has made in the workplace, data management very quickly led to a perceived jump to information management, and now onto knowledge management. However, questions immediately arise as to whether knowledge can be effectively managed by computers, or IT systems, because of the inherent 'data processing' paradigm used in the computing world. The intangible nature of knowledge is perhaps not so suitable for direct processing by computers. The popular data-information-knowledge hierarchy (Ackoff, 1989, p. 28) also adds to the confusion about knowledge management, because

it implies knowledge can be managed using the same paradigms used for data and information management. This is where the actual nature of knowledge becomes important because, unless it is known what is being managed, it is hard to design a system to manage it.

The current epistemological debate about the nature of knowledge can be traced back to when Plato first defined knowledge as perception, true judgement and true judgement with account (Jashapara, 2004, p. 35). Following from Plato, the historical journey defining knowledge travels though the works of Aristotle, Descartes, Kant, Husserl, Heidegger, and Wittgenstein, to name a few (Magee, 2000, p. 14). More contemporary definitions followed (Jashapara, 2004, p. 40) from the likes of Ryle (1969, p. 25) and Polanyi (1966, p.4), who made the distinction between tacit and explicit knowledge, or 'knowing how' and 'knowing that'. The recognition that knowledge is no longer just an entity, but perhaps a process as well, meant that the focus started to shift onto the act of knowing. Knowing as a process was subsequently explored in the domain of taking effective action, and hence the link between action and knowledge is further emphasised (Orlikowski, 2002, p. 251). However, moving beyond definitions of knowledge, it is important to remember one of the reasons behind knowledge management: becoming a more efficient organisation. Organisational efficiency immediately brings business/management theory into the domain of knowledge management. To an extent, this perspective places monetary value on knowledge management activities, with the organisation seeking to increase profits, or more cost efficiency, for not-for-profit organisations.

The link between knowledge management and organisational learning is vague, and also complicates the apparent aim of knowledge management. It is generally agreed that organisational learning came into existence before knowledge management, with research as early as 1975 (March and Olsen, p. 150) linking individual learning to organisational learning. Organisational

learning attempts to help organisations gain new knowledge and adapt to its environment through the collective learning of its employees (Blackman et al., 2004, p. 11). An issue arises when trying to resolve the positions of organisational learning and knowledge management because there is a considerable degree of overlap in the area of knowledge generation and adapting to a changing business environment. Despite organisational learning being developed before knowledge management, for the purposes of this research, the position will be taken whereby organisational learning is part of KM, because then organisational learning can be treated as an approach to knowledge management. The advantage of this approach is that organisational learning can become embedded into knowledge management, which will eventually allow it to become complementary to knowledge management, as opposed to competing.

As these examples show, knowledge management is a multidisciplinary subject, but also suffers for the same reason. For a subject with at least ten underlying disciplines (Jashapara, 2004, p. 10), the fundamental issues such as defining knowledge or the role of information technology in knowledge management (Metaxiotis et al., 2005, p. 11) could never be resolved. The different disciplines will always keep their perspective, which may be fine in an academic environment, but for organisations in the real world, this is not an option. What is needed is a way to giving knowledge management a new foundation that is capable of encompassing all the underlying disciplines and perspectives, while at the same time not becoming just another perspective on knowledge management. The use of systems theory has been suggested (Johanessen et al., 1999, p. 24; Scholl et al., 2004, p. 25), arguing it has the potential to combine the different perspectives that underlie knowledge management. The notion that systems theory could be applied to knowledge management is clearly very attractive, and in line with integrating knowledge management to business processes, systems theory also has the potential to act as a way of existing for organisations (Johanessen et al., 1999, p. 25), in other words, they follow the rules of systems theory. As identified by Scholl et al.

(1999, p. 25) autopoiesis is a systems theory that could be applied to KM to give it the new foundation needed.

Numerous authors have begun applying autopoiesis to knowledge management (Maula, 2000, p. 158; Hall, 2005, p. 170; Limone and Bastias, 2006, p. 44), and it does appear that there are commonalities between the numerous knowledge management theories and autopoiesis. However, these studies have been very focused and narrow in scope, essentially going against the non-reductionist approach encouraged by systems theory. A new need can be identified, whereby autopoiesis is applied to knowledge management in a comprehensive manner, instead of attempting to just apply one or two of the notions from autopoiesis.

1.2 An Introduction to Autopoiesis

Autopoiesis was developed by Maturana and Varela (1980, p. 78) to define beyond the diversity of all living systems a common denominator (Luisi, 2003, p. 49). In other words, autopoiesis attempts to explain what makes something 'living', such that it can be distinguished from something that is not living. Previous answers to this question have included using systems theory, but the weakness was that systems related notions such as feedback and homeostasis could easily be built into a simple machine that could never be considered living (Mingers 1995, p. 9). The next paradigm described living systems by enumerating characteristics such as reproduction, growth, respiration and movement. However, the counter argument is that if a machine could reproduce itself, or carry out any of the other characteristics of the living, it should be living (Maturana and Varela 1998, p. 42). The problem in describing what makes something living is now apparent: we inherently know what makes something living, but are unable to create a suitable definition.

Autopoiesis was developed as an alternative approach to describing what makes something living, and is based on four notions (Mingers 1995, p. 10). The first notion states that the cell is the prime example of a living system and that everything can be described with reference to it. Second, autopoiesis assumes that living systems operate in a mechanistic way. In other words, living systems are made up of components, from which the systems' overall behaviour is derived. The third notion is the awareness that all explanations are made by observers. This is important because it recognises the role the observer has in the system being observed. In other words, a system cannot be observed independently, the act of observing changes that which is being observed. Finally, any explanations should be non teleological. This means that an explanation of what makes something living should not refer to the entity's function or purpose, since function and purpose are concepts introduced by observers (Mingers 1995, p. 10).

Before looking at the definition of autopoiesis it is first necessary to consider what produces a cell, and what does a cell produce. The answer to both questions is the same: a cell produces itself. With this insight, it is possible to define living systems as being organised in such a way that all of the components and processes together produce those same components and processes to create a self-producing/autonomous entity. It is subsequently possible to define an autopoietic machine as:

'a machine organized (defined as a unity) as a network of processes of production (transformation and destruction) of components that produces the components which: (i) through their interactions and transformations continuously regenerate and realize the network of processes (relations) that produced them; and (ii) constitute it (the machine) as a concrete unity in the space in which they (the components) exist by specifying the topological domain of its realization as such a network.' (Maturana and Varela 1980, p. 78)

This definition highlights the importance of the network of processes (or relationship between the components) as the key notion in autopoiesis. It is the relationship between components (or organisation) that allows the machine to be living, not the actual components (the structure). It would then make sense to infer that autopoiesis is the act of maintaining constant a living system's organisation.

1.3 Research Aim and Objectives

The aim of this thesis is to investigate, if and how creating an autopoietic foundation for knowledge management could improve knowledge management within organisations.

The research aim will be achieved by undertaking the following objectives:

1. To review critically the current literature to understand the extent of research on autopoiesis and knowledge management.
2. To evaluate if organisations can be autopoietic.
3. To investigate whether autopoiesis, or its principles, can be applied to an existing model of organisational learning.
4. To establish if the autopoietic model of organisational learning is reflected in an organisational setting.
5. To develop a new model of knowledge using the epistemological insights from autopoiesis.
6. To evaluate whether the new model of knowledge is an accurate representation of knowledge in organisations.
7. To determine if guidelines on how to apply principles from autopoiesis to existing knowledge management models can be developed.

The first objective is essential to determine what position the current literature takes, along with how effectively autopoiesis has already been applied to knowledge management, and also examining any shortfalls. Meeting this objective also requires an overview of knowledge management, organisational

learning and autopoiesis, as well as providing a critique of these areas. The second objective is important since it is the first step in applying autopoiesis comprehensively to knowledge management. It needs to be determined how successfully autopoiesis can be applied to organisations because, if possible, autopoiesis could provide the framework for integrating knowledge management into everyday process in the organisation.

The third, and fourth objectives break down the task of applying autopoiesis to organisational learning and testing whether any improvements have arisen. Objective three undoubtedly requires the most creativity in experimenting with the different concepts, looking for commonalities between autopoiesis and organisational learning or knowledge management, whilst ensuring the process is methodologically rigorous. Objective four assesses the best way of testing the model used, whilst objective five looks to assess the changes made specifically by autopoiesis on employees.

Objective five uses the remaining, cognition related, aspects of autopoiesis to develop a new model of knowledge. In line with objective one, objective six ensures as much as possible of autopoiesis is used and applied to knowledge management. Objective six moves on to test the new model of autopoietic knowledge to determine whether it is truly representative of the nature of knowledge.

It is prudent at this point to make clear the relationship between objectives three and five, and the relationship between organisational learning and knowledge. This research initially set out to apply autopoietic principles of models of knowledge management and organisational learning, where organisational learning is taken as a discipline in its own right, but falls under the larger umbrella of knowledge management. Indeed, it is accepted that organisational learning grew from individual learning theories and that

organisational learning has been in existence for much longer than the concept of knowledge management. Considering the shift in focus of this research from applying autopoietic principles to existing models to creating a model of knowledge, having created and tested the autopoietic model of organisational learning it became apparent that this was not the way forward. The issue that arose was only the autopoietic principles that were relevant to the model were utilised and in other places autopoiesis theory lacked the breadth to make other changes. This prompted a shift to creating an autopoietic model of knowledge because the autopoietic epistemology, by its very nature, contained all the fundamental autopoietic principles. This was, however, a necessary path because it is not without the first stage, that the creation of the model of knowledge could have occurred, a fact reinforced by the lack of autopoietic and knowledge management literature (Chapter 2).

The final objective aims to turn the findings from this research into a set of guidelines for converting any future models of knowledge management into autopoietic models. This will help organisations wishing to utilise the scientific approach autopoiesis brings to knowledge management because it will enable them to gain the benefits without having to go through the complete process of interpreting autopoiesis, creating and comparing commonalities, through to creating the final model.

1.4 Research Environment

Testing the autopoietic model of organisational learning was carried out in two organisations. The organisations were carefully selected to ensure they are knowledge intensive organisations that use knowledge as the key asset driving success. The two organisations are:

Conservation Services Group (CSG) – founded in 1984 to help consumers and businesses lower energy usage whilst increasing comfort, health and safety,

and whilst protecting the environment. CSG is a not for profit organisation, with approximately 250 employees. Headquartered in Westborough, Massachusetts, USA, CSG also has offices in California, Florida, Iowa, Kansas, New Jersey, New York and Oregon, USA.

(OSI) Prosidion – a wholly owned subsidiary of OSI Pharmaceuticals Inc. (Headquartered in New York USA), dedicated to the development of safer and more effective therapies for the treatment of obesity and Type II diabetes. Prosidion is situated in Oxford, UK, with approximately 100 employees. Most of Prosidion's financing comes from either licensing patents or investment from OSI Pharmaceuticals who recently invested US$85 million.

The experts selected for the expert evaluation of the autopoietic model of knowledge came from both academia and industry, all with five or more years experience in knowledge management, and from a range of positions and age ranges.

1.5 Thesis Layout

This thesis contains eight chapters, of which the first has just provided an introduction to the research domain, the definition, and explanation, of the aim and objectives and an overview of the organisations and knowledge management experts that took part in this research. Chapter two is the literature review, which explores and critically reviews the current literature in the area of autopoiesis and knowledge management, ending with the confirmation that the research objectives had not been met by the current literature.

Chapter three focuses on the research methodology and discusses the research philosophies, approaches and strategies relevant to this research. Chapter four

details the process of creating the autopoietic models, starting with a creating a taxonomy, identifying the gap, through to covering the matching methodology and finally developing the two models.

Chapters five and six present and analyse the results from testing and evaluating the models of organisational learning and knowledge, along with identifying and discussing significant findings. Chapter seven discusses the findings in the context of the current literature, identifying implications of key results in themes from the literature as well as discussing complementary and contradictory findings. Chapter eight concludes this thesis by presenting an overview of the research, discussing its limitations and identifying opportunities for further research. An overview of the research process is shown in Figure 1.1. The orange boxes show the flow of processes that occurred, and the blue boxes represent the different chapters that resulted, and how they fit with the flow of work.

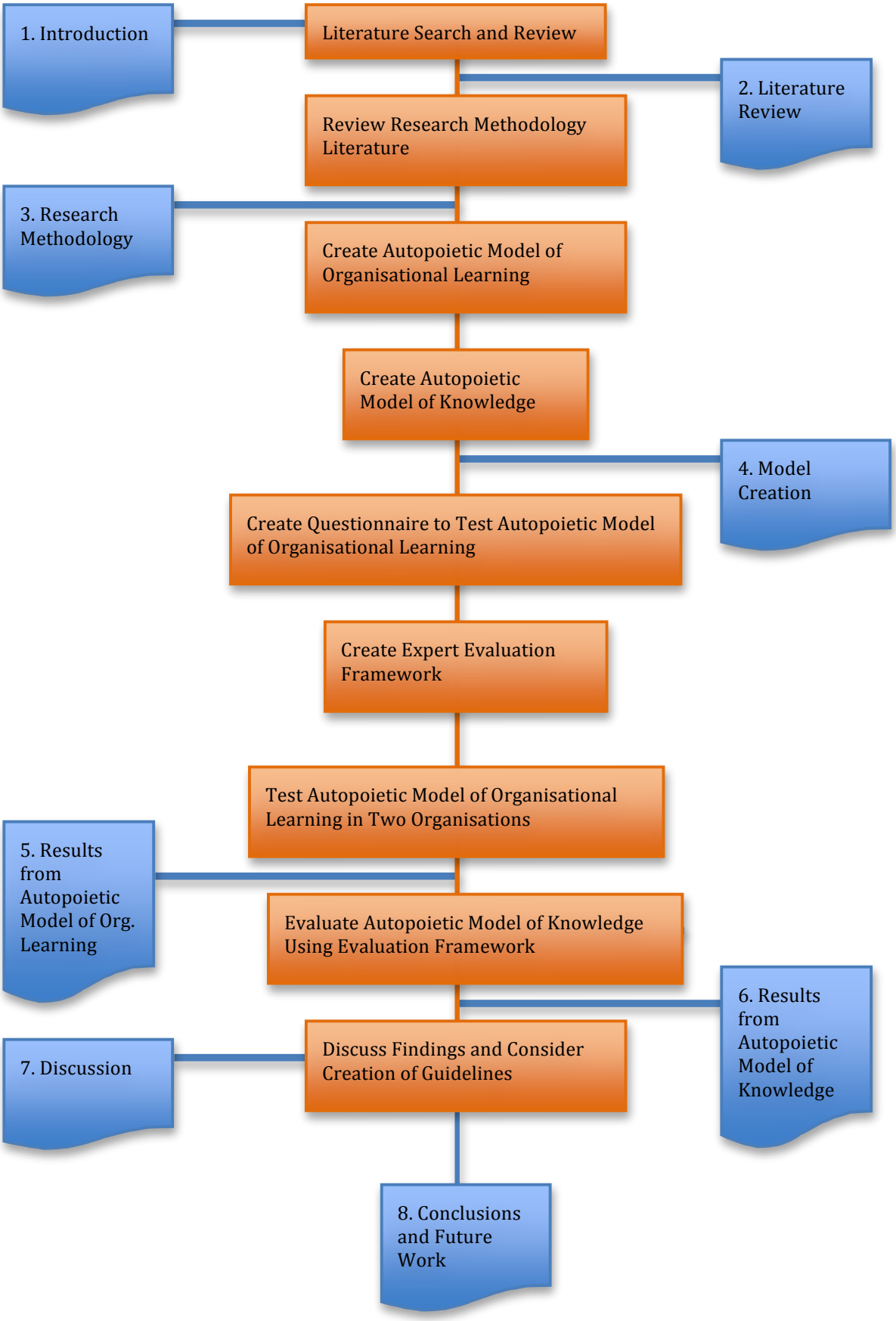

Figure 1.1 Overview of Research Process

Chapter 2 Literature Review

This chapter analyses the literature to evaluate the current position regarding autopoiesis and knowledge management research, and to determine whether organisations can be considered autopoietic (Objectives 1 and 2). The chapter starts by exploring the rise in interest surrounding autopoiesis and its application to knowledge management before considering the detailed case studies that have been recorded. A paper summarising the current literature, identifying opportunities for research and the need for a new foundation for knowledge management was published in IRMA conference proceedings (Parboteeah and Jackson, 2007a). Also, a paper assessing in more detail the implications of knowledge management in a living organisation was published in EST conference proceedings (Parboteeah and Jackson, 2007b).

2.1 Introduction

Maturana and Varela developed autopoiesis in the 1960s as a way of identifying what makes something living. Their aim was to prove scientifically what feature was common among all living systems, from single celled amoeba to multi-cellular people. They successfully showed that a system's organisation was key to its autopoietic nature and that any attempt to change the autopoietic organisation of a system would cause its death. However, when autopoiesis started being applied to apparently non living systems such as organisations, social systems and even knowledge management, one point of contention arose: can autopoiesis be applied to things which are not living? This was a key issue in the autopoiesis community because autopoiesis was developed to explain what makes something living, and now it was being applied to non-living systems. At this point research split into two distinct categories: one which believed autopoiesis could only exist in the molecular domain, as supported by Maturana, and the second which believed that autopoiesis could exist in other physical domains, as supported by Varela.

This review starts with an analysis of the current state of the field of autopoiesis and knowledge management, before introducing autopoiesis, and

moving onto whether or not autopoiesis can only exist in the molecular domain. It then considers how and why autopoiesis has started being applied to knowledge management before considering how the two perspectives have affected research in knowledge management.

2.2 The Emergence of Autopoiesis in Knowledge Management Research

A recent international Delphi study by Scholl et al. (2004, p. 25) found that knowledge management experts regarded autopoiesis as one of the most important theoretical advancements in knowledge management. Organisational learning and theories regarding implicit knowledge also featured highly in the study. The unique feature of a Delphi study is that experts in the field of study participate in several rounds of survey, each round refining findings from the previous one. The principle behind the Delphi method for research is that participants should converge on one or two answers, principles or viewpoints. Since the aim of Delphi studies is to obtain consensus around a particular issue, divergent viewpoints tend to fall to the side, however it is for the researcher to consider their implications in any final results. The Delphi study conducted by Scholl et al. (2004, p. 19) aimed to solicit views on the future of knowledge management. The questionnaire asked six questions concerned with challenges, issues, theoretical advancements and practical approaches within knowledge management theory. The main findings suggest that human factors are increasing in importance, perhaps emphasising a sociological perspective in knowledge management. Interestingly, IT based knowledge management ranked low in the survey, indicating the failures of first generation knowledge management (Metaxiotis et al., 2005, p. 7). The integration of knowledge management activities into organisational processes also emerged as a key issue. Respondents felt that knowledge management is an activity that must be carried out by everyone in an organisation, not just a knowledge management department. Perhaps one of the most interesting findings is the respondents' belief that an interdisciplinary approach is the best way to solve the problems within knowledge management since 'knowledge

management approaches have to integrate different perspectives' (Scholl et al., 2004, p. 24).

The main recommendations from the Delphi study (Scholl et al, 2004, p. 19) indicate that the priority in knowledge management must be on people, with IT as an enabler. It also recommends the integration of knowledge management within the whole organisation. Whilst the survey did identify autopoiesis as an important advance, at first glance it appears autopoiesis can resolve many of the issues identified by the Delphi study (Scholl et al, 2004, p. 19). For instance, one finding was the need to integrate knowledge management into the whole organisation. If an autopoietic view of the organisation is taken, then the potential exists for all organisational processes to be integrated into that framework. The application of autopoiesis to knowledge management can be considered within the interdisciplinary approach that the study identified as crucial for the success of future knowledge management initiatives. Further rounds of questionnaire, focusing on why autopoiesis has the potential to help knowledge management, could have improved the survey. These further rounds could have explored in more detail what a systems based approach to knowledge management would entail as well exploring any larger organisational issues, such as culture.

The Delphi study is reinforced by earlier research by Ishikawa (1999, p. 821) who proposed that apoptosis, as well as autopoiesis, should be applied to knowledge management. Apoptosis is a series of biochemical events leading to the programmed death of a cell. It can also be referred to as cell suicide. Ishikawa (1999, p. 825) proposed that autopoiesis is not always the best approach, especially in research and development settings. He suggests that knowledge is susceptible to noise and insecurity, and that an autopoietic approach could have detrimental effects for the organisation. Whilst autopoiesis and apoptosis appear contradictory, the two theories are in fact complementary; it is just unfortunate this is not mentioned in the research

(Ishikawa, 1999, p. 825). The apoptic nature of the cell would in fact be one of the processes within the autopoietic network of the cell. Apoptosis would then be employed when the cell could no longer exist in an autopoietic nature. Whilst Ishikawa (1999, p. 825) does present some interesting ideas, the general consensus within the rest of the literature does not support an apoptic view of knowledge management, mainly because it is believed that knowledge can never be useless to the degree that it must be destroyed.

Research by Johanessen et al. (1999, p. 24) also supports the Delphi study and outlines the key arguments for using systems theory, of which autopoiesis is a part, as a foundation for knowledge management. They identify the starting point for their investigation as the philosophic shift in management style that occurred in the 1990s: the rise of the knowledge organisation. The knowledge organisation moved away from a mechanistic view of working, and towards a systems based view. Johanessen et al. (1999, p. 26) articulate three elements key to this change of paradigm: the importance of internal motivation, an emphasis on relations and widespread idea generation in the organisation. Although not outlined in their research, these three elements could map onto different aspects of autopoiesis. Internal motivation is akin to a cell's identity, and the maintenance of its identity. The emphasis on relations within an organisation correlates with the notion of characterising cells by their organisation (the network of processes that realise the cell as an entity). Finally, idea generation from everyone in the organisation is similar to everything in a cell subordinating themselves in favour of the cell's autopoietic nature.

Johanessen et al. (1999, p. 36) also state that the structure of the organisation affects organisational changes and how they might be implemented. The concept of structure, referred to by Johanessen et al. (1999, p. 36), would be termed 'organisation' in autopoiesis literature. Additionally, they identify three characteristics of an organisation that are directly comparable, and indeed

represent, an autopoietic cell organisation. They conclude by considering how systems theory can be applied to organisational design and development, and this is where they appear to disagree with autopoiesis theory because autopoiesis suggests systems can only ever evolve and can never be designed.

Johanessen et al. (1999, p. 24) provide a suitable explanation for why autopoiesis, or systems theory, can be applied to organisations. However, it is rather retrospective in its approach, stating how the conditions suit autopoiesis. A better approach would be to show how organisations and society have developed, such that they can be better explained by autopoiesis. Gregory (2006, p. 962) proposes that the industrial revolution has led to sub systems within society and organisations becoming self-serving, or pathologically autopoietic. Gregory (2006, p. 968) also proposes that society is headed for another revolution, which will lead to the reintegration of economic activities with social and political activities. Such a view seems to suggest applying autopoiesis to knowledge management; organisations, or even society, are preparing, and even encouraging such a revolution.

The foundation does appear to be set for applying autopoiesis to knowledge management. Numerous authors (Gregory, 2006; Johanesssen et al., 1999, p. 24 and Scholl et al, 2004, p. 9), provide multiple reasons and benefits that can arise from this new theoretical insight, along with the support of the experts in the Delphi study (Scholl et al., 2004, p. 19). Next, an introduction to autopoiesis will be provided, before moving onto current applications of autopoiesis to knowledge management.

2.3 Autopoiesis

Autopoiesis was developed to define 'beyond the diversity of all living organisms, a common denominator that allows for the discrimination of the

living from the non-living' (Luis, 2003, p. 49). A system that is autopoietic in nature can be defined as:

'*a machine organized (defined as a unity) as a network of processes of production (transformation and destruction) of components that produces the components which: (i) through their interactions and transformations continuously regenerate and realize the network of processes (relations) that produced them; and (ii) constitute it (the machine) as a concrete unity in the space in which they (the components) exist by specifying the topological domain of its realization as such a network.'* (Maturana and Varela 1980, p. 78)

Hence living systems are characterised by their autopoietic organisation, and all processes within a living system go towards maintaining that organisation. This definition also proposes the notion that living systems produce nothing other than themselves. The implication of such a viewpoint is that an autopoietic entity can bring itself into existence and cease to exist by itself.

However, autopoiesis is also based on one assumption: that the cell is the prime example of life (Mingers, 1995, p. 10). Autopoiesis also ignores the idea that DNA is the main component in living systems. This is a controversial point since it ignores current scientific research. Arguments that support autopoiesis tend to involve the idea that the observer is an important part of living systems and that living systems cannot be characterised by their properties, including the presence of DNA. However, a DNA based view of living systems aims for objectivity and the independence of living systems from all external entities. It can also be claimed that autopoiesis is not as scientifically rigorous since it is based on this assumption. With two such extreme positions, knowledge management research tends to associate with one view or the other.

Attempts have been made to resolve the two positions, for instance, it is possible to say that 'autopoiesis is primarily concerned with the internal logic (the general "bio-logical" aspects) of minimal life … nucleic acids are only seen as agents that participate in the cell's self-production' (Luisi, 2003, p. 53). However, this attempt to resolve the positions highlights the problem that autopoiesis is seen as a property of the living system. Viewing autopoiesis as something the living system possesses is not correct. It is a way of existing, or something the living system is: autopoietic. With such different and incompatible views, it is not surprising that autopoiesis was marginalised and DNA theory flourished. This research will be adopting the stance that autopoiesis is a valid definition of life, that can also be applied to different domains of study.

Autopoiesis also needs to introduce two concepts to support its theory of living systems: organisation and structure. Organisation is defined as the 'relations that must exist among the components of a system for it to be a member of a specific class' (Maturana and Varela 1998, p. 47). In other words, the concept of organisation is concerned with identifying the common feature among a certain class. Structure, on the other hand, is defined as 'the components and relations that actually constitute a particular unity and makes its organisation real' (Maturana and Varela, 1998, p. 47). Structure is more concerned with implementation and realisation of a system's organisation. In the case of living systems, they all have the same organisation (that which makes them living), but they have different structures, hence allowing for variety.

Previous to the development of autopoiesis, the common method of identifying living systems was to enumerate their characteristics, and then use it as a checklist. However the problem with this approach is it assumes that which is in need of explanation: a distinction between the living and the non-living (Mingers, 2006, p. 33). Autopoiesis, on the other hand, defines the class to which all living systems belong, and hence identifies what it means to be living.

The implications of being autopoietic: autonomy, individuality, organisational closure and self-specification of boundaries (Maturana and Varela 1980, p. 80) could just as easily have been the characteristics describing living systems. However, with the understanding that these four characteristics are derived from autopoiesis, it is much more rigorous than the previous method.

2.4 Autopoiesis and the Molecular, Conceptual and Physical Domains

Autopoiesis was developed in the context of a cell and, whilst remaining in that context, autopoiesis is the perfect solution for describing life and what it means to be living. However, moving away from the molecular domain raises the question: can autopoiesis exist outside the molecular domain? It is an issue on which Maturana and Varela, the creators of autopoiesis cannot even agree. Romesin (2002, p. 8) believes that autopoiesis can only ever exist at the cellular level because only the molecular domain can provide the right conditions for the spontaneous creation and destruction of autopoietic entities. Varela, on the other hand, appears to believe that autopoiesis can exist outside of the molecular domain, and that other systems, physical or conceptual, can display autopoietic characteristics. Varela even supported McMullin (2004, p. 4) in developing a computer model of autopoiesis. However, Maturana did support the original model of autopoiesis, developed in Fortran (Varela et al., 1974, p. 187). A formal theoretical model was also developed by Zeleny (1977, p. 15), based on Varela et al.'s (1974, p. 187), but also purely in the conceptual domain. Perhaps over time, Maturana came to realise that applying autopoiesis to non-living entities would require those entities to be classified as living, even if they were not living.

The foundation for this debate can be traced back to 1974, when Varela et al. (p. 187) produced a six-point checklist to test whether something is autopoietic, and a computer simulation of autopoiesis. The FORTRAN program developed was set in a chemical scenario with a collection of substrates reacting with a substrate. Once developed, it raised several questions, such as

whether autopoiesis can exist in a chemical domain, whether autopoiesis can be modelled and whether autopoiesis can be applied outside of the molecular domain. The answers to all of these questions depend on which situation in Figure 2.1 (Adapted from Mingers, 1995, p. 44) is deemed correct. Situation 1 proposes that autopoiesis can be applied to any domain: physical, computer based, or abstract, and that such systems are therefore living. It would appear essential that autopoiesis directly correlates with living; since it is the reason autopoiesis was developed. However, it also assumes that apparently non-living systems can be autopoietic, such as the computer model developed by Varela et al. (1974, p. 187). Situation 2, on the other hand, assumes that only physical systems can be living, but that autopoiesis can still be applied to non-living systems. It would also appear a weakness in autopoiesis, since autopoiesis explains the phenomenon that makes something living, if autopoiesis can explain non-living systems too (Mingers, 1995, p. 44). The last situation is the most restrictive, and suggests that all autopoietic systems are living and that autopoietic systems can only exist in the physical domain. Whilst appearing most promising, Situation 3 also has flaws because it implies that all physical systems have the potential to be autopoietic.

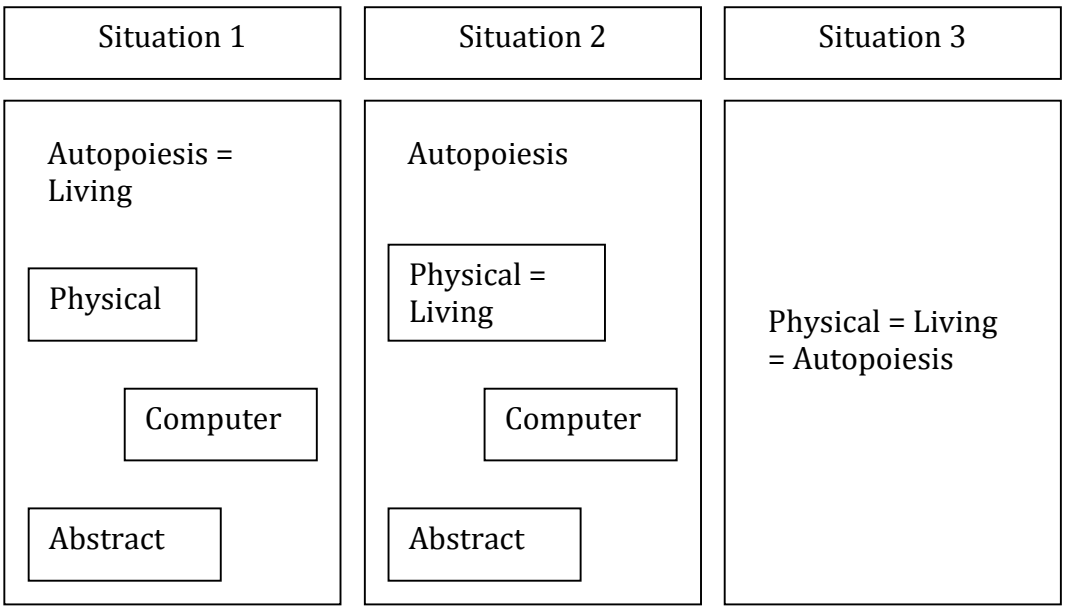

Figure 2.1 Different Domains of Autopoiesis

Developments by Maturana (2002, p. 11) propose that autopoietic systems can only exist in molecular space, since it is the only domain capable of supporting the dynamic environment needed for the spontaneous creation and destruction of autopoietic entities. This clearly appears to be the most desirable situation, and can be represented as shown in Figure 2.2. Despite the situation shown in Figure 2.2 being more restrictive than Situation 3 in Figure 2.1, it is a more accurate representation of autopoiesis and the domains it can exist in. However, numerous authors (for example, Ishikawa, 1999, p. 824; Maula, 2000, p. 157 and Thannhuber et al., 2001, p. 314) appear to claim that autopoiesis can exist outside the molecular domain, through their application of autopoiesis to organisations. Applying autopoiesis directly to organisations implies that organisations themselves are living, as opposed to being comprised of living systems. Implying that organisations are autopoietic creates numerous problems; such as do cells keep their autopoietic nature? And what criteria are used to confirm that the organisation is autopoietic? Firstly, when considering an autopoietic entity, everything internal to that entity becomes subservient to that entity's autopoietic nature. In other words, it could be suggested that the cells, which comprise the people within the organisation, would lose their autopoietic nature in favour of the organisation's autopoietic nature. Robb (1989, p. 348) warns that the development of autopoietic organisations will be an ill-gotten gain since it will result in 'the subordination of all human aspirations and ambitions, values and welfare to the service of preserving the unity of such systems and not to any human end. Once formed, such organisations appear to be beyond human control'.

This apparently stark warning goes back to the key idea in autopoiesis, that autopoietic entities are self controlled and cannot be directly manipulated to external agents. In other words, autopoietic entities can only have change triggered within them; a third party cannot predetermine the change. Autopoiesis has also been applied to organisations in a metaphorical sense (Kay, 2001, p. 472). However, the problem with this approach is that it only

allows for a top-level comparison, and useful insights from a detailed analysis of autopoiesis and organisations may be missed.

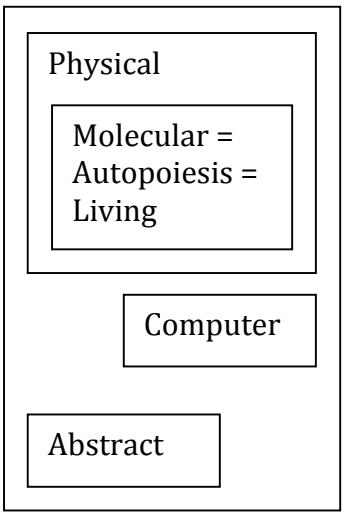

Figure 2.2 Autopoiesis in the Molecular Domain

2.5 Second and Third Order Autopoietic Entities

Using the notion of structural coupling, ideas from autopoiesis can be applied to people and organisations. When an autopoietic entity exists, it is free to interact with its environment, and can experience 'structural drift' (Kay and Cecez-Kecmanovic, 2002, p. 385), since its structure is not fixed in the same way its organisation is fixed. When interactions between two or more autopoietic entities become recurrent, the entities become structurally coupled (Maturana and Varela, 1998, p. 75). However, just because something was comprised of autopoietic entities, did not make it a second order autopoietic entity (Mingers, 1995, p. 42). The multi-cellular entity had to be autopoietic in its own right. In 1980 Maturana and Varela retreated and suggested that multi-cellular entities could become second order entities, so long as the cells lost their autopoietic nature. This obviously created an untenable situation since cells, which were once vital to life, had been stripped of their living nature, in favour of the second order autopoietic entity. Finally, Maturana and Varela

(1998, p. 87) settled on a view that states that cells are first order autopoietic entities, and that entities created from collections of cells, or meta-cellulars, are second order autopoietic entities. With this viewpoint in mind it becomes obvious that organisations can never be first order autopoietic entities.

However, Maturana and Varela (1998, p. 181) also introduced the concept of third order autopoiesis to describe the emergence of social phenomena. Third order structural coupling occurs when two or more second order autopoietic entities have a history of recurrent interactions. However, structural coupling between second order autopoietic entities is more complicated than between first order autopoietic entities. Second order entities typically have a nervous system, and it becomes possible for them to communicate with each other, going beyond mere perturbations. 'Language is an example of higher order coupling' (Kay and Cecez-Kecmanovic, 2002, p. 385), and can be described as a consensual domain. A consensual domain can be defined as 'a domain of arbitrary and contextual interlocking behaviours' (Mingers, 1995, p. 78). With such a view, it becomes possible to view organisations, or social systems in general, through the lens of autopoiesis (Kay, 2001, p. 472).

2.6 Autopoiesis, Cybernetics and Systems Theory

Autopoiesis is a systems approach to defining and explaining life and as such puts itself in the domain of systems theory. With the focus of autopoiesis clearly on the observer (Maturana and Varela, 1998, p. 27) it is also generally considered a second order cybernetic theory. The purpose of this section is to examine the relationship between autopoiesis, cybernetics and systems theory and outline why this research only takes forward autopoiesis in the application to knowledge management.

In order to explore the relationship, it is necessary to return back to the disciplines of Biology and Engineering. General Systems Theory was developed

by von Bertalanffy to describe the principles common among systems in general. Cybernetics, on the other hand, can be argued as having come from the discipline of engineering and is the study of feedback. The history of the development of cybernetics can be split into two parts: classical and new cybernetics. The difference between the two is the recognition of the importance of the observer (Espejo, 1993, p. 518) in new cybernetics, a realisation not present in classical cybernetics. It is at this point a shortcoming in autopoiesis is apparent: it is a poorly referenced theory attempting to be almost standalone in nature. Even a passing look at the key texts on autopoiesis (Maturana and Varela, 1980; Maturana and Varela, 1998) reveals very few references to other, undeniably relevant work.

A later publication on the early development of autopoiesis (Varela, 1996) subtly reveals that autopoiesis was developed in a Department of Biology, but with significant input from von Foerster (a cybernetician). Which then raises the question of whether autopoiesis or cybernetics should be applied to knowledge management in this research, especially considering Beer's work with Management Cybernetics (1959) and the Viable Systems Model (1984). Returning to the start of the literature review, it was found that experts had identified autopoiesis as showing potential to give knowledge management a theoretical foundation. Whilst systems theory in general had also been raised in the research (Scholl et al., 2004, p. 22), autopoiesis was the concept that matched an increase in interest from the knowledge management domain. Autopoiesis, coming from a biological background, also has greater epistemological insight than cybernetics, a feature necessary for any research trying to underpin knowledge management.

2.7 Autopoiesis and Knowledge Management

The literature exploring the application of autopoiesis to knowledge management covers several areas of interest. The concept of autopoietic knowledge is the starting point, before moving on to knowledge management

in autopoietic organisations. Literature also exists on designing and building autopoietic knowledge management systems. The autopoietic position that knowledge cannot be managed also encourages the application of autopoiesis to organisational learning.

2.7.1 Epistemology

Reviewing the history of knowledge, the death of Socrates and the writings of Plato is a good place to start, mainly because Plato was the first philosopher to start writing down his works (Magee, 2000, p. 14). Instead of defining knowledge, Socrates' aim was always to get a better understanding of the problem through continual questioning. Following this line of reasoning, it is possible to deduce the theorem that a person's knowledge can only increase, or change, through questioning. However, it is unclear whether continual questioning leads to an optimum 'level' of knowledge, or if knowledge can continue to grow infinitely. Despite the approach of using questions as a way to further a person's knowledge, after Socrates' death, Plato and others started trying to define knowledge.

Plato defines knowledge as having three components: perception, true judgement, and true judgement with an account (Jashapara, 2004, p. 35). This categorisation of knowledge is perhaps the first recognition that knowledge can take more than one form, and also opens up the possibility for transfer between the different types. Plato's three constructs of knowledge are also similar to the constructs used in the theory of justified true belief (Gettier, 1963, p. 121). Justified true belief makes three propositions:

1. p is true;

2. S believes that p is true; and

3. S has adequate justification for believing that p is true.

This suggests that to know something, something must be true, the knower must believe it to be true and the knower must have evidence for believing it to be true. This was a generally accepted definition of knowledge until The Gettier Problem arose. Gettier (1963, p. 122) proved that the definition of knowledge provided by the justified true belief theory was incorrect by counter example. Proof by counter example means that finding one situation where the definition does not work is enough to disprove a theory or definition. The counter examples provided proof that the three propositions 'do not state a sufficient condition for someone's knowing a given proposition' (Gettier, 1963, p. 123). Despite its failings, the justified true belief was the first attempt to create a working definition of knowledge.

The main philosopher to follow Plato was Aristotle, who distinguished between potentiality and actuality in the process of knowing (Dougall, 1999, p. 783). The potential for a person to know must exist before a person can actually admit any knowledge. The theory of actuality also suggests that possessing knowledge is only a first level actuality, and that using or applying knowledge occurs at a higher level of actuality (Dougall, 1999, p. 785). However, terms such as potentiality and actuality are still hard to apply and use when trying to define knowledge. Whilst the process of acquiring knowledge is important, it still does not define knowledge.

The next paradigm change occurred with the arrival of pragmatists, such as Dewey, who views knowledge as a survival mechanism (Jashapara, 2004, p. 38). Dewey also proposed that observers are an inseparable part of the world they are trying to master and understand (Magee, 2000, p. 293). This is perhaps the first realisation that people cannot observe an independent reality. Observation is uncontrollably influenced by past experience and other mental models. This theory also supports later ideas that knowledge has a personal, context specific part to it that may be hard to capture or record. Dewey also introduced the influential theory of learning by doing (Magee, 2000, p. 296).

This is a vital breakthrough since it is the first link between knowledge and action. Linking knowledge to action can help to understand how knowledge is created, modified or even destroyed. This could be the link that knowledge has with the outside world. However, as with most philosophers, Dewey does not appear to consider the implications of his theories for knowledge, especially with regards to organisations.

After pragmatism, knowledge theories were influenced by phenomenology, with the main authors being Husserl and Heidegger (Jashapara, 2004, p. 39). Phenomenology, despite being defined differently by each philosopher, can be generalised as saying the world has no meaning except consciousness and consciousness has no meaning except for the world. Alternatively, phenomenological philosophers take consciousness as their starting point and claim that everything that happens in the world is inextricably linked to each person's consciousness. Husserl, for instance, proposed that the mind was directed towards objects under aspects (Magee, 2000, p. 256). Here, Husserl is saying that nearly all mental activity, of which knowing is a part, is directed towards some object or concept which the person believes is present. The object or concept does not have to exist; the person only has to believe it does.

Wittgenstein, identified as the last historical philosopher (Jashapara, 2004, p. 39) to comment on knowledge, focused on how language represents reality and how sentences represent states of affairs. Wittgenstein's proposal was that sentences were somehow linked to reality, and that the structure of reality could be determined from the structure of language (Magee, 2000, p. 323). Following this line of reasoning, it could be argued that all knowledge is linked to language, and that by communicating using a language, you are accessing and using knowledge. Of course, the problem with this perspective is the issue of visual images, and babies, who do not communicate with language until later in life. Although an extreme perspective, perhaps visual imagery is another language, just not a verbal one. Subsequently, it would almost appear that

language is the only tool that can be used to access and manipulate knowledge. Wittgenstein's later work changed track and he thought language affects our view of reality, and not the other way around (Jashapara, 2004, p. 40). However, it would seem appropriate that instead of reality affecting language, or vice versa, that reality and language mutually changed each other, in a circular manner.

2.7.2 Modern Perspectives on Knowledge

The starting point for contemporary definitions of knowledge is the work of Polanyi (1966, p. 4), who proposed that 'we know more than we can tell'. Theory around tacit knowledge focuses heavily on Gestalt psychology, which demonstrates 'that we may know a physiognomy by integrating our awareness of its particulars without being able to identify these particulars' (Polanyi, 1966, p. 6). For instance, when considering a face, we may be able to judge aspects of that person's character, but not know how we are able to. Tacit knowledge is comprised of two terms (closely linked events, often focussed on the nervous system's perception of an external event), and 'we know the first term only by relying on our awareness of it for attending to the second' (Polanyi, 1966, p. 10). In certain circumstances, we focus our attention purely on the second term, leaving the first term, and its relationship to the second term, tacit. The main ideas from Polanyi (1966, p. 4) that have been carried forward are those of tacit and explicit knowledge. It is interesting to note that the more complex ideas about what tacit knowledge is have been left behind. Perhaps an awareness of the two terms of tacit knowing could aid theories looking at the transfer of tacit into explicit knowledge and vice versa.

Numerous authors have proposed that tacit, or implicit knowledge (Dienes and Perner, 1999, p. 735) and explicit knowledge are opposite ends of a continuum, insisting that all knowledge is partly tacit and partly explicit (Jasimuddin et al., 2005, p. 104). The benefit of such a view is it brings the realisation that even knowledge considered explicit is never totally explicit: there just exists a

shared set of beliefs, or a common understanding. This viewpoint also supports the notion that knowledge can 'slide along' the continuum. For example, knowledge can gain or lose some of its tacit nature, making it more explicit. Such a view has also helped prompt theories looking at the direct conversion of tacit knowledge into explicit knowledge and vice versa. The spiral of organisational knowledge creation (Nonaka, 1994, p. 20) looks specifically at the transformation between tacit and explicit knowledge, and how it develops through the organisation.

However, the concepts of tacit and explicit knowledge are still very abstract, and most organisations benefit from having a working definition of knowledge. Working definitions of knowledge typically involve experience and insights. This standpoint could define knowledge as:

'a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the mind of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms'. (Davenport and Prusak, 2000, p. 5)

This definition of knowledge captures the key ideas that knowledge is more than just data or information, and that experience is also important. It also outlines the possibility that knowledge can become embedded in organisational documents and routines. However, it remains unclear whether embedded knowledge is the same as stored knowledge, and if not, how they are different. An alternative view comes from the relationship between knowledge and information, which subsequently means that knowledge can be defined as:

information that changes something or somebody – either by becoming grounds for actions, or by making an individual (or an institution) capable of different or more effective action. (Drucker, 1988, p. 4)

This definition proposes that knowledge is constructed from information, which then allows an individual or organisation to take action. This definition is based on the popular 'knowledge hierarchy' (Anantatmula, 2005, p. 171). The knowledge hierarchy views information as linked and organised data, and knowledge as information that is linked and analysed with other information (Anantatmula, 2005, p. 172).

The process of knowing is perhaps more important than the abstract concept of what knowledge is (Assudani, 2005, p. 33). As identified by Orlikowski (2002, p. 251), a shift in perspective from knowledge to knowing has 'substantial conceptual implications'. Focusing on the process of knowing inherently makes action important. A focus on knowing also brings with it the concept of knowledgeable performance (Orlikowski, 2002, p. 253), further highlighting the importance of action. The focus on knowing, as opposed to knowledge, is heralded as the transition to the third generation of knowledge management (Metaxiotis, et al. 2005, p. 8). The first two generations were concerned with defining KM and exploring business benefits, and developing KM systems, tools and measurement systems, respectively.

2.7.3 An Autopoietic Perspective on Knowledge

Epistemological research in the field of autopoiesis typically takes one of two paths: one, assuming knowledge is autopoietic itself, and another suggesting knowledge is an emergent property of second order autopoietic systems. This difference can also be traced back to the debate concerning whether autopoiesis can exist outside the molecular domain. Authors proposing knowledge itself is autopoietic (Hall, 2005, p. 171) believe that autopoiesis can

be applied to conceptual and other physical domains and ultimately that knowledge is living. Authors proposing that knowledge is an emergent property (Abou-Zeid, 2007, p. 616) believe that knowledge is embodied in the knower, and subsequently cannot be separated from them. As identified by Limone and Bastias (2006, p. 39), any activity in the field of knowledge management should start from an autopoietic definition of knowledge because, since organisations are cognitive systems, any knowledge management effort should entail a cognitive aspect.

Hall (2005, p. 171) put forward the notion that knowledge must be biological in nature and any attempt to manage knowledge in organisations must start from this premise. Hall (2005, p. 177) suggested that knowledge exists in two forms within autopoietic systems: embodied knowledge and encoded knowledge. Embodied knowledge, also known as tacit knowledge is that which the autopoietic system would normally gain through its activities. Encoded knowledge, or 'control information' (Hall, 2005, p. 177), is knowledge encoded into the system's structure, such that it is used for that system's survival. Hall's concept of control information seems to bear a striking resemblance to that of DNA. This appears to be a reappearance of the idea put forward by Luisi (2003, p. 53) that autopoiesis provides the 'biologic', or the rules for operating in the domain, for the operation of the autopoietic entity.

An alternative view of autopoietic knowledge arises from the perspective that autopoiesis cannot exist outside of the molecular domain. This view proposes that knowledge is embodied in the knower, and cannot be stored, transferred or externally manipulated (Abou-Zeid, 2007, p. 616). Biggiero (2007, p. 4) also supports this view, stating: knowledge is always private, and that only information or data can be stored, transferred or manipulated. With this as an epistemological base, it appears difficult to see how knowledge can be managed. From this viewpoint it would appear all that can be done is try and support people learning and acquiring knowledge by themselves. With this in

mind, it is possible to create a knowledge management support system (kmss) (Abou-Zeid, 2007, p. 614). The design of a knowledge management support system should feature two parts: one for the actual system, and one for the procedures of designing the system, or 'meta-design'. Such an approach would ensure that the principles of autopoiesis were inherent in the design of the system.

A less explored aspect of autopoietic knowledge is the notion that knowing is a process intertwined with the process of living. Knowing can be defined as leading to 'effective action, that is, operating effectively in the domain of existence of living beings' (Maturana and Varela 1998, p. 29). The essence of this definition is that knowledge is the key to effective action, and that, perhaps through the process of living, and acting, knowledge may be admitted. An option that does not appear to have been explored in the literature is whether observation of, and participation in, effective action leads to the admittance of knowledge, whatever the form of knowledge may be. However, trying to follow this line of research could result in numerous problems, such as trying to define effective action, trying to evaluate whether any knowledge had been admitted, and trying to determine whether that knowledge was the correct knowledge. It would seem prudent to end with Biggiero's (2007, p. 8) statement that 'explicit knowledge is an oxymoron'. In other words, all knowledge is embodied within the knower, and subsequently, knowledge management systems trying to directly manage knowledge will fail. The position taken in this research will be akin to Abou-Zeid's (2007, p. 616) that knowledge cannot be stored, manipulated or transferred: it is embodied in the knower, along with Biggiero's (2007, p. 4) view that all knowledge is private and only data or information can be transferred.

2.7.4 Organisational Knowledge

When considering the concept of organisational knowledge, it is important to consider that whilst people exist in the physical domain, organisations can only

exist in the non-physical domain (Kay and Cecez-Kecmanovic, 2003, p. 4). This profound statement implies that organisations cannot have the same physical knowledge as people, if they are capable of knowing at all. Following autopoiesis theory, organisational knowledge could be deemed an emergent property of organisations, as observed by other systems (i.e. people). However, the autopoiesis and knowledge management literature does not venture on how organisational knowledge arises, or indeed what it is comprised of. Typical knowledge management literature tends to assume organisational knowledge resides in organisational documents, procedures and other formal/informal documents. However, following the autopoietic view of knowledge, it would appear such documents are merely data or information stores, with the 'real' knowledge being stored by the potential knower.

If it is assumed that organisations are second order autopoietic entities, then the knowing capability in people (truly second order autopoietic entities) can be compared to the knowing capability in organisations (the pseudo second order autopoietic entity). According to autopoiesis, people admit knowledge whenever they observe effective action. This can be interpreted as meaning that knowledge always exists in a context, and is inextricably linked to action. Knowledge of the knower can then only be displayed through effective action, which may or may not be observed by another potential knower. Applying this line of thought to organisations becomes difficult because it implies the organisation, as a whole, is capable of observing (which is not limited to seeing) actions. The organisation must then have the ability to store the knowledge it gains in a suitable structure, which may be comparable to the brain. By this stage, it becomes obvious that the concept of organisational knowledge is not a tenable position, and that only truly second order autopoietic entities can possess knowledge.

2.7.5 Knowledge Management in First Order Autopoietic Organisations

Regarding the organisation as a first order autopoietic entity, Maula (2000, p. 157) considers the organisation's senses and memory, and how they affect knowledge flows. It is proposed that integrated ideas about an autopoietic organisation's memory and senses can improve the organisation's ability to learn and adapt to its environment. However, Maula (2000, p. 158) considers organisations as first order autopoietic entities, on account that they are biological phenomena that constantly reproduce their own boundary and internal strategic components. Whilst organisations can be described as biological phenomena (being comprised of people, who are comprised of cells), it is contentious to argue that they can reproduce their own boundaries, when it is generally unclear what the boundaries of an organisation are. Whilst boundaries can be defined as 'a connecting and absorbing surface between the company and its environment' (Maula. 2000, p. 160), it remains a very abstract concept, one that would be very difficult to identify in real life. The concept of strategic components also remains an abstract concept.

With regards to knowledge management, Maula (2000, p. 161) proposes that the boundary elements of an organisation allow knowledge to flow to and from the organisation, but with a 'screening' process incurred. As a result, the organisation will become more aligned with its environment. Once knowledge has entered the organisation, the 'memory function', or strategic components, allows access to accumulated knowledge, which in turn maintains the organisation's effective operation. Returning to the analogy of the cell, the boundary elements correlate to the boundary of the cell whilst the strategic components of the organisation relate to the cells internal metabolism. Whilst Maula created and applied the model to case studies, it remains to be seen whether such a view of organisations and knowledge management can be maintained when organisations are viewed as third order autopoietic systems. Whilst it appears no research has been performed, it can be assumed that since third order autopoietic entities do not have a 'defined' boundary, or internal metabolism, the model would collapse. Perhaps a new model could look at

modelling the interaction between people as the 'internal metabolism' and the society within which the people exist as the boundary to the system.

2.7.6 Designing and Building Autopoietic Knowledge Management Systems

Following the notion that both knowledge and organisations can be autopoietic, the issue of designing and creating autopoietic knowledge management systems arises: a path followed by Abou-Zeid (2007, p. 614) and Thannhuber et al. (2001, p. 313). For instance, Thannhuber et al. (2001, p. 314) used autopoiesis as an underlying framework; hoping autopoiesis can resolve microscopic and macroscopic perspectives on knowledge. Abou-Zeid (2007, p. 616) suggested the use of autopoiesis as a kernel theory for designing knowledge management systems, whilst separating the design product and design process. Both approaches, whilst using different terminology, are in fact using autopoiesis as the theoretical foundation for knowledge management systems. However, Abou-Zeid (2007, p. 616) fails to indicate how the framework for designing autopoietic based knowledge management systems can be implemented. At the current stage of research, it would appear that all aspects of autopoiesis can be applied and that all aspects are relevant to the knowledge management system. However, as demonstrated by Thannhuber et al. (2001, p. 317), this is not the case.

The autopoietic framework by Thannhuber et al. (2001, p. 314), does not use all aspects of autopoiesis. Instead, key aspects, all of which are relevant to the system developed, are used. Concepts such as circularity and self-reproduction are used, whereas ideas such as the spontaneous emergence of autopoietic entities are not used. Whilst apparently not using autopoiesis in its true sense, or even using autopoiesis in the context of second/third order autopoiesis, the proposed model appears to work in its context. This could be because only aspects of autopoiesis that are needed are used, with the rest discarded. This resistance not to use all of autopoiesis just because it is possible, has benefited the model being developed. However, because only parts of autopoiesis have

been used, and other parts of the model do not obey autopoiesis, the final model (Thannhuber et al., 2001, p. 313) should not be called autopoietic, as has been done.

2.7.7 Organisational Learning

Organisational learning is a concept through which organisations aim to improve their performance through the coordinated learning of its members. Therefore, individual learning will play a role in organisational learning, but it is not sufficient alone. Organisational learning can be defined as:

'the product of organisational members' involvement in the interaction and sharing of experiences and knowledge. This shared form of knowledge is bigger than the simple added [sic] *of the individuals' learning capacities.'* (Curado, 2006, p. 26)

This definition clearly emphasises the importance of employees actively learning, as well as being free to explore by themselves. Curado (2006, p. 26) appears to emphasise delegation of tasks and responsibility by encouraging people to achieve the results they want to achieve. In this way, Curado (2006, p. 26) is keeping the emphasis of organisational learning firmly on individual learning.

From the literature, it would appear that organisational learning is comprised of three processes (Yeo, 2005, p. 377): individual learning, team/group learning and organisational learning. Individual learning focuses on activities that help the individual to learn, or solve problems on their own and is generally accepted as following the Lewinian experiential model (Kolb, 1984, p. 21). The Lewinian model of learning is a four-stage cycle, which places great importance on experience. The cycle starts with a concrete experience, which

gives an opportunity for observation and reflection. These observations and reflections are then formed into generalisations or theories, which, in the final stage, are tested in new situations (Kolb, 1984, p. 21). The emphasis of this cycle is that learning is a continual process based on a person's experience and testing of abstract concepts they develop as a response. Based on experience, it would appear Kolb's philosophy is the guiding ethos in statements such as 'learn by doing' and 'practice makes perfect'; showing that there has to be some element of practical experience involved in learning.

Team learning is when individuals 'solve problems by drawing on the strengths of other members in a team' (Yeo, 2005, p. 377). The third process, organisational learning, is somewhat different from the first two processes since the focus is on external resources. The main objective in organisational learning is to 'develop new principles, positions, aims, roles and identity in preparing the organisation for the dynamic changes of the external environment' (Yeo, 2005, p. 379). These three processes are important in organisational learning since they show, first, that organisational learning occurs when individuals learn, and second, that individuals are perhaps the most important feature in organisational learning. This means a direct link can be made from individual learning, through team learning, to organisational learning. The implication is that general learning theories become important.

The concept of single loop and double loop learning is also important in learning theories. Single loop learning proposes that in the context of problem solving, the individual only looks at 'strategies of action' (Argyris and Schön, 1996, p. 20), i.e. they look at changing the method of operation to achieve the desired result. With single loop learning, the focus is on creating the desired scenario without too much consideration for how it will happen. Double loop learning, is a lot more reflective than single loop learning, and is concerned with looking at what behaviour caused a certain outcome, and how to change that behaviour to obtain the desired outcome. The concept of triple loop

learning has also been developed which encourages people to learn about learning, generally through reflection. This is a valuable contribution since it should not be assumed that people know how to learn and maximise their learning potential.

Johnson-Laird's (1983, p. 3) ideas about mental models also play an important part in the theory of learning, since they provide an explanation for what learning tries to do or change. According to Nonaka and Takeuchi (1995, p. 60) mental models occur when 'human beings create working models of the world by making and manipulating analogies in their minds'. The idea of mental models also fits in with the Lewinian model. It could be argued that stage three (creating generalisations or theories) is directly modifying the individual's mental models. This would also link the Lewinian model of learning with constructivism.

One of the most common organisational learning models is March and Olsen's (1975, p. 150) 'Organisational Learning under Ambiguity' model. The model proposes that the impetus for all organisational action is a personal belief. This belief ultimately manifests itself in an individual taking action, which leads to an organisational response, usually some kind of action. The action by an organisation elicits a response from its environment, which then feedbacks into affecting the beliefs of the individual that triggered the action. Kim (1993, p. 44) has integrated these apparently different strands of organisational learning, and created a model which integrates Kolb's (1984, p. 21) experiential learning model, the theory of single and double loop learning, Johnson-Laird's (1983) theory about mental models and March and Olsen's (1975) 'Organisational Learning under Ambiguity' model.

2.7.8 Autopoietic Organisational Learning

Several researchers have been keen to apply autopoiesis to organisational learning (for example, Hall, 2005, p. 169; Maula, 2006, p. 1 and Jackson, 2007, p. 78). At first glance the attraction appears obvious. First, the task of defining knowledge is no longer an issue, since individual learning theories are the focus of organisational learning. Determining whether organisations are autopoietic or not, is also an issue that does not need to be covered. This is because a focus on individual knowledge leads to the possibility of organisational knowledge, which invariably leads to the issue of whether organisations are autopoietic. Of course, this issue has been considered closed by some (Romesin, 2002, p. 8) who claim that autopoiesis can only exist in the molecular domain, and that most other systems are second or third order autopoietic systems. This also raises another interesting research avenue: can autopoiesis be used to make the 'jump' from individual learning to organisational learning? It is an issue that does not appear to have been covered in the literature.

The one of the first applications of autopoiesis to organisational learning was by Hall (2005, p. 169), who aimed to provide a biological based framework for how organisations operate, with a focus on knowledge and organisational learning. Hall (2005, p. 178) achieved this aim by creating an autopoietically-founded model of individual learning and linking it with a modified version of Popper's three worlds. The main foundation for Hall's work (2005, p. 169), was that organisations were emergent, autopoietic and evolutionary in nature, and had learning as a core process within themselves. Hall (2005, p. 177) is also correct to note that any knowledge management activity should start from an autopoietic-based understanding of knowledge. However, a fundamental error exists because Hall (2005, p. 180) attempts to define organisations as first order autopoietic entities, using Varela et al.'s (1974, p. 187) checklist for identifying autopoietic entities.

Maula (2006, p. 80) defines the organisation as a living system, and proposes a 'living composition' as an enabling infrastructure. However, the underlying problem in Maula's model (2006, p. 80) is that it also assumes organisations are first order autopoietic entities, and subsequently falls into the problems described earlier. Maula also discusses two knowledge flows: 'sensing' and 'memory' (2006, p. 93). The problem of objectifying knowledge in this way assumes that knowledge takes on a form that it was not meant to: namely that it can exist outside the knower. Whilst Maula (2006, p. 47) does consider learning as a process, it is unfortunate that an assumption is made that organisations are autopoietic. Despite also using Varela et al's (1974, p. 187) checklist for identifying autopoietic systems, the incorrect conclusion that organisations are autopoietic is used. Perhaps the model could be redesigned such that it recognises that only data and information can flow between different people/entities, and that organisations are not first order autopoietic entities.

It is also evident from the literature that research has not looked at applying the scientific principles of autopoiesis to a pre-existing model of organisational learning. However, this approach falls into the trap of not starting from an autopoietic definition of knowledge. The result of this process would be a list of criteria for making an existing model of organisational learning, or even knowledge management, autopoietic. The models to which autopoiesis had been applied would then need testing to ensure the changes made a positive impact. No impact, or a negative impact, would obviously require a profound restructuring of the research.

Jackson (2007, p. 90), starts from the premise that current research within knowledge management is lacking a foundation, and is filled with lots of disagreements. However, after an introduction to autopoiesis, the article simply presents comparisons between autopoiesis and different aspects of knowledge management and organisational learning, arguing that autopoiesis

in its entirety is too complicated to be useful in an organisational setting. However, the resulting metaphorical analysis finds that aspects of autopoiesis that were used were far too simple to be applied to organisational learning. Whilst this paper did follow the social constructivist approach (Jackson, 2007, p. 78), it failed to recognise that organisations could be viewed as cognitive systems, or third order autopoietic systems, instead focusing solely on first order autopoiesis. Jackson (2007, p. 89) does realise a problem exists in viewing organisations as first order autopoietic entities because truly autopoietic entities are purposeless, and the same cannot be said for organisations. Viewing organisations as third order autopoietic entities would have removed the boundary problems (Jackson, 2007, p. 80) and allowed research to focus on how third order autopoiesis can create a consensual domain, and allow for languaging to occur, and ultimately increasing knowledge sharing within the organisation. With this in mind, it should be possible to develop the concept of organisational learning to include concepts such as embodied knowledge and enacted cognition.

2.8 The Relationship Between Knowledge Management and Organisational Learning

Knowledge management and organisational learning are two domains that have a considerable degree of overlap, both in terms of terminology and ideas (Vera and Crossan, 2010, p. 2). The purpose of this section is to explore the relationship between knowledge management and organisational learning, as well as the issues to be taken forward in an application of autopoiesis.

It appears the reason for such confusion between the two domains is because both attempt to improve organisational performance through increased employee and organisational knowledge. There have, however, been research attempts to map, or even correlate, the two domains (Liao and Wu, 2009, p. 70; Sanchez, 2005, p. 1). Liao and Wu (2009, p. 70) for instance, after examining knowledge intensive organisations, found organisational learning to be a

mediating domain between knowledge management and organisational performance. This contradicts with the more complicated picture given by Sanchez, (2005, p. 2) who proposes that knowledge management has two perspectives, personal and organisational. The personal orientation is focused on maintaining learning cycles, whilst the organisational orientation is concerned with knowledge dissemination and application. It is possible however, to reinterpret this perspective as shown in Figure 2.3.

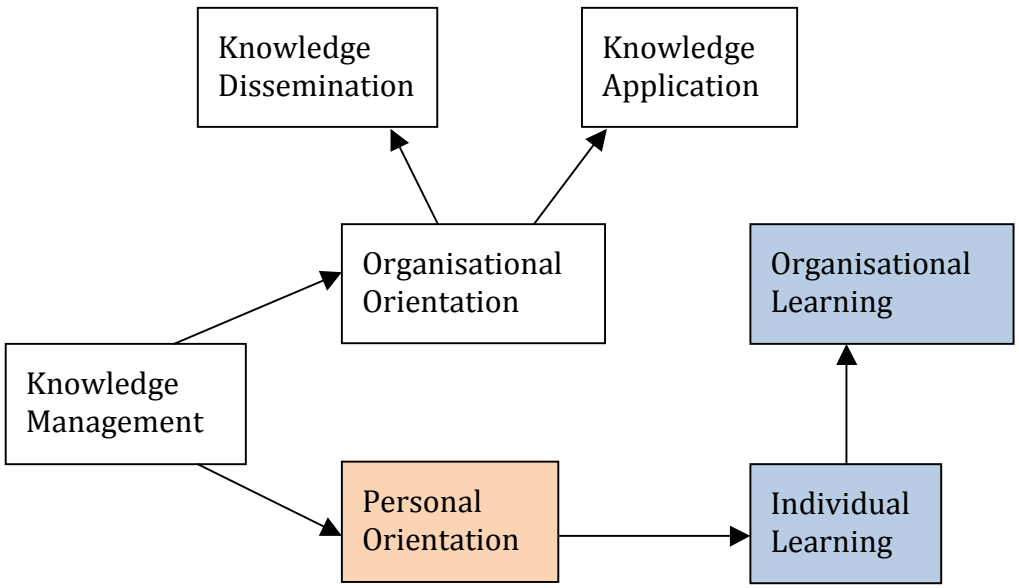

Figure 2.3 The Relationship Between Knowledge Management and Organisational Learning

As shown in Figure 2.3 there is an intricate relationship between knowledge management and organisational learning. Knowledge management has a personal orientation, the focus of which is individual learning. Individual learning can then be evolved into organisational learning, and hence the link between knowledge management and organisational learning. Figure 2.3 also shows how it is possible for the domain of organisational learning to have grown and matured before the concept of knowledge management arose.

Viewing Figure 2.3 in light of autopoiesis adds another dimension. Autopoiesis theory can be applied to the individual and organisational learning boxes because learning in autopoietic terms is developing suitable responses to environmental action. The personal orientation to knowledge management box can also benefit from autopoiesis because this is where the autopoietic epistemology becomes relevant. Mapping this onto the objectives presented in Chapter 1, applying autopoiesis to a model of organisation learning, applies autopoiesis to the blue boxes in Figure 2.3, and creating the autopoietic model of knowledge is akin to applying autopoiesis to the orange box in Figure 2.3.

2.9 Organisations Featured in Autopoiesis and Knowledge Management Research

Knowledge management in large organisations is a complex task, however there are unique challenges encountered by small and medium enterprises (SMEs) wishing to undertake KM activities (Supyuenyong et al., 2009, p. 64). SMEs differ from large organisations in the following areas: flexibility, volatility, skill shortages and limited market power (Wong and Aspinwall, 2006, p. 7).

Organisations, as social systems, are third order autopoietic entities, and there exists many ways of categorising such organisations. However, using the SME/large organisations distinction, a problem arises. When SMEs change into large organisations, they lose a lot of their natural features, and morph into predefined structures. In other words, whilst large organisations remain collections of people, their natural development in the autopoietic sense has been lost. Whilst one study does apply autopoietic theory to learning in organisations (Maula, 2006, p. 147), its downfall is designating organisations as first order autopoietic entities. Whilst it can be argued this is incorrect, the fact the study applies autopoiesis to large organisations becomes irrelevant. SMEs can be considered true third order autopoietic entities, as a result of their unique features shown in Figure 2.4 (Supyuenyong et al., 2009, p. 66).

Less standardisation of work occurs. Processes are more fluid and adaptable to different situations. There is greater employee versatility. There exists a more informal and organic culture. The relative small size encourages viewing the organisation as a whole, as opposed to a collection of departments.

Figure 2.4 Unique Features of SMEs

Numerous definitions of SMEs exist, but most focus on either turnover or staff head count. With this research containing one not for profit organisation, it is more pertinent to focus on head count definitions, which for the EU is 250 employees or fewer, whilst in the USA it is 500 or fewer. Despite the disparity, the important factor is that both CSG and Prosidion are treated as SMEs in their respective markets. SMEs typically have limited resources, and their unique features (Figure 2.4) usually mean developing a knowledge management strategy falls outside the reach of their operations (Desouza and Awazu, 2006, p. 33). SMEs tend to focus on sharing tacit knowledge on a face-to-face basis, rather than by creating repositories, and the behaviour of employees is influenced more easily by the senior management team/owner. As such most owners/managers of SMEs are either unaware of KM or do not understand it, resulting from the lack of a sound conceptual foundation for knowledge management (Wong and Aspinwall, 2005, p. 70). This is where an autopoietic model of organisational learning can help. By using autopoiesis, a theoretical foundation is being created, which should help SMEs move past these initial problems.

A review of autopoiesis and knowledge management literature shows the majority of papers are entirely conceptual, with only four case studies (Figure 2.5). Perhaps disappointingly, none of the authors who presented a conceptual

piece put forward reasons why no testing of their model of theory occurred. With only four case studies it is not prudent to speculate why so many authors stopped at the conceptual stage, but suffice to say the required jump up to testing needs to be explored to determine whether applying autopoiesis really does provide any benefits, or if it is just an interesting academic endeavour. Of the four publications, two report the same study (one large organisation and two SMEs) and the remaining two publications also focus on SMEs.

Year	Authors	Level of Application
1994	von Krogh et al.	Conceptual
1995	Mingers	Conceptual
1999	Ishikawa	Conceptual
2000	Cardoso et al.	Conceptual
	Maula	**Case Study**
2001	Thannhuber et al.	Conceptual
2002	Kay and Cecez-Kecmanovic (2002a)	Conceptual
	Kay and Cecez-Kecmanovic (2002b)	**Case Study**
	Savory	Conceptual
2004	Blackman and Henderson	Conceptual
2005	Hall	Conceptual
2006	Limone and Bastias	Conceptual
	Maula	**Case Study**
	Mingers	Conceptual
	Zeleny	Conceptual
2007	Abou-Zeid	Conceptual
	Jackson	Conceptual
2008	Koskinen	Conceptual
	Pamkowska	**Case Study**
	Radosavljevic	Conceptual

Figure 2.5 Classification of Studies in Autopoiesis and KM

2.10 A Lack of Literature

A detailed search of 'ISI Web of Knowledge', along with 'Google Scholar', 'Emerald Fulltext', 'IngentaConnect', 'Wiley InterScience' and 'ScienceDirect' revealed 22 publications in the field of autopoiesis and knowledge management. This is despite over 250 citations for 'Autopoiesis' (Maturana and Varela, 1980) and over 200 citations for 'The Tree of Knowledge' (Maturana and Varela, 1998). The lack of publications considering applications of autopoiesis is almost certainly due to the fact that there are only six main publications on autopoiesis itself, along with two reviews. It could be argued that before any more applications of autopoiesis can occur, there should be substantially more publications looking at autopoiesis, and its strengths, weaknesses and scope. With this reality, it is entirely possible that all current research in autopoiesis, including its applications, will be used to help autopoiesis find its feet, before any effective use can be gained. Whilst this may be a shame, it is still a necessary path in the development of a topic area.

There are numerous reasons why autopoiesis theory never gained much attention. Firstly, the primary authors, Maturana and Varela, are Chilean. So any work produced was always in Spanish, with an English translation following later. The terminology within autopoiesis also creates difficulties because it introduces lots of new concepts, as well as new words. This problem is further compounded when the issue of translation is brought in. The self referential terminology used by Maturana and Varela also creates problems because the concepts developed are all developed around each other, resulting in the fact that it becomes very difficult to extract and reapply ideas elsewhere. The result is a very inaccessible field with conceptually abstract ideas. The excerpt quoted below, which is representative of the text, shows how the problem of combining a complicated lexis with the issue of translating:

'In fact, a living system is specified as an individual, as a unitary element of interactions, by its autopoietic organization which determines that any change in it should take place subordinated to its maintenance, and thus sets the boundary

conditions that specify what pertains to it and what does not pertain to it in the concreteness of its realization. If the subordination of all changes in a living system to the maintenance of its autopoietic organization did not take place (directly or indirectly), it would lose that aspect of its organization which defines it as a unity.

(Maturana and Varela, 1980, p.87)

Making these two sentences more coherent, this proposes that autopoietic systems exist as a collection of interactions of processes (organisation), working together as one entity. Any change in an autopoietic entity must be in support of the maintenance of its autopoietic organisation. This determines for the boundary what is appropriate to enter the entity and what is not appropriate to enter, in order to realise the entity in a physical space. If any change in the autopoietic entity did not support the maintenance of its network of process (organisation), then part of the entity's organisation would no longer be realised. This may or may not affect the entity's ability to exist as an autopoietic entity in the physical space it exists. Perhaps autopoiesis would have been better received had it used pre existing terminology to explain its new concepts. However this raises the issue that the current terminology at the time was inadequate in defining living systems. Maturana did also report that creating the term autopoiesis made the task of defining living systems much easier.

This review has already identified the reasons why autopoiesis is being applied to living systems, however it does not identify why it took so long. It would appear that the publication of Mingers (1995, p. 1) was a turning point since he was instrumental in reviewing of the autopoiesis literature, summarising it, identifying key issues within the literature and because it was written in English. For a long time as well, Maturana and Varela resisted the application of their ideas to other domains, claiming it would weaken the strength autopoiesis had in defining living systems. However, applications of autopoiesis started in 2000, and started to apply autopoiesis to organisations,

hoping to yield, as then, unknown benefits. In 1995, Luhmann created his theory of self-reproducing social systems, based loosely on ideas in autopoiesis. However, his main weakness appeared to be the assumption that social systems were first order autopoietic entities, and that communication was the unit of self-reproduction. Luhmann (1995, p. 143) was followed by numerous others (Maula, 2000, p. 157; Thannhuber et al., 2001, p. 313 and Goldspink and Kay, 2003, p. 470) who also claimed that organisations could be autopoietic.

Regarding autopoiesis and knowledge management, the first consideration of the two fields coming together was by Gaines and Shaw (1983, p. 35), who looked at the knowledge environment within the organisation. However, knowledge management is unique because it is a relatively young field. This could be cause for concern because, as both autopoiesis and knowledge management are relatively young, any incorrectly grounded theories could be amplified by a cross sharing of ideas. However, just focusing on knowledge management, the application of autopoiesis could be beneficial as it will cause questioning of fundamental ideas and notions that could otherwise go untested.

The lack of literature on autopoiesis could also be partly due to its lack of acceptance within the scientific community. Developed at approximately the same time as ideas regarding DNA, autopoiesis was competing directly with it. As speculated by Varela (Maturana and Varela, 1998, p. 252), this could be because autopoiesis was never seen as scientific, or viewed as too simplistic and conceptual. Even to this day, it appears autopoiesis is still unpopular among scientists. Why autopoiesis remains so unpopular may never be fully understood. However, as stated earlier, autopoiesis is gaining popularity in social science fields, mainly because it gives researchers a chance to start scientifically explaining their ideas.

As identified by the literature, there are lots of new ideas that have not been fully explored or exploited to their potential. The application of autopoiesis to knowledge management is one of these ideas. The general consensus is that autopoiesis is a theory describing the nature of people and that this approach can yield numerous benefits for knowledge management.

2.11 Summary

As identified by this review, the application of autopoiesis to knowledge management and organisational learning is a relatively new notion, with lots of ideas in their infancy (Objective 1). This literature review started by examining the emergence of autopoiesis in knowledge management research. Scholl et al. (2004, p. 25), Johanessen et al. (1999, p. 36) and Metaxiotis et al. (2005, p. 7) find that the failures from the first and second-generation knowledge management ventures could be remedied by the application of systems theory and autopoiesis. However their studies are essentially scoping studies and it is necessary to look to other authors for actual applications.

Having set the justification for the application of autopoiesis, the literature review then moved on to explore the development of autopoiesis. Having defined autopoiesis, the first area of interest was the restriction of autopoiesis to the molecular domain and the relationship of autopoiesis to DNA. The literature review found that the cell is the key autopoietic entity and obeys six key principles. People and social systems are subsequently explained using higher orders of autopoiesis. The principles of autopoiesis will be applied to the existing model of organisational learning, whilst the theory of second and third order autopoiesis will be carried forward into the autopoietic epistemology. The literature review also covered the autopoietic concepts of organisation and structure, whilst not directly applicable to knowledge management, are important concepts to the theory of autopoiesis.

The literature review then moved onto the applications of autopoiesis to knowledge management. However, a necessary first step was a review of the existing literature of the theory of knowledge itself. This would feed into the autopoietic epistemology section and provided the theoretical backdrop. The concept of organisational knowledge was also explored, although this was not taken forward in this research because it goes beyond the scope of an autopoietic model of knowledge. However, it provides scope for further research by affording the opportunity to build up the autopoietic model of knowledge to an organisational level using third order autopoiesis.

The literature review then moved onto explore some research that considered making organisations first order autopoietic entities (Maula, 2000, p. 158) and research that implied a system could be built to be autopoietic (Abou-Zeid, 2007, p. 614). Neither idea was taken forward, however, since, as demonstrated, they are based on incorrect applications of autopoiesis.

The next major area the literature review moved onto was the domain of organisational learning. This became an important aspect because a model of organisational learning was chosen as the model that would have autopoietic principles applied to it. The review explored the concept of single and double loop learning (Argyris and Schön, 1996, p. 20) and the concept of error correction. Kolb's (1984, p. 21) experiential learning model and Johnson-Laird's (1983, p. 3) concept of mental models were taken forward and integrated into a comprehensive model of organisational learning, developed by Kim (1993, p. 44). This model was then taken forward in this research as the model chosen to apply the principles of autopoiesis.

With an autopoietic model of organisational learning one of the aims of this research, the literature review then moved onto existing applications of autopoiesis theory to organisational learning. The review found that Hall

(2005, p. 169), Maula (2006, p. 1) and Jackson (2007 p. 78) were the key publications, and all had considered organisations as first order autopoietic entities. This perspective does not fit the more complicated picture of first, second and third order autopoietic entities, and so these specific pieces of work were not taken forward in this research.

The literature review also considered organisations typically featured in autopoiesis and knowledge management research concluding that SMEs were favoured in knowledge management studies for reasons outlined in Figure 2.3 and that, in general, there was a lack of interest in generating empirical research in the area. A potential lack of literature was also explored in the literature review, and focused on the apparent lack of key research on solely autopoiesis.

Chapter 3 Research Methodology

This chapter presents the rationale behind choosing a suitable research methodology, along with the possible research approaches. A critique of the different research strategies is also provided along with a justification for the strategies chosen for this research. This chapter also discusses the pilot studies conducted during this research and a discussion of organisations selected, questionnaire design and expert selection.

3.1 Introduction

When research is conducted, it is comprised of two aspects: the research philosophy and the research strategy. Research philosophy is essentially the viewpoint taken as to whether the world is viewed in a subjective or objective manner, whilst research strategy is viewed as the actual methods used to undertake the research (Cornford and Smithson, 1996, p. 58 and p. 67). Subsequently, this chapter outlines the possible research philosophies, along with the chosen one, and then moves onto what research strategies were used in the study.

3.2 Research Philosophies

Whilst the term 'research' is in general usage, it can be defined as a process of inquiry that has clearly defined parameters, and has the aim of creating or discovering new knowledge (Hernon, 1991, p. 3). The process of inquiry will be governed by a philosophy. Deetz (1996, p. 198) identifies a range of four philosophies: normative, which is comparable to positivism (Cornford and Smithson, 2006, p. 62), interpretative, critical and dialogical.

Positivists believe that all knowledge arises from observing phenomena in a real and objective world (Cornford and Smithson, 1996, p. 37). Favoured by the science disciplines, positivist based research aims to give hard, objective facts for results, which are easily repeatable. Repeatable results enable predictions to be made, assuming all variables remain the same or constant. With this in mind, it is possible to change different variables within a situation, one at a time, to enable relationships among the variables to be observed.

However, such a viewpoint seems untenable when dealing with the social sciences, with some suggesting that, since social science is highly subjective, it is not even science (Cornford and Smithson, 1996, p. 38). The issue is 'whether the methodology of the physical sciences can be applied to the study of social phenomena' (Kumar, 1996, p. 12). So a new perspective was needed, one which recognised the phenomena, spontaneity and subjectiveness, associated with social objects. This new perspective could also be seen as the opposite of positivism, with a focus on culture, society and communication.

This new perspective was interpretivism, and can be defined as seeking to 'understand reality through the realm of individual consciousness and subjectivity' (Jashapara, 2004, p. 42). Such an approach recognises that researchers affect the object they are researching, simply by researching it. Hence, perception becomes an important aspect to research, along with the realisation that many different interpretations may exist for the same reality. As such, 'understanding becomes a part of valid knowledge' (Cornford and Smithson, 1996, p. 39).

The third research philosophy identified by Deetz (1996, p. 198) is critical research, which assumes deep, fundamental flaws exist in today's society that need to be fixed (Cornford and Smithson, 1996, p. 60). Such an outlook fits with ideologies such as Marxism and Feminism. Critical researchers attempt to

bring the underlying issues in a discipline to the surface, so they can ultimately be eliminated. The fourth, and final research philosophy (Deetz, 1996, p. 198) is dialogical, or post-modernist approach. This dialogical approach is very similar to critical research in that it questions underlying assumptions and values of today's society. Dialogical philosophy diverges from critical theory when it attempts to 'reclaim everyday realities, meaning systems and self conceptions' (Deetz, 1996, p. 203).

3.2.1 Choice of Research Philosophy

The main factor when choosing the research philosophy was whether the philosophy chosen was the best for achieving the aim and objectives set out in Chapter 1. For this reason, an interpretivist approach was used to evaluate the autopoietic models (Chapter 4). First, this research was conducted in a social environment, as opposed to a laboratory. This is an important recognition because if people become research participants, factors such as repeatability and objectivity of results can no longer be assured (as is the case with a positivist approach). The interpretivist approach is fit for the purpose of this evaluation because knowledge management cannot be considered a science. A theory can be considered scientific if, and only if, it is falsifiable (Popper, 1972, p. 13). Considering specifically the autopoietic model of knowledge, the model fails in this respect because it is not falsifiable. The cause of this inability to falsify the model arises from the fact that the model of knowledge treats the actual 'knowledge' component of the model as an unknown black box.

A positivist approach is not suitable for testing either of the models because its underlying belief in an objective world which exists independent of any observation (Cornford and Smithson, 1996, p. 37) does not agree with the fundamental notion in autopoiesis that everything is observer dependent and that no external, objective reality exists for us to observe or interpret. Critical research and post-modernism are also not appropriate because, whilst not directly positivist, they do assume an objective reality as a starting point.

At this point, it is interesting to note the philosophical position of autopoiesis. Autopoiesis, while attempting to remain completely scientific in its approach, wanted to define life as subjective, open to interpretation and completely based on perception. Autopoiesis could be likened to a positivist approach to interpretivism, which might also explain why autopoiesis never gained popularity among the scientific community.

3.3 Research Approach

There are three approaches to research: Constructive, Nomothetic and Idiographic (Cornford and Smithson, 2006, p. 66). The constructive approach focuses on creating frameworks where none currently exist, or creating models with no need for a 'physical realisation' (Cornford and Smithson, 2006, p. 66). A significant part of the planned research was constructive in its approach – creating the autopoietic model of organisational learning and creating the model of knowledge.

Having used the constructive approach to create the two models (Chapter 4), an idiographic approach was necessary to test and evaluate the autopoietic models. An idiographic approach was needed because the models' inherent abstract nature made using a survey fraught with difficulties, such as testing for the presence of knowledge. Testing the model of knowledge was suited to an idiographic approach since it aims to create the richest, and most in depth understanding of a particular situation (Cornford and Smithson, 2006, p. 67). A summary of the research approaches that were used is presented in Table 3.1.

Stage	Approach	Reason
Creating the Autopoietic Model of Organisational Learning	Constructive	Using existing literature to create new knowledge
Creating the Autopoietic Model of Knowledge	Constructive	Using existing literature to create new knowledge
Testing the Autopoietic Model of Organisational Learning	Idiographic	The model attempts to explain a natural phenomena, which is then being compared to a conceptual interpretation of it
Evaluating the Autopoietic Model of Knowledge	Idiographic	Involves an attempt to understand subjective phenomena

Table 3.1 A Summary of Research Approaches

3.4 Research Strategies

As identified by Galliers (1992, in Cornford and Smithson, 1996, p. 46) numerous research methods exist, as presented in Table 3.2. Each research method has also been categorised according to the different research philosophies discussed above. It is not possible to have a third column for post-modernist approaches since, by their very nature, they are a mixture of pre-existing approaches, blended to suit whatever research is being conducted. Not all approaches in Table 3.2, such as laboratory experiments, theorem proof and role/game playing are relevant to this research and will not be explored, because they are typically only suited to certain domains, such as scientific (laboratory experiments) or mathematical (theorem proof), or for exploring participant reactions to a certain situation. It can also be argued the term 'Surveys' needs more clarification. Survey methods are generally assumed to be questionnaires, and sometimes interviews. However, interviews, by their very nature: subjective and unstructured (Denscombe, 2005, p. 164), can also be considered an interpretivist strategy, and not a positivist strategy.

Positivist	Interpretivist
Laboratory Experiments	Subjective/Argumentative
Field Experiments	Reviews
Surveys	Action Research
Case Studies	Descriptive/Interpretative
Theorem Proof	Futures Research
Forecasting	Role/Game Playing
Simulation	

Table 3.2 Research Approaches

Table 3.3 provides an overview of different research methods that might be applicable to this research. Interviews are often chosen based on the understanding that they would allow the respondents' answers to be probed (Denscombe, 2005, p. 165) and additional help could be given if necessary (Frey and Oishi, 1995, p. 3). Additional support could be deemed necessary because of the abstract nature of certain concepts in this research. The personal nature of interviews is also an important factor because, since respondents will be asked about organisational procedures, any current problems could be conceived as criticism of the organisation. Interviewing would make it easier for respondents to reveal if this was the case, as opposed to responding to a questionnaire (Denscombe, 2005, p. 165). Semi-structured interviews also place more emphasis on the participant providing more information and examples when needed (Denscombe, 2005, p. 167)

The main benefits of using questionnaires include anonymity, time efficiency, increasing number of potential respondents and ease of standardisation and comparison (Denscombe, 2005, p. 145). Questionnaires can be developed as an online survey to aid distribution and collection of responses. Online surveys allow respondents to remain anonymous, which often results in respondents being more honest in their answers. They can also be more efficient for the

respondent to complete. For example, they are often received quicker, can be filled in fairly promptly on the computer from a link in the email, and do not require the user to address an envelope and return the survey in the post.

Approach	Summary	Strengths	Weaknesses
Field Experiments	Organisation based experiments into a limited number of relationships	Context sensitive, issues with controlled environment are overcome	Results are specific to host organisation. Difficult to make generalisations.
Surveys	Surveys can be used to obtain an instant picture of the organisation at that time. Different analytical techniques can be used to make predictions about the different relationships that may exist.	Easy to deploy. Large amounts of data can be acquired. Insights gained can be more easily transferred if the survey is designed well.	Surveys can be superficial. Surveys often only scratch the surface of issues in an organisation. A more detailed look may be necessary.
Case Studies	Detailed attempt to observe different relationships that may exist in an organisation.	Often organisation specific, and can often be combined with other research methods.	Hard to generalise finding since cases often are not similar.
Forecasting/ Futures Research	Time series analysis, such as extrapolation.	Provides insights when relationships are too complex to consider separately.	Past performance is not an indicator of future potential.
Subjective/ Argumentative	Creative/ speculative approach to research	Unstructured approach useful in very novel situations.	Extremely open to biases.
Action Research	Applied research where direct, useful solutions are developed for the host organisation.	Creating practical solutions while re-inforcing current theory in the area.	Results specific for each organisation. Ethics of researcher very important.

Table 3.3 Research Strategies: Strengths and Weaknesses

3.5 Testing the Autopoietic Model of Organisational Learning: First Impressions

The abstract nature of the model did hinder developing a suitable survey. Concepts such as mental models are by their very nature abstract, and trying to identify and evaluate them could have proved very difficult. It was more suitable, and more useful, to look at the effect of the presence of mental models. For instance, instead of asking respondents about their own frameworks and routines, the questions asked about the respondents' personal experience and how often they used assumptions.

The model is also very circular, which itself is suited to autopoiesis. Testing the circular nature means the questions become self-checking. In other words, as questions develop around one part of the model, by the time they move around the model and end up in the same place, the questions should be testing what they were testing originally. The circular nature of the model also caused problems because, since elements are related in a circular nature, it could make it difficult for questions to make an entrance into the loop to start testing. However, an alternative approach to viewing the model as circular was to view the model as numerous authors' works combined into one model. This would aid testing because each authors' section could be independently tested. Questions also arise from the synergy that arose between the different sections.

The very nature of organisational learning itself undoubtedly had an impact on the method used to test the model. As already identified, the abstract nature of concepts involved means the survey either had to make explicit what the concepts mean, potentially reducing their meaning or leave the respondent to interpret the concepts. A balance was clearly required, so the survey would interpret the more abstract and vague concepts, while leaving the respondents to interpret the better-known concepts.

There was also a problem with the German word 'Weltanschauung', of which there is no direct English translation. In the original model, 'Weltanschauung' is interpreted as the organisation's view of the world, or even just the organisation's view point (Kim, 1993, p. 45). A problem then arises if a native German answers the survey, because they could understand the full extent of the term, and so provide an answer different from other respondents. The best approach was therefore to put the interpretation of the word from the original publication (Kim, 1993, p. 44) into the survey, and not allow the respondents to interpret 'Weltanschauung' for themselves.

Also when dealing with abstract concepts in surveys, it could have been very easy to give away intended answers in the question itself. It would be better for the respondents to offer the answers themselves, which is why an interview, which allows respondents to elaborate when they feel necessary, appeared better.

3.6 Developing the Interview

The initial method chosen for testing the model was a semi structured interview based on the understanding that it would allow the respondents' answers to be probed (Denscombe 2005, p. 165) and additional help could be given if necessary (Frey, Oishi, 1995, p. 3). Additional support was deemed necessary because the abstract nature of the concepts might leave respondents confused, and wondering whether something was important. Interviewing would make it easier for respondents to reveal if this was the case, as opposed to writing in a questionnaire (Denscombe 2005, p. 165).

The modular nature of the model determined the development of the guideline questions for the interview; they were split into different sections, each

representing different sections of the model. Development of the questions went through several iterations to check for coherence and ease of understanding. The first set of questions was demographic, and these would be used in the data analysis to evaluate any trends that might be present. The following questions then followed the layout of the model, starting with individual learning, onto mental models and ending with organisational learning.

3.7 Organisations Selected

As identified by Marr et al. (2003, p. 776), service and product based companies both suffer from a misalignment when considering an employee's view of, and the organisation's perspective of, knowledge management. Knowledge based organisations, on the other hand, benefit from a common view among both employees and the organisation about the aims of a knowledge management system. Since both product based and service based organisations lack the epistemological understanding required for knowledge management (Marr et al., 2003, p. 778) these are the two organisation types that were selected to test the autopoietic model of organisational learning. The service-based organisation that will be used in this study is the Conservation Services Group. The product-based organisation that will be used in this study is Prosidion Ltd.

3.7.1 Conservation Services Group

The Conservation Services Group is a not for profit, nationwide company in the USA, set up to help home owners and business lower their energy usage and carbon footprint, whilst increasing levels of comfort, health and safety. The majority of their work is with organisations and government departments. The Conservation Services Group has approximately 300 employees across all locations, with sales of approximately $18.9 million to support itself. The workforce is made up of mainly consulting professionals, along with middle and higher managers and numerous support staff.

3.7.2 Prosidion Ltd.

Prosidion Ltd. is a wholly owned subsidiary of OSI Pharmaceuticals Inc. OSI Pharmaceuticals is a USA based organisation, with three office/laboratory locations throughout the country. Prosidion operates as distinct, separate entity and is based solely in Oxford, UK. Prosidion is concentrated on the development of new drugs for metabolic diseases, particularly obesity and type two diabetes. Prosidion averages approximately 100 employees, made up of placement students, research scientist, senior research scientists, department leaders, directors and numerous other support staff. The majority of Prosidion's capital comes from licensing patents and investments from its parent company. Turnover figures for Prosidion are not available publicly.

3.7.3 Discussion of Organisation Choice

Comparing the organisations selected, they are both relatively small organisations, with a relatively flat organisational structure. Removing layers of bureaucracy also enables both organisations to become more responsive to environmental changes and operate more effectively. Both organisations also only operate in one country (despite Prodision's subsidiary status). However Prosidion is a single site organisation whilst CSG is a multi-site organisation. Numerous differences also exist between the two organisations. The main difference is that CSG is a service-based organisation providing consultancy services, whilst Prosidion is a product-based organisation whose focus is on continual development of drugs. This also highlights another difference between the organisations: the market in which they operate. Prosidion is clearly in the pharmaceutical industry, whilst CSG operates in the energy industry. Whilst the similarities would seem to suggest that any results obtained could be combined, the striking differences with the market differences and the product/service focus mean the results obtained are not suitable to combine.

In theoretical or conceptual studies, it is advantageous if the organisation is sympathetic to academic research in order to allow their employees time to participate (Supyuenyong et al., 2009, p. 69). Both CSG and Prosidion are familiar with the academic research process, with both organisations encouraging PhD study, where relevant, for their staff. In Prosidion, it is also beneficial that all employees above the level of speciality supervisor held PhDs. As such, the two organisations could be termed a convenience sample. They are not believed to be atypical or operate in a significantly different way from other SMEs.

3.8 Testing the Autopoietic Model of Organisational Learning: The Pilot Study

A pilot study was conducted in the Department of Information Science (11 responses received from 20 requests) at Loughborough University. The purpose of the pilot study was to evaluate the effectiveness of the interview and to remove potential problems. Various problems were encountered during the pilot interviews. First, respondents found it difficult to answer the questions presented to them. This difficulty was probably due to the abstract nature of the concepts involved but also, in part due to the inherent nature of semi-structured interviews. Semi-structured interviews place more emphasis on the participant providing more information and examples when needed (Denscombe 2005, p. 167). The abstract nature of the topic meant respondents were often left wondering if information was relevant and whether it should be revealed. Another round of interviews was conducted in the pilot study, and they tended to work better because the format was changed to that of a structured interview. This meant being more specific and using closed questions, and possibly giving an indication of what sort of answers were required.

The change in interview style suggested it may be better to continue the pilot study as a questionnaire, which would allow a wider range of responses as well

as saving time and money (Bourque and Fielder, 1995, p. 9). However, changing to a questionnaire that uses Likert scales introduces the risk of three biases: central tendency bias, acquiescence bias and desirability bias. Central tendency bias is when respondents avoid using the extreme ends of a scale, acquiescence bias is when respondents agree with statements as presented and desirability bias is when respondents choose answers that make themselves, or their organisation, look desirable. It was hoped that by keeping the questionnaire anonymous and confidential, issues with desirability bias could be minimised and that my keeping the questions as neutral as possible that acquiescence bias could also be reduced. Finally, considering the central tendency bias, the decision on the number of options in the Likert scale is ultimately a compromise. An even number of choices is sometimes preferred because it forces the respondents to pick one side over another, whereas an odd number gives the respondent the choice of choosing the middle option if they so wish. The decision over an odd or even number of options also needs to consider the questions being asked. For instance if the Likert scale itself is a scale then adding or removing a choice does not have too much impact. However, if the Likert scale is comprised of descriptors, then it should be considered if creating 6 options is significantly different from 5. For example, a 5 point scale can be considered more appropriate with the scale Strongly Disagree - Disagree - Neutral - Agree - Strongly Agree than a 6 point Likert scale with the scale Strongly Disagree - Disagree - Slightly Disagree - Slightly Agree - Agree - Strongly Agree. However, as Garland (1991, p. 70) notes, the decision whether to use an odd or even number of items is largely down to researcher preference.

The main benefits of using questionnaires include anonymity, time efficiency, increasing number of potential respondents and ease of standardisation and comparison (Denscombe 2005, p. 145). The questionnaire was developed as an online survey to aid distribution and collection of responses. Online surveys allow respondents to remain anonymous, which often results in respondents

being more honest in their answers. Online surveys are also more efficient for the respondent to complete.

3.9 Using Experts to Evaluate the Autopoietic Model of Knowledge

Evaluation is oriented towards assessing and improving any given object, programme, system, theory and most other entities (Stufflebeam and Shinkfield, 2007, p. 4). Evaluation provides a gauge, and often assesses the value of an object for the benefit of a user/consumer. There are two broad categories of evaluation: formal and informal (Clarke, 1999, p. 1), distinguished by the means with which they are conducted. Informal evaluation occurs on an almost daily basis, judging the value or worth of a purchase for example. Formal evaluation, however, is a disciplined form of inquiry that applies to the collection and analysis of information (Lincoln and Guba, 1986, p. 550). Formal evaluation can be defined as:

'the systematic process of delineating, obtaining, reporting, and applying descriptive and judgmental information about some object's merit, worth, probity, feasibility, safety, significance, and/or equity' (Stufflebeam and Shinkfield, 2007, p. 16)

This definition highlights the importance that perceived value plays in evaluation, and subsequently the role of subjectivity and judgement. In the context of knowledge management theory, it is likely that safety is not a useful indicator for evaluation. This definition ignores the differences that exist between the different indicators: merit, worth, probity etc. An object's success is defined against its purpose, but an object's merit, worth or significance is measured against the requirements the object serves (Scriven and Coryn, 2008, p. 92). These distinctions are necessary when it comes to creating the evaluation framework.

Within formal evaluation there are two different, and complementary, evaluation techniques: formative evaluation and summative evaluation

(Stufflebeam and Shinkfield, 2007, p. 25). Formative evaluation focuses on the process of improvement and is about identifying strengths and weaknesses (Clarke, 1991, p. 7). Summative evaluation, on the other hand, is concerned with post process decision-making and has a focus on providing information to make a decision for action (Clarke, 1991, p. 8). The evaluation necessary for this research was formative because the aim was to improve or ensure the quality (Stufflebeam and Shinkfield, 2007, p. 23) of the autopoietic model of knowledge. It might appear that summative evaluation is more appropriate, with its focus on the completion of a programme, process or product; however, summative evaluation does not allow the clarification of goals or debate surrounding the nature of any implementation (Clarke, 1991, p. 8).

3.9.1 Evaluation in Knowledge Management

Knowledge management, with its numerous 'best practices' and 'lessons learnt' is a suitable candidate for an evaluation methodology (Patton, 2001, p. 329). The lack of a confirmed definition of knowledge creates uncertainty within knowledge management, which also favours an evaluation methodology. Specifically within knowledge management, an evaluative methodology is especially suited towards model testing, theory testing, measuring outcomes and generating lessons learned (Patton, 2001, p. 332). Evaluation should be ideal for testing the autopoietic model of knowledge previously developed (Chapter 3).

The abstract, and necessarily unmanageable nature of knowledge (Abou-Zeid, 2007, p. 615) means positivist, critical or post modernist approaches to testing are not suitable because they require the existence of an objective, independent reality. Only an interpretivist approach is suitable, of which evaluation is one technique. Evaluation is the best approach for allowing participants to determine the place of the autopoietic model of knowledge among existing models and theories, as well as determining the model's potential practical applications. Other interpretivist approaches could have

been used, but lacked the structure possible with an evaluation framework (Scriven and Coryn, 2008, p. 97).

When using an evaluation methodology, it is necessary to provide a framework to guide the process (Scriven and Coryn, 2008, p. 93). Adapting the guide to creating a framework from Scriven and Coryn (2008, p. 97), the necessary framework for guiding the evaluation is shown in Figure 3.4.

1. Determine the evaluator's definition or understanding of the terms used in the model.
2. Determine whether the evaluator perceives all elements of the model as equal, or whether some elements are more important.
3. Determine whether the evaluator agrees with the relationships present, and whether any relationships need adding.
4. Determine whether the evaluator feels any elements can be measured.
5. Determine whether evaluator agrees with model, if not, determine necessary changes through a second round.

Figure 3.4 The Evaluation Process

Evaluation in knowledge management yields one major problem: how to account for the different perspectives, or paradigms, the evaluators may have, whether it is information science, philosophy, psychology, management studies or sociology (Jashapara, 2004, p. 10). Rather than becoming an obstacle, the key to a successful evaluation is to 'make evaluators more aware of their methodological biases and paradigmatic assumptions so that they can make flexible, sophisticated, and adaptive methodological choices' (Patton, 1988, p. 119). Once the evaluation process from Figure 3.4 had been followed, it is subsequently necessary to determine the philosophical position of the evaluator, and determine how the model, or indeed the process just followed might be different. Along with the philosophical perspective, factors, such as

the duration of time the evaluator has been working in knowledge management. The evaluations were conducted individually in an interview.

3.9.2 Choice of Evaluator

Deciding on the composition of the evaluation team, variety is perhaps the most important factor, especially given the vast philosophical perspectives that can be found in knowledge management (Jashapara, 2004, p. 10). There appears to be three key dimensions on which the evaluators could vary: length of active time in knowledge management, philosophical perspective and whether the evaluator is a practitioner or theorist (researcher). A sample population was taken across all dimensions provides the best representation for a balanced evaluation.

When looking to define an expert, most definitions are similar and a common perspective is that an expert is someone with evaluative skills in their domain of expertise (Weiss and Shanteau, 2003, p. 106). The specialised skill and knowledge of experts takes practice and a willinginess to learn in order to develop expertise and become an expert (Lichtenstein, 2009, p. 1035). Once the concept of an expert has been defined, the issue of deciding who qualifies as an expert arises. In accordance with an autopoietic philosophy, a person can only be an expert if they meet the criteria in the eyes of one of their peers. This is an important distinction because, as defined in the key autopoietic literature, (Maturana and Varela, 1998, p. 27) everything said is said by an observer. This infers there cannot be an objective method of determining an expert and it is only relative to the person making the claim. The approach taken in this research was to use the peers of the expert to assess whether a person can be considered an expert of knowledge management.

3.10 Summary

This chapter has presented the necessity of following an interpretivist philosophy for this research. With regards to the different research approaches, a constructive approach was required for creating the two models and an idiographic approach for testing the autopoietic model of organisational learning and evaluating the autopoietic model of knowledge. These approaches were allocated to the different stages after an analysis of each approach was compared to the task required. Finally, the research strategies were selected: expert evaluation for the autopoietic model of knowledge and, after the pilot study, questionnaires for the autopoietic model of organisational learning.

Specifically relating to this research, Table 3.5 outlines the strategies that were adopted.

Stage	Research Strategy	Reason
Creating the Autopoietic Models	Matching	Provides a unique approach to pairing up two different domains and their language.
Testing the Autopoietic Model of Organisational Learning	Questionnaire	Verification nature of research looks for either agreement or disagreement with model.
Evaluating the Autopoietic Model of Knowledge	Evaluation (Subjective/ Argumentative)	Allows model to be aligned among existing literature/perspectives.

Table 3.5 Research Strategy

Chapter 4 Creating the Autopoietic Models

This chapter develops a categorisation of all autopoiesis and knowledge management research, and uses it to show the conceptual gap that exists in the current literature. This was the impetus for creating the autopoietic models of knowledge, and organisational learning (Objectives 3 and 5), that will subsequently attempt to make autopoiesis more appealing, and indeed, more accessible to researchers in the domain of knowledge management research. A paper presenting the case for, and the development of, an autopoietic foundation to a model of organisational learning was published in the proceedings for KMAC (Parboteeah and Jackson, 2006), with a more detailed and comprehensive version appearing in Knowledge and Process Management (Parboteeah and Jackson, 2007c). The development of the autopoietic model of organisational learning was also selected for publication in a new volume on autopoiesis in organisations (Parboteeah et al., 2009b). The autopoietic model of knowledge was published in the proceedings of the ACIS conference (Parboteeah et al., 2009c).

4.1 Gaps in the Autopoiesis and Knowledge Management Literature

Having critically reviewed the literature on autopoiesis and knowledge management (Chapter 2), it is obvious that numerous authors have started to explore the application of autopoiesis and knowledge management. However, as the literature review reveals, most of the research focuses on several core areas. A review and categorisation of the literature reveals the research can be grouped into four main categories (Table 4.1). The first step to create the taxonomy was to find all the literature concerned with applying autopoiesis to knowledge management. This involved a keyword search across 'ISI Web of Knowledge', along with 'Google Scholar', 'Emerald Fulltext', 'IngentaConnect', 'Wiley InterScience' and 'ScienceDirect'. However, the keyword search was also extended to include information management and information science, as well as the autopoietically related terms of self reproduction, self recreation and self organisation. Not all the expanded terms yielded suitable research, and

these were filtered out. The remaining papers were then categorised according to content, and placed accordingly into Table 4.1.

Level	Topic	Authors
Level 4	Autopoiesis and Knowledge Management Systems	Thannhuber (2001) Maula (2006) Abou-Zeid (2007)
Level 3	Autopoiesis and Knowledge Management	Ishikawa (1999) Maula (2000) Kay and Cecez-Kecmanovic (2002) Jackson (2007)
Articulation of Autopoietic Principles and Insights		
Level 2	Autopoiesis and Knowledge	von Krogh et al. (1996) Cardoso et al. (2000) Hall (2005) Limone and Bastias (2006) Mingers (2006) Zeleny (2006)
Level 1	Autopoiesis and IS	Mingers (1995) Savory (2002) Kay and Cecez-Kecmanovic (2002)

Table 4.1 Autopoiesis and Knowledge Management Literature

From a conceptual standpoint, the categorisation starts with information systems because this is where the evolution to knowledge management started. As research in knowledge management progressed, knowledge and epistemology became the focus of study (Metaxiotis et al., 2005, p. 7), and so these are presented second in the taxonomy. Third and fourth, are the application of autopoiesis to knowledge management and knowledge management systems respectively. A separate level was created for knowledge management systems because not every approach to knowledge management requires a technical system: such as organisational learning or changing organisational culture.

Reviewing the literature in Table 4.1, an interesting trend emerges from levels two to four inclusively. All authors in level two agree that knowledge is unmanageable, embodied in the knower and non-transferable (Hall, 2005, p. 177 and Limone and Bastias, 2006, p. 43).

However, the problem arises from level three because this is where authors disagree on a number of issues. Firstly, whether organisations themselves are autopoietic (Maula 2000, p. 158) or not (Ishikawa, 1999, p. 821), and secondly, whether knowledge is autopoietic in nature or instead, just emergent (Abou-Zeid, 2007, p. 615), and finally, whether autopoiesis can only be used metaphorically (Jackson, 2007, p. 90), or literally (Maula, 2006, p. 80). It would appear there is a conceptual gap between levels two and three, which would essentially break down autopoiesis into principles and insights as well as to provide a correct interpretation, and this is the focus of the next section in this chapter. This gap is shown in Figure 4.1 between levels two and three. Once the central tenets of autopoiesis had been established, along with other relevant insights, they were used to create an autopoietic model of organisational learning from a pre-existing model, and to create an autopoietic model of knowledge. Creating these two models is the first step to systematically giving knowledge management the autopoietic foundation it needs (Limone and Bastias, 2006, p. 39). Applying autopoiesis to knowledge management in this way will give knowledge management a common, biological foundation, which is based on a true representation of knowledge (Maturana and Varela, 1998, p. 27). By identifying the principles of autopoiesis for knowledge management, and by creating the autopoietic model of knowledge, it should become possible to apply autopoiesis to knowledge management through these concepts/models instead of having to keep referring to the autopoiesis literature. In this way, a common understanding of autopoiesis can be used, and knowledge management can develop from a common foundation when it comes to ideas pertaining to knowledge and learning (Limone and Bastias, 2006, p. 39).

4.2 The Principles of Autopoiesis

Autopoiesis is a systems thinking way of viewing living systems, such that it can define 'beyond the diversity of all living organisms, a common denominator that allows for the discrimination of the living from the non-living' (Luisi, 2003, p. 49). Autopoiesis highlights the importance of the network of processes (or relationship between the components) as the central idea. It is the relationship between components (or organisation) that allows the machine to be living, not the actual components (the structure). It would then make sense to infer that autopoiesis is the act of maintaining constant a living system's organisation.

There are four consequences of an entity being autopoietic: autonomy, individuality, organisational closure and self-specification of boundaries (Maturana and Varela, 1980, p. 80). Autonomy is the ability of an entity to specify its own laws and the behaviour it exhibits (Maturana and Varela, 1998, p. 48). The view that living entities are autonomous also contributes to the individuality of living entities. Maintaining their organisation as autopoietic, living entities are also actively maintaining their identity (Maturana and Varela, 1980, p. 79). Organisational closure is an essential feature of autopoietic entities, if they are going to remain living; if they did not maintain their autopoietic organisation, they would disintegrate, and die. However, just because a system is organisationally closed, does not mean it cannot receive physical inputs (Mingers, 1995, p. 33). An autopoietic entity is also able to specify its own boundaries. In the case of a cell, the internal dynamics produce the necessary components for the boundary while, at the same time, the boundary contains the processes of self-production (Maturana and Varela, 1998, p. 46).

Developed in 1974 (Varela et al., p. 192) there are six principles of autopoiesis that can be used to determine whether any given system is autopoietic (two principles have been absorbed into point 4 below).

1. Make sure the system/object under study is suitably bounded, such that it

can be identified and separated from everything else.

2. The system must have component parts to study.

3. The system must be mechanistic - change can only come about from within the system. External factors can only trigger change and not determine it. No synergetic processes are allowed.

4. All processes should be circular. Not directly linked to boundaries, but internal components should have a preference to interact with each other and not external processes (no identifiable entity otherwise).

5. There should be no direct input to change the systems organization.

Autopoiesis also provides numerous insights into knowledge (Limone and Bastias, 2006, p. 39; Luisi, 2003, p. 55; Maturana and Varela, 1980, p. 119; Maturana and Varela, 1998, p. 174; Mingers, 1995, p. 47), and these are as follows:

1. Without a question, or apparent lack of knowledge, no new knowledge will be admitted.

2. Knowledge gives certainty to acts.

3. Objective knowledge constitutes a description of that which is known i.e. there is no such knowledge.

4. There is only personal knowledge.

5. Informing is the process of converting data into knowledge

These five insights can be combined to create a new, autopoietic definition of knowledge: 'We admit knowledge whenever we observe effective action/behaviour in a given context (realm/domain), which we define by a question, either explicit or implicit' (Maturana and Varela, 1998, p. 174). It is not necessary to define the actual nature of knowledge, since it is necessarily embodied in the knower. The first insight states that a question is the starting point for the generation of knowledge. Without a question, the potential knower is not aware they lack knowledge on a certain topic, and therefore will

not attempt to create any new knowledge. The second insight confirms the notion that knowledge is linked to action, and that any action is necessarily based on knowledge of the actor. The third insight attempts to objectify the problem by classifying knowledge as either tacit or explicit. It proposes that objective knowledge is not really knowledge, since it is merely a description of what the knower has knowledge of. The final insight articulates that knowledge can only exist when it is embodied in the knower, and that knowledge can never be stored independently of the knower. The notion of personal knowledge also implies that knowledge cannot be transferred to another knower, with no loss of meaning. The notion that informing is the process used to convert data into knowledge recognises the autopoietic position that only data and knowledge exist. Everything that exists in the 'real world' is data, and everything that is embodied within a person is knowledge. The data/information/knowledge hierarchy that is so popular is in fact a misrepresentation of the process, and attempts to make information an entity, as opposed to the process it is.

Having identified the main principles of autopoiesis, along with its perspective on knowledge, it is now possible to achieve objective three and five of this study, determining whether autopoiesis can be applied to an existing model of organisational learning and whether an autopoietic model of knowledge can be developed.

4.3 A Matching Methodology

At this stage, a suitable methodology is needed to create a new model of knowledge. Research methodologies typically fall into two categories: positivism and interpretivism. As described in more detail in the methodology chapter, positivists believe that all knowledge arises from observing phenomena in a real and objective world (Cornford and Smithson, 1996, p. 59). Favoured with the science disciplines, positivist based research aims to give hard, objective facts for results, which are easily repeatable. Interpretivism, on the other hand, seeks to 'understand reality through the realm of individual

consciousness and subjectivity' (Jashapara, 2004, p. 42).

It is apparent that neither positivism nor interpretivism is solely suitable for applying autopoiesis to knowledge management. However, an integration of ideas from both perspectives would ideal, and this possible using matching. Matching is a methodology developed by von Krogh et al. (1996, p. 160) and is used for the integration of two or more theories. Often described as unifying languages and relationships, matching is a two-step process: theoretical discourse and inscription. Theoretical discourse is the frequent dialogue about the theories, from which a new language emerges and through which the theories unite. Following on from which is inscription, which can be defined as 'the process of making and presenting knowledge from the first stage, such that it can inform other theory building attempts' (von Krogh et al., 1996, p. 160).

The matching process used to develop the models of knowledge and of organisational learning, took place over the course of several meetings between the author and the supervisory team. All potential terms to be used in the models were discussed and definitions of words were explored to resolve any conflicts; for instance, whether the term 'observation' was purely related to sight, or all senses. Ideas pertaining to the data/information/knowledge hierarchy were discussed, along with whether information is a pseudo step that really represents the process of informing. Applications of the models were also explored to ensure terminology being used was not inherently restrictive. The second stage of the process involved the creation of the models of knowledge and organisational learning. After the initial models were created, they were subject to a minimum of two reviews prior to being finalised.

4.4 The Autopoietic Model of Organisational Learning

There were numerous models that could have been chosen, such as Buckler (1996, p. 37), Matthews (1999, p. 26) or Ortenblad (2004, p. 139), but Kim's

model (Figure 4.2) was selected. Whilst Buckler's (1996, p. 37) model does contain elements of feedback, it is not an inherently circular model, like that of Kim's (1993, p. 44). Buckler's (1996, p. 37) emphasis is also on organisational learning, virtually ignoring the process of individual learning. Matthews (1999, p. 26), on the other hand, has undeniably created a circular model, but again does not detail how individual learning occurs, or indeed that it occurs in a separate cycle to organisational learning. Örtenblad (2004, p. 139) uses the slightly different perspective of the learning organisation, and has a circular model but, unlike Kim's (1993, p. 44) model, has two inputs to the cycle, which, in autopoietic terms, is undesirable, since external influences cannot determine change that occurs within an autopoietic entity.

Kim's (1993, p. 38) model of organisational learning starts on the employee level, and defines individual learning as based on the Experiential Learning Model. The cycle starts with a concrete experience, on which an observation may or may not be made. If an observation is made, then the individual will assess that observation (either consciously or sub consciously) to create, or design, generalisations or abstractions of that situation. Finally, the individual will test, or implement the generalisation in the real world, hence creating another experience and starting the cycle again. From individual learning, Kim (1993, p. 45) adds the notions of single and double loop learning to the model. The main distinction made by Kim (1993, p. 39) is that only double loop learning uses memory, and single loop learning links straight from the Observe-Assess-Design-Implement cycle (Figure 4.2) to individual action. The link to memory by double loop learning infers the presence of mental models, which take the form of frameworks and routines. Together, these frameworks and routines model a person's view of the world, in turn affecting any abstractions/ generalisations they design and implement.

Moving to the organisational level, Kim (1993, p. 43) identifies shared mental models as the key to access the organisational memory. Shared mental models

can directly lead to organisational action, but can also affect individual action through a person's individual mental models. The model goes on to show how individual and organisational action occurs, with the resulting environmental response that is observed by the original Observe, Assess, Design and Implement cycle at the start of the model.

4.4.1 Individual Learning through the Lens of Autopoiesis

The model proposed by Kim (1993, p. 44) was examined under two main sections, individual learning and organisational learning. This section will focus on individual learning, and how autopoiesis can be applied.

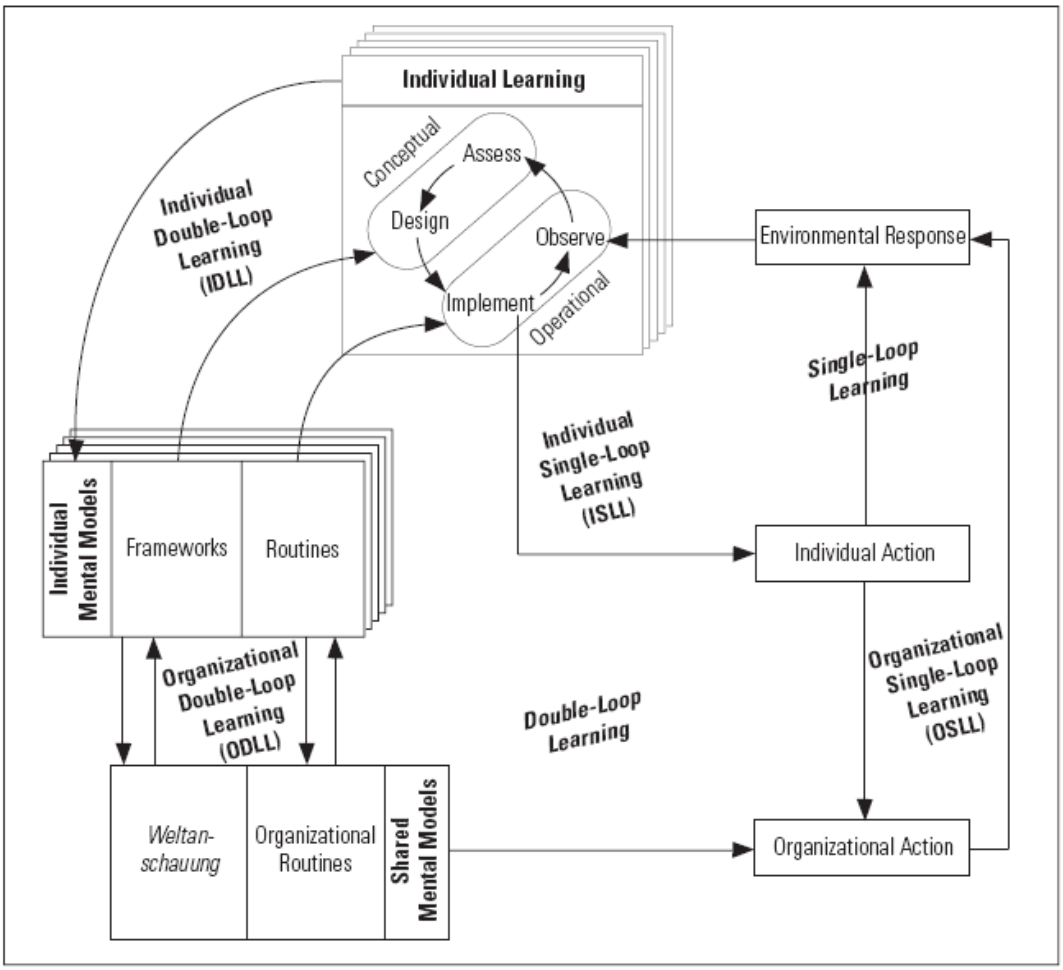

Figure 4.2 Kim's Model of Organisational Learning (1993, p. 44)

Individual learning can be summarised as shown in Figure 4.3 (Modified From Kim,1993, p. 44). The model shows the Observe, Assess, Design and Implement (OADI) framework for learning, along with single and double loop learning. It details how single loop learning is concerned with adapting actions according to the difference between the target output and actual output, whilst double loop learning looks at how to change any necessary behaviours and mental models. For the purposes of analysis, the model will be divided into the learning process (OADI framework), single loop learning and double loop learning.

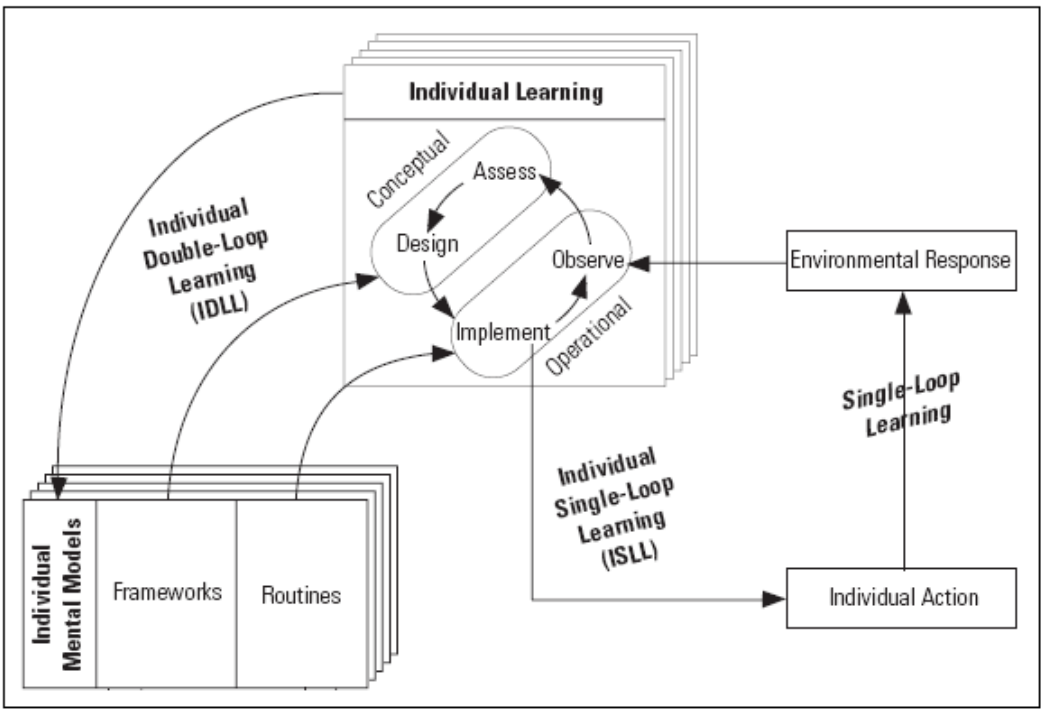

Figure 4.3 Individual Learning

4.4.2 OADI Framework

In terms of autopoiesis, the most significant feature of the OADI framework is its circularity. Kim (1993, p. 39) has portrayed individual learning as being an iterative process, with the implication of no starting point, rather than a series of steps, as in a linear model. A comparison can be drawn with Maturana and

Varela's (1998, p. 46) discussion of the boundary and metabolism of cells. They say that 'it is not that first there is a boundary, then a dynamics, then a boundary, and so forth' (Maturana and Varela, 1998, p. 46). Rather they propose that the circularity is a 'type of phenomenon in which the possibility of distinguishing one thing from a whole depends on the integrity of the processes that make it possible' (Maturana and Varela 1998, p. 46). This means the processes that compose the entity are not linear, and it is a never-ending loop, and that this is integral to an autopoietic entity.

The cell and OADI framework can now be compared. The learning process is comprised of four stages, which follow on from each other, with the implied assumption that learning is a continuous process. However, it would appear that a more accurate representation of the loop should have two observe stages, placed next to each other. This would then accurately represent observing a potentially solved problem, and a different problem that is about to occur. This is shown in Figure 4.4.

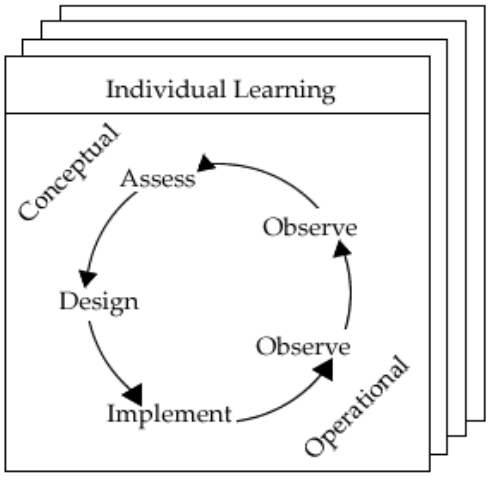

Figure 4.4 OOADI Framework

The new OOADI framework, along with cells, can be considered a 'unitary phenomenon' (Maturana and Varela 1998, p. 46), because it exists as a

continuous process which can never be stopped, without disintegration of the entity. However, single and double loop learning form an important part of individual learning, and it would be desirable to apply autopoiesis to them.

4.4.3 Single Loop Learning and Autopoietic Learning

Single loop learning is based on the idea that 'learning involves the detection and correction of error' (Argyris & Schön, 1996, p. 21). This error based approach means that if an error occurs, the person changes their actions so the error does not happen again. As shown in Figure 4.5 (modified from Smith, 2001), single loop learning is when the action strategy is changed as a result of some consequence. E_s shows where the error correction occurs in single loop learning, and E_D shows where error correction occurs in double loop learning.

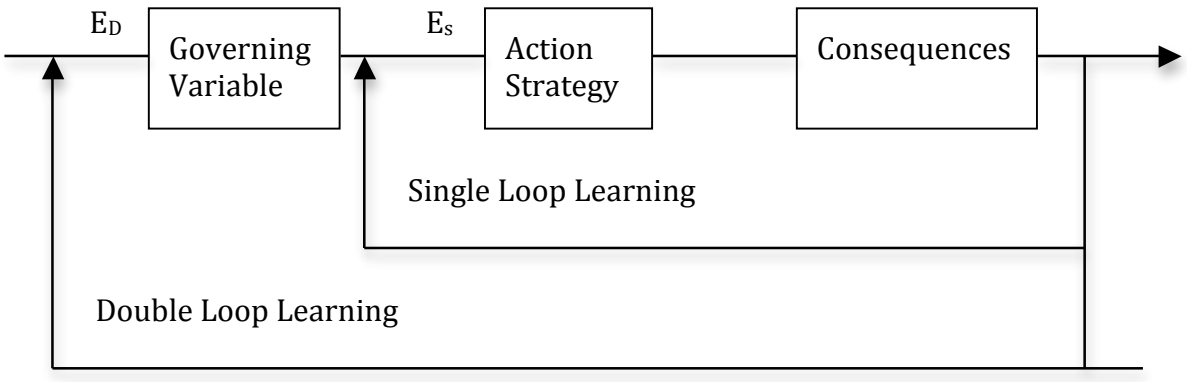

Figure 4.5 Single and Double Loop Learning

One feature of autopoietic entities is that 'the environment only triggers structural changes in the autopoietic unities (it does not specify or direct them)' (Maturana and Varela, 1998, p. 95). This is akin to single loop learning because the consequences do not determine the change that will happen, it merely starts it. This kind of learning can be renamed autopoietic learning, defined as a random change of behaviour when current actions do not have the desired effect or outcome.

The key feature of autopoietic learning is that when an undesired outcome occurs, the person undertakes an unconscious attempt to produce the desired effect. This is characterised by a random change of behaviour without any analysis of what went wrong in the first instance. The second key point is concerned with the person's mental models and could be portrayed as a benefit over double loop learning. When a person is trying to gain the desired outcome by trial and error, they are also adding to their mental model the fact that other solutions do not work. There is also the chance of discovering something that can be used elsewhere, or to solve another problem, and this can be beneficial.

4.4.4 Double Loop Learning and Allopoietic Learning

Double loop learning is when the consequences of an action cause the person to look back at their 'governing variable' (Smith, 2001), or 'individual mental models' (Kim, 1993, p. 45) and determine frameworks or routines that caused the consequences so that they can be changed. This is not similar to an autopoietic entity because the environment can only trigger the change, it cannot determine it. However, if a machine is not autopoietic, it is an allopoietic machine which has, as a product of its functioning, something different from themselves (Maturana and Varela, 1980, p. 80).

Hence, double loop learning can be considered allopoietic learning because, when a person carries out double loop learning, the product is a new mental model or a model specified by the environment. Allopoietic learning can be defined as a specific and, possibly, known change of behaviour when current actions do not have the desired effect or outcome. Several examples of allopoietic learning exist, such as teaching secondary school children about cells or gravity. Since the children have no concept of gravity, or that all living things are composed of cells, they will require new mental models.

It is also interesting to note the location of where the arrows indicating double loop learning (Figure 4.2) leave and return to the OADI cycle. With single loop learning, the individual 'sees' the result of their actions through the Observe Stage of their learning. This observation then affects the implementation next time, and this has already been shown as being autopoietic. However, the difference comes with double loop learning. The arrow going to the Individual Mental Models box does not leave from one of the four processes in the OADI cycle. This again shows that double loop learning is not autopoietic, as it must be actively employed by the individual.

So far, it has shown how autopoiesis theory can be applied to individual learning. Single loop learning has been shown to be autopoietic, displaying the properties of an autopoietic entity, where the person's mental models were taken as the entity. However, double loop learning was shown not to be autopoietic in nature. This is not a downfall as it was shown to display allopoietic properties, which is still part of autopoiesis theory. Figure 4.6 shows Kim's model (1993, p. 44) as modified by this section.

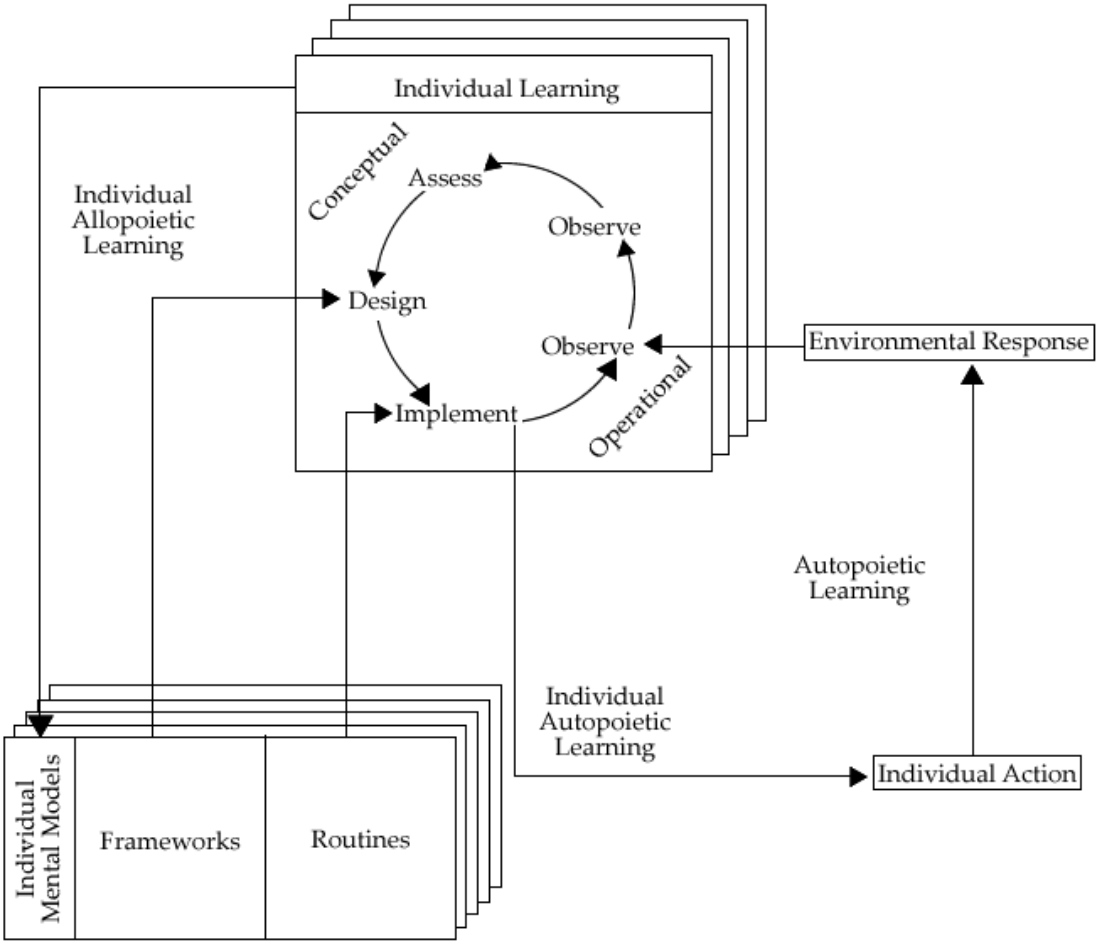

Figure 4.6 Autopoietic Individual Learning

4.4.5 Individual and Shared Mental Models: The Link

Having considered how individual learning can be considered autopoietic in nature, the next step is to evaluate individual and shared mental models. The relationship between individual mental models (IMM) and shared mental models (SMM) is one of the most influential parts of the organisational learning model.

The concept of shared mental models is an important concept in Kim's model (1993, p. 45). As shown in the model, the shared models have most effect on the individual mental models, and this is shown in Figure 4.7. If the individual and shared mental models are considered as two autopoietic entities, then it

would appear their relationship can be modelled using structural coupling. This is because their relationship with each other is one of dependency.

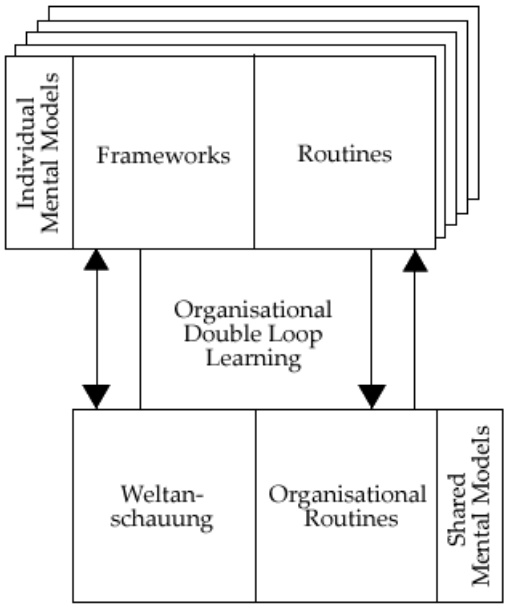

Figure 4.7 Link Between IMM and SMM

Individual mental models use the shared mental models as a reference for forming its frameworks and routines. If anything changes in the 'Weltanschauung' or 'Organisational Routines', then a change will occur in the frameworks or routines of an individual's mental models. However, it is also important to note that the link is that of double loop learning, which means the change in one entity not only triggers the change in the other entity, but it also determines the change. This means that the relationship cannot be modelled by structural coupling because any change must be determined by the entity, and not the environment. It also means that mental models are not autopoietic, since any change in an autopoietic entity can only be determined by its structure, not an external entity.

Perhaps a better representation between the individual and shared mental models is that shown in Figure 4.8 (Modified from Maturana and Varela, 1998,

p. 46), which shows a continual circularity with no start or end. It is obvious that the shared mental models cannot occur before the individual mental models, yet the individual mental models are based on the organisation's shared models. It has also been shown previously that double loop learning is comparable to allopoietic learning. However, a problem exists when considering newly formed organisations. Whilst no research appears to exist on this, it can be assumed that the main founder imposes their mental models as the shared models, and then the models are refined as more people start to have an input.

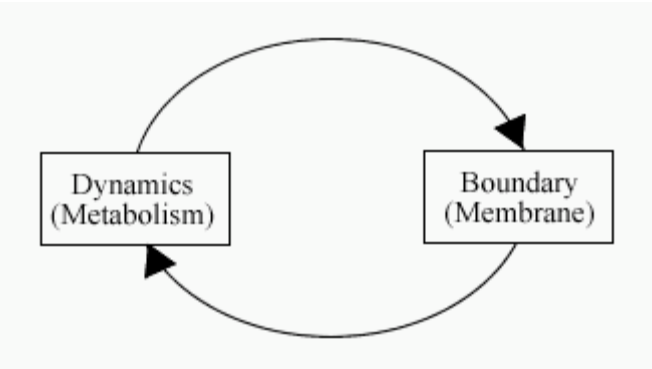

Figure 4.8 Cell Metabolism

This section has shown how organisational learning can be considered autopoietic by looking at the ideas on which Kim (1993, p. 44) built his model. It has used the circularity of autopoietic entities as the main foundation. This section has also considered shared mental models and how these can be explained using autopoietic theory.

4.4.6 Organisational Learning through the Lens of Autopoiesis

The model by Kim (1993, p. 44), as shown in Figure 4.3, shows organisational learning as an 'add on' to employee learning. This is better than taking an overall view to organisational learning because it recognises the importance of employees.

4.4.7 Organisational Learning Model

As discussed by Kim (1993, p. 42), the preliminary aspects of organisational learning are dependant on March and Olsen's model (1975, p. 150). The model is shown in Figure 4.9. The most important feature of this model is its circularity. There are additional labels in the original model, but these are not important and hence have been excluded. This circularity is the fundamental aspect of all autopoietic entities.

The distinction that Maturana and Varela make about Figure 4.8 is that it is not sequential. Rather, they state it is 'two different aspects of a unitary phenomenon' (Maturana and Varela, 1998, p. 46). This means that it is not the case that the boundary exists first and then the internal dynamics, or vice versa, but instead, they both come about simultaneously. The same logic can be applied to Figure 4.10 (March and Olsen, 1975, p. 150). For instance, every belief will manifest itself in a person's action, whether it is conscious or not. Also, every action will cause an environmental response, although this response does not have to be an actual change.

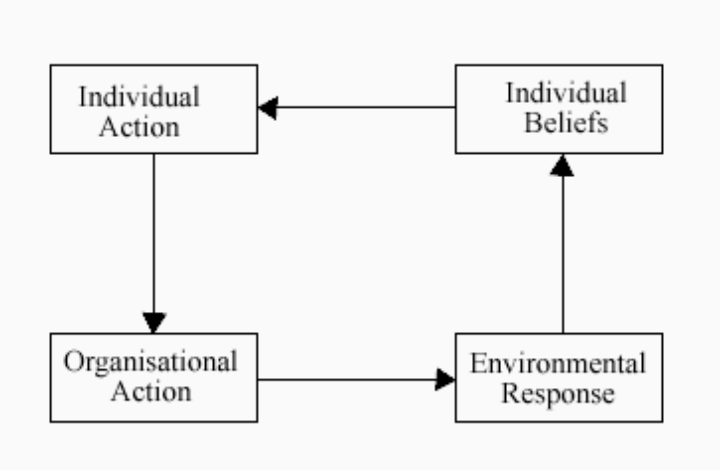

Figure 4.9 Organisational Learning Model

There is one problem with the model by March and Olsen (1975, p. 150) as they include the environmental response as part of the cycle; Maturana and

Varela clearly state that an autopoietic entity must be distinguishable from its environment (Maturana and Varela, 1980, p. 79). Hence, the environment cannot form part of the organisational learning loop. However, if that stage is changed to 'Observed Environmental Response' the problem disappears as it is then the person's, or organisation's, perceived response, and this is internal to the entity.

The adapted model has been shown in Figure 4.10. However, the Observed Environmental Response area needs further examination. One of the key statements underpinning autopoiesis theory is that 'everything said is said by someone' (Maturana and Varela, 1998, p. 27). This is expanded by Maturana (1988, p. 25), who says observing is both the ultimate starting point and the most fundamental question in any attempt to understand reality and reason as phenomena of the human domain. This means that it is not possible to comprehend any kind of reality or objective world, without understanding how people observe, because perception affects how the world is viewed.

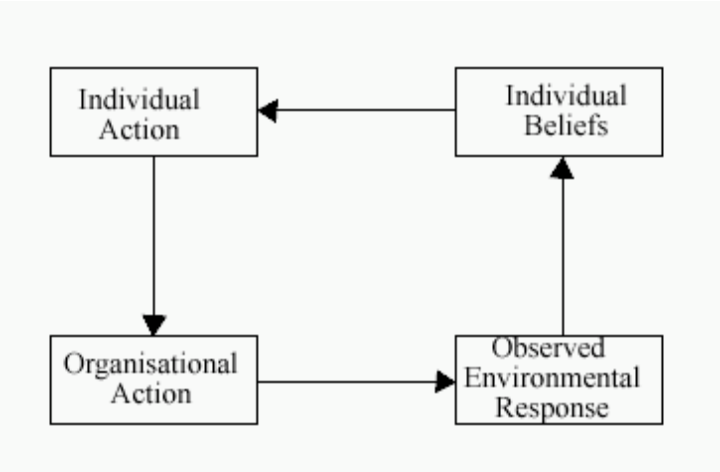

Figure 4.10 Adapted Organisational Learning Model

Once people have observed the environmental response, they form perceptions based on their observations. Hence, when Maturana and Varela

(1998, p. 27) say that 'everything said is said by someone', they mean that everyone views the world through their perceptions and so embeds those perceptions in their view of the world or any actions in it.

4.4.8 The Final Autopoietic Model of Organisational Learning

A new model of organisational learning is shown in Figure 4.11. It shows the changed relationship between the individual and shared mental models as well as the new, observed environmental response box. The relationship between the individual and shared mental models is now curved to show the circularity that is inherent in the relationship. The new OOADI loop is also shown within Figure 4.11.

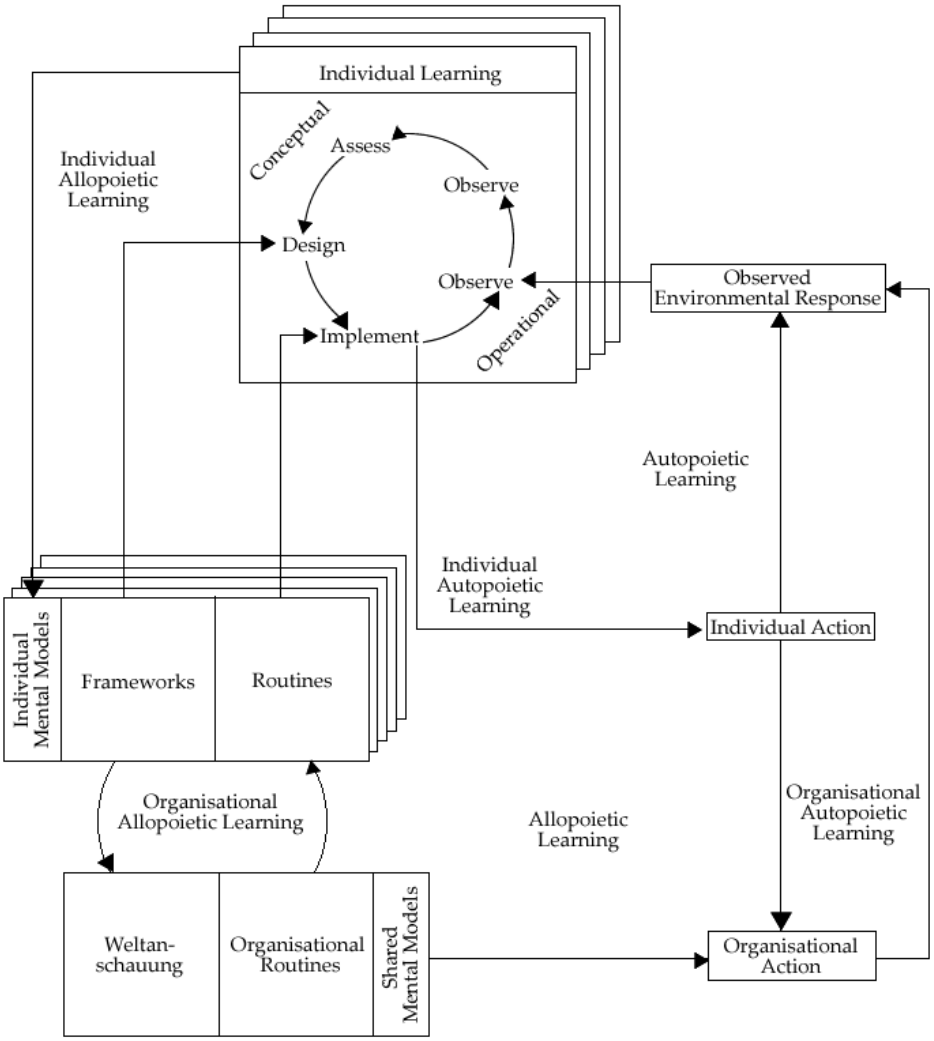

Figure 4.11 Autopoietic Organisational Learning Model

4.5 The Autopoietic Model of Knowledge

Using the autopoietic principles and insights presented earlier, it is possible to create a model of knowledge, and this model is explained in detail in this section.

4.5.1 Distinctions and Observations

Living systems observe by making distinctions (Maturana and Varela, 1998, p. 40) where observations are not necessarily related to sight, and as such, this should be the starting point for any model of knowledge. The argument for this is that any time we refer to anything, either explicitly or implicitly, a criterion of distinction is being made. This criterion indicates the object under observation and any properties relevant to the object. In other words, living systems must be able to tell apart an object it can observe from its 'ambient' environment. Subsequently, any object in the environment is observed, or perceived by an act of distinction. This is not an option process, 'we are necessarily and permanently immersed in it' (Maturana and Varela, 1998, p. 40). For instance, consider a single swan in the middle of a large lake, with no other plants or animals around. It is only possible to see the swan because it can be distinguished from its ambient environment: the water and the sky. At nighttime, with no light, artificial or otherwise, the situation is different. With no light, it is no longer possible to see the swan since it cannot be distinguished from its environment. So, it is possible to see a direct link between observation and making a distinction: it is not possible to observe without making a distinction, as shown in Figure 4.12. The arrow indicates the flow of data containing the criterion for the distinction, which feeds into the observation stage.

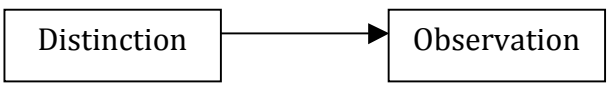

Figure 4.12 The Relationship between Distinction and Observation

4.5.2 Observation and Knowledge

'We admit knowledge whenever we observe effective action' (Maturana and Varela, 1998, p. 174) is one of the cornerstones of an autopoietic view on knowledge. This direct link identifies the main 'handle' for working with knowledge as observation. It is important to note that the action can originate from either the knower or anything in the environment. Immediately, one problem arises: this view assumes that observing ineffective, or wrong, action does not lead to knowledge gain. However, considering the autopoietic perspective that 'failure' and 'ineffective action' are external concepts that presuppose a shared, common reality, it becomes apparent that the action is only viewed as ineffective by the observer. From the viewpoint of the actor, all action is effective action because it is always based on knowledge. It would also seem unsatisfactory to say people gain knowledge by just observing, based on literature surrounding single and double loop learning (Argyris and Schön, 1996). It would appear that there needs to be a third process occurring, possible from the individual learning literature, either before the observation takes place (p1), or once it has occurred and before any knowledge is created (p2), as shown in Figure 4.13. The arrow in this instance carries the data obtained from the act of observing.

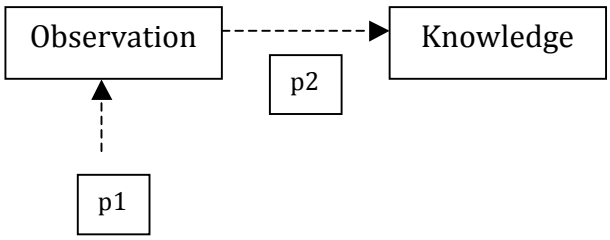

Figure 4.13 The Relationship between Observation and Knowledge

4.5.3 Knowledge and Action

As previously identified, there is a link between observing effective action and admitting knowledge; this means knowledge should lead to effective action, also indicating a direct relationship. This finding also correlates with previous work, which finds knowledge and action linked in a mutual relationship (Maturana and Varela, 1998, p. 27; Orlikowski, 2002, p. 251). Numerous examples of this link appear to exist, generally from 'training' perspectives. For instance, anybody old enough can pick up a paintbrush and paint a wall, but the quality of work will vary. If people are trained how to paint a wall, they will inevitably increase their knowledge about painting, enabling them to be more effective in carrying out the painting.

4.5.4 Questions and Knowledge

Without a question, or apparent lack of knowledge, no new knowledge will be acquired (Maturana and Varela, 1998, p. 174). This fundamental statement implies the presence of an internal, cognitive process that assesses current knowledge and determines whether there are any gaps or inaccuracies that need addressing. The creation of a question also addresses the issue raised earlier when considering the link between observation and knowledge. The assessment procedure that results in the question is capable of acting as 'p2' in Figure 2 because it removes the issue of random observation adding to a person's knowledge. Subsequently, Figure 4.13 now changes as shown to Figure 4.14. The arrow from question to observation represents the flow of data that contains the need for the observation to occur.

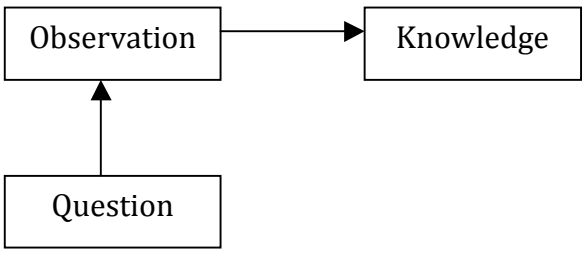

Figure 4.14 The Relationship between Observation, Question and Knowledge

4.5.5 Action and Distinctions

Any action a person takes as a result of their knowledge will result in an opportunity for observation (the opportunity also exists when observing action taken by others). However, as proved earlier, observation only occurs through making distinctions, therefore a link will exist between 'Action' and 'Distinction'. A special case exists where people observe the effect of their own action. In this instance, the model effectively becomes self-checking because, once the person takes action, they are able to assess if the desired outcome is achieved, and whether there is any room for improvement. This is essentially the role of reflection.

4.5.6 The Final Autopoietic Model of Knowledge

Having explored all aspects of autopoietic insights into knowledge, the final model can be presented (Figure 4.15). It shows how distinctions allow observations to take place and how those observations can lead to knowledge. It also shows that creating knowledge depends on a lack of knowledge existing (in the form of a question) and also that knowledge leads to effective action. The model concludes that this action then leads to an opportunity for more observation to occur, provided that a question also exists such that more knowledge can be gained.

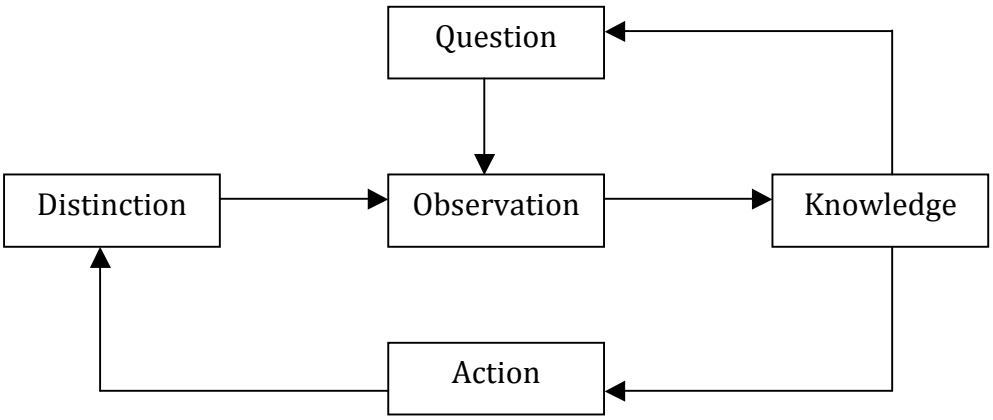

Figure 4.15 The Autopoietic Model of Knowledge

Having created this new, autopoietically based model of knowledge, the next step is to consider its applications in knowledge management. Since autopoiesis considers knowledge as embodied in the knower (Abou-Zeid, 2007, p. 615) the other elements in the model effectively act as a 'handle' on knowledge, giving it a way to be managed: albeit indirectly. In line with the aim to give knowledge management an autopoietic foundation, the next step for this model is to test its applicability to other models/definitions of knowledge management. Every knowledge management system must have at its core a definition of knowledge, and applying this model in its place will be the first step in giving knowledge management an autopoietic foundation. Since the model was developed to span the different perspectives on knowledge management, applying the model of knowledge to models or theories in these different perspectives should unite knowledge management. With this achieved, it should become easier for organisations to identify what knowledge management can achieve, what it is capable of doing and what limitations it may have.

4.6 Summary

Having created two autopoietically based models (Figure 4.11 and Figure 4.15), from the autopoiesis and knowledge management/organisational learning literature, the next stage considers testing them to explore whether they still reflect organisational working procedures or are still a true representation of reality. Testing the models involves assessing the correct research philosophy and approach to use and creating the test instrument. If these models are proven to be correct, it will be the first step to creating a domain wide foundation for knowledge management, which will allow the discipline to move forward with a common understanding.

To try and make the model more applicable to real-life work scenarios, guidelines will need to be developed to help users apply the model to their

current knowledge management practices or theories (Objective 7). This is an important stage because knowledge management will not get the autopoietic foundation it needs if only theoretical aspects are underpinned by autopoiesis, and not the practical.

Chapter 5 Testing the Autopoietic Model of Organisational Learning

Chapter four detailed the development of an autopoietic model of organisational learning, and this chapter presents the findings from the questionnaire to test the model. Testing the autopoietic model of organisational learning (Objective 4) was important for two reasons: first, the original model had never been tested, and second, it was important to ensure that providing the autopoietic foundation to the model did not misrepresent what actually occurred in organisations. A paper detailing the development, and piloting, of the questionnaire was presented at ECKM (Parboteeah et al., 2007).

5.1 Introduction

The questionnaire to test the autopoietic model of organisational learning (Appendix 1), had mainly questions with linear scales, typically starting with never, totally disagree or yearly, and ending with always, totally agree or daily. For the purposes of analysis, the results were coded, with 1 being allocated to the response least supportive of an autopoietic perspective, and 5 to the most supportive result. Thirty three responses were received from Prosidion, out of 39 requests, giving a 84.6% response rate. A total of 37 responses were received from CSG, out of 61 requests. The raw data collected is presented in Appendix 2 As stated in the methodology (Chapter 4), there are several tools available to analyse the data collected. Mode and median analysis can be performed as a measure of central tendency, calculating quartiles can be used to analyse the spread of the results (Stevens, 1946, 678).

The survey used was descriptive in nature, as opposed to being exploratory (Chen et al., 2006, p. 10), since its purpose was to either confirm or disprove a final model. Despite the relatively low sample sizes, they are above the recommended minimum of 30 (Saunders et al., 2007, p. 211) and are

substantially above the response rates normally received for KM surveys: 5% - 23% (Wong and Aspinwall, 2005, p. 67). SMEs also tend to be more reluctant than large organisations to participate in academic research, especially theoretical work (Chen et al., 2006, p. 11).

5.2 Developing the Questionnaire

The majority of questions were closed questions, with the only open ones being used for demographic questions, and the last question, which asks if there are any comments the respondent would like to make. Using so many closed questions had the benefit of keeping the respondent focused on the important issues and forced them to think specifically about the issues. Multiple-choice answers were the most common closed question type, because they were most suited to ask respondents about their level of agreement about something. Questions in the questionnaire followed the same flow as the interview: individual learning, mental models finishing with organisational learning. The first set of questions aimed to check the respondent's awareness of the individual learning loop. The second set of questions aimed to surface understanding of the role of mental models, and how they impact on the individual learning loop. The questionnaire finished with questions focussed on learning at the organisational level.

5.2.1 Rationale for AMOL Questions

Demographic Questions

These three demographic questions set the scenario for the respondents' answers. They could also reveal trends about whether certain ages, or attitudes associated with ages, are responsible for the responses given, or whether the employees' time in the organisation is a factor. The level of authority the employee has is also likely to have a large impact on the answers given.

1. Please select your age range:

[Under 18] [19 – 30] [31 – 40] [41 – 50] [51 – 60] [61 – 70] [71 and over]

2. How many years have you been working at this organisation?

[Open Ended]

3. What position do you hold?

[Open Ended]

Individual Learning Questions (OOADI Framework)

In order to test the OOADI Framework, it is first necessary to pick out an event for which the employee has experience of. The assess stage of the cycle can be performed either consciously or subconsciously (Kim, 1993, p. 44), but as it is impossible to test a subconscious assessment, question five only considers active reflection. Questions six and seven test the design and implement stages of the cycle by asking how much of an impact the experience has made on future work.

4. How frequently do you reflect on why things happen at your organisation?

[Never] [Rarely] [Sometimes] [Frequently] [Always]

5. How often can you work out what caused something to happen in your organisation?

[Never] [Rarely] [Sometimes] [Frequently] [Always]

6. When you do reflect on why things happen in your organisation, does it impact on your work?

[Never] [Rarely] [Sometimes] [Frequently] [Always]

7. What percentage of your work would you estimate as routine?

[0% - 19%] [20% - 39%] [40% - 59%] [60% - 79%] [80% - 100%]

8. For aspects of your work which are routine, how frequently do you encounter problems?

[Daily] [Weekly] [Monthly] [6 Monthly] [Yearly]

9. Do you often accept facts without checking if they are correct?

[Never] [Rarely] [Sometimes] [Frequently] [Always]

Individual Mental Models Questions

The main components of individual mental models are frameworks and routines. If an employee thinks of their work as routine, it is reasonable to assume that they have developed routines for what they do. The existence of routines subsequently proves the existence of mental models. Question ten is used to try and elicit whether people are aware of any mental aids to problem solving. Questions eleven, twelve and thirteen attempt to show that frameworks are present in employees' mental models, and do this by assessing whether the employee uses assumptions and has their own problem solving routines.

10. How often do you use past experience when facing a new situation?

[Never] [Rarely] [Sometimes] [Frequently] [Always]

11. How often do you follow the same process when you problem solve?

[Never] [Rarely] [Sometimes] [Frequently] [Always]

12. Do you have ideas about how your work could be done better?

[Yes] [No]

13. To what extent do you agree with the following statement? 'I would attempt to make something better even if there was no problem with it'

[Totally Disagree] [Mostly Disagree] [Neither Agree or Disagree] [Mostly Agree] [Totally Agree]

Organisational Learning Questions

This section of questions examines the organisational learning cycle part of Kim's model (1993). The cycle starts with individual beliefs, which leads to individual action. Individual action subsequently leads to organisational action, and then to an environmental response. Question fourteen starts by trying to elicit the individual's beliefs. It was decided not to ask about beliefs directly as this could cause confusion with religious beliefs. It is inevitable that all respondents will have views about their work, even if they are negative ones. Question fifteen hopes to find out the proportion of people that act upon their beliefs. It is essential that some employees take action, else according to the model, nothing in the organisation would happen.

Question sixteen attempts to show whether the link between individual and organisational action exists. If ideas are being formally approved and incorporated into company policy, then it shows the model is correct. However,

even if the idea is not accepted, so long as it is considered, then it proves the model because if ideas are not suitable, then they should not be implemented. Question seventeen is testing whether individuals follow up on their ideas once they turn into organisational action. This would then complete the cycle of organisational learning.

14. When have you or your colleagues last had an idea that has been formally implemented?

[More than 1 year ago] [In the last year] [In the last 6 months] [In the last month] [In the last week]

15. How often do you follow up what happens to your ideas when you suggest them?

[Never] [Rarely] [Sometimes] [Frequently] [Always]

16. Do unwritten rules exist within your organisation?

[Yes] [No]

17. How often do unwritten rules affect working procedures in your organisation?

[Never] [Rarely] [Sometimes] [Frequently] [Always]

Shared Mental Models Questions

This section of questions would examine whether organisation wide mental models exist and if they had an impact on employees' working style. Questions eighteen and nineteen consider the concept of unwritten rules and their effect on organisational procedures. Whilst not identified by Kim (1993, p. 44) as

part of an organisation's mental models, they are an important part because they are neither documented nor formalised in organisational procedures. It is expected that most respondents will admit to the existence of unwritten rules, but it is not possible to estimate the response to question eighteen because it depends on how observant the employee is.

Questions twenty and twenty one attempt to show the organisation's 'Weltanschauung' by drawing a comparison to its ethos. The ethos of a company is possibly the most accurate method of making an organisation's 'world view' explicit. The current trend is for organisations to display this clearly, but testing whether employees know, and agree with it, will examine its value. The final part of the shared mental models is the organisational routines that exist, either documented or intangible. This line of questioning aimed to determine whether respondents were aware of unwritten rules and their impact on organisational procedures.

18. How frequently do you follow guidelines when they exist for what you do?

[Daily] [Weekly] [Monthly] [6 Monthly] [Yearly]

19. How frequently do you question guidelines that affect your work?

[Daily] [Weekly] [Monthly] [6 Monthly] [Yearly]

20. How frequently do you attempt to change the guidelines that affect your work?

[Daily] [Weekly] [Monthly] [6 Monthly] [Yearly]

21. How much do you agree with your organisation's mission statement?

[Totally Disagree] [Mostly Disagree] [Neither Agree or Disagree] [Mostly Agree] [Totally Agree]

22. Are there any other comments you would like to make?

5.3 Analysing the Questionnaire Results

When considering what analysis will be conducted on the results obtained, it is important to consider the type of data collected. The questionnaire generates mainly ordinal data, with some interval data where timescales are concerned. The questionnaire does not use nominal or ratio data types. Ordinal data requires the use of modes or medians to assess the central tendency and the use of percentiles to assess the spread of the data (Stevens, 1964, p. 679). The interval data generated does permit the use of means to assess the central tendency and standard deviation for an assessment of the spread of data. The nominal, ordinal, interval, ration hierarchy provided by Stevens (1964, p. 678) is cumulative, meaning tests available for nominal data are also permissible on ordinal data. Likewise, tests for nominal and ordinal data are also valid on interval data. The questionnaire sent to CSG and Prosidion had 22 questions and questions 4 – 21 were subject to mode, median and inter quartile range analysis. Questions 1 – 3 and 22 were used to supplement the numerical analysis where appropriate.

5.4 Individual Learning Results

Six questions (Q4 – Q9) were asked in relation to the Observe-Observe-Assess-Design-Implement Loop. Considering the frequency of reflection (Q4) at CSG, only one respondent selected 'rarely', with all others selecting either 'sometimes' (16%), 'frequently' (70%) or 'always' (11%). Importantly, no respondent answered 'never'. At Prosidion, the figures are not focused so

heavily on 'frequently'. 12% of respondents selected 'rarely', 42% of respondents 'sometimes' reflected, 36% of respondents selected 'frequently', with the rest selecting 'always' (9%). Again, no respondent selected 'never'. This is initially a promising result, all respondents to some degree, reflecting on their work and organisation. Comparing the modal (most common) values, CSG's mode is 4, whereas Prosidion's is only 3, which appears to indicate that employees at Prosidion reflect less. The median value for CSG is 4, indicating that 50% of employees selected Frequently or Always, whereas at Prosidion, the median value is 3, indicating a wider lower central tendency. Considered along with the inter-quartile ranges of 0 for CSG and 1 for Prosidion, it can be deduced that employees at CSG not only reflect more frequently, but a greater percentage reflect more often than at Prosidion.

Question 5 focused on how easy it is for respondents to identify the cause of organisational action. Starting with Prosidion, only one respondent said they are 'never' able to identify the cause of organisation action, and no respondents said they could 'always' identify the cause of organisational action. The one person at Prosidion who could 'never' work out the cause of organisational action had been at the organisation for 1 to 5 years and held the post of scientist. At CSG, the other extreme exists. No respondents said they could 'never' work out the cause of organisational action, whilst three respondents said they were 'always' capable of determining the cause of organisational action. However, the length of time in the organisation does not reveal any pattern because one respondent had been at CSG for over 20 years, whilst one had just started and had between 1 and 5 years of experience at the organisation. The mode and median values are 3 for both CSG and Prosidion, indicating that 'sometimes' was the most common answer, with 50% of respondents either side. The inter-quartile range of 1 for both organisations indicates that 50% of respondents chose a response between 'sometimes and 'frequently' again indicating the tendency towards the centre of the scale.

Question 6 went onto consider the role of reflection as part of the OOADI Framework. For question 6, 16 (48%) respondents at Prosidion 'never' or 'rarely' felt their reflection impacted on their current work. Whilst at CSG only 5 (14%) respondents thought their reflection did not, or rarely had an, impact on their work. Whilst the result from Prosidion is particularly high, it does reflect the nature of the work force. Every year, Prosidion employs a large number of undergraduate students for a placement year, and the students do in fact make up over half of the 16 employees from Prosidion reported earlier. Interestingly, no respondents from Prosidion thought reflection 'always' impacted on their work, and only 2 respondents (5%) from CSG thought reflection 'always' impacted their work. The rest of the respondents, 17 (52%) from Prosidion, and 30 (81%) from CSG thought reflection 'sometimes' or 'frequently' had an impact on their work. Comparing the mode values from both organisations, CSG's was 3 but Prosidion's was only 2, supporting the claim that a largely transient workforce is detrimental to organisational learning. Inter-quartile range values for both organisations are 1, indicating a reasonably tight spread of the data. The ideal answer is that reflection always impacts on current work, because it offers the greatest learning experience. From the data obtained, it is not possible to determine why more respondents do not fully utilise reflection as a learning exercise, but speculation might suggest going with the status quo or insufficient training. Further work would benefit from follow up interviews to explore further employee perspectives on reflection.

Questions 7 and eight went on to ask about the percentage of routine work the respondent encounters and the frequency of problems. The perception of a routine across different tasks is important because it shows respondents have become aware of common underlying problem solving approaches. At CSG, the modal value as 4 indicating respondents felt 60-79% of their work was routine. At Prosidion however, the mode dropped to 2, indicating respondents generally thought only 20-39% of their work was routine. The inter-quartile range of 2 shows that 50% of responses fell in the range of 20-79%.

Considering Q8, both organisations had the same results: the mode was 4, the median was 4 and the inter-quartile range was 1. These results indicate that respondents only encountered problems in their routine work on average every 6 months. The inter-quartile range puts 50% of respondents in the Monthly – 6 Monthly range. Together these results show that whilst the percentage of work thought to be routine varies, the frequency with which problems occur is generally rare. The medians and inter-quartile ranges for both organisations are the same, showing a consistency among the results.

Q9 attempted to assess how frequently respondents accepted facts without checking. At CSG, all answered 'never' (8%), 'rarely' (60%), or 'sometimes' (32%). Whilst it appears undesirable to accept facts without checking, it is in fact part of the autopoietic learning. At Prosidion, the answers were spread among: 'never' (12%), 'rarely' (24%), 'sometimes' (49%) and 'frequently' (15%). The probable reason for Prosidion respondents to select 'frequently' lies in the nature of its business. As a drug development organisation, it is sometimes acceptable to take published work as proven, without the need to always question it. Alternatively, work may be repeated in different projects, and different processes could be transferred very simply, with no need for modification. This claim is further supported by comparing the mode and median values for the two organisations. At CSG, both the median and mode are calculated to be 2, or 'rarely' whereas at Prosidion, the mode and median are both calculated as 3, or 'sometimes'.

5.5 Individual Mental Models Results

The first question on the concept of individual mental models was Q10 and asked about the role of past experience in new situations. At Prosidion, only 1 (3%) respondent said they 'rarely' used past experience when facing a new situation, with all other respondents either 'frequently' or 'always' using past experience. At CSG, only 5 respondents (14%) 'sometimes' used past experience, with all other respondents again selecting 'frequently' or 'always'.

It is entirely possible that, whilst people are generally aware of using past experience in new situations, they are unaware of the process that is involved. Median analysis also supports this view, with both CSG and Prosidion median values being 4, or 'frequently'. The low inter-quartile range (0 for CSG, 1 for Prosidion) indicates very little spread of the data. The answer that supports the model is that past experience is always used when facing a new situation. It is entirely possible that respondents were aware of the benefit of past experience, but could not always recognise when it was being used in their thought processes.

Question 11 asked about the respondents' general awareness of a problem solving routine. The answer to the question was that supports autopoiesis is that the same process is followed to solve all problems, irrespective of domain, person, or even organisation. At Prosidion, only 2 respondents (6%) gave the answer that supports an autopoietic position, whilst at CSG, only 1 respondent (3%) gave that answer. The modal values for both Prosidion and CSG were 4, however this time the inter-quartile range was 0 for Prosidion and 1 for CSG. The implication this time is that whilst the modes suggest the majority of employees frequently followed the same process when problem solving, it is at Prosidion where less spreading of the results occurs.

Question 12, which asked whether respondents had ideas about improvements for their work, saw a unanimous response from CSG. All respondents answered 'yes', which clearly shows they must be observing and assessing the constantly changing environment around them. In order to have improvements to make, the respondents must also be designing potential solutions as well. At Prosidion, however, there was not a unanimous response. Two respondents selected 'no', whilst two opted not to answer the question. Whilst not desirable answers, these four respondents did not hold senior or management positions; and there was no commonality with age or time in the organisation.

Question 13 was asked in order to assess how likely it was the respondent would take action to improve a process if no fault currently existed. On a scale of 1 to 5 (5 = Strongly Agree) 24 respondents, at CSG, (64%) answered with a 4 or 5, a further 5 (14%) respondents answered 3, whilst 8 (22%) respondents answered 1. The median value was 4, or 'mostly agree' and the inter-quartile range was 2. This question attempts to determine how likely a respondent is to improve something that is not directly their responsibility, or directly resulting from their work: whilst it may be expected that everyone takes action when it is part of their job description, it is taking action outside of a job description that is the real test of the OOADI loop. At Prosidion, responses are also centred at the higher end of the scale, with a median of 4: 18 respondents (55%) selected 4 or 5, 10 respondents (3%) selected 3, and 5 (15%) respondents selected 1 or 2. The inter-quartile range for Prosidion was 1, which is lower than CSG and shows a smaller spread of the data. Both organisations' employees' tendency to take action to improve a process of product is almost certainly because of the organisations' cultures. CSG is a consulting organisation, demanding self-motivating employees who regularly take the initiative, and Prosidion is a highly innovative and dynamic organisation requiring employees to keep up with the market, their subject domain, and to be prepared to change direction suddenly.

5.6 Organisational Learning Results

Questions 14 through to question 17 examine the organisational learning cycle part of the autopoietic model of organisational learning. Question 14 starts by asking when the respondents last had experience of an idea being formally implemented. A summary of the results is shown in Figure 5.1. The results are supportive of the model with both organisations having a modal value of 5, or 'in the last week' and a median of 'in the last month'. The first quartile for both organisations is 3, indicating that in both organisations, 75% of respondents had seen an idea implemented in the last 6 months.

	CSG	Prosidion
More than 1 year ago	3 (8%)	1 (3%)
In the last year	0	4 (12%)
In the last 6 months	8 (22%)	8 (24%)
In the last month	12 (32%)	9 (27%)
In the last week	14 (38%)	11 (33%)

Table 5.11 Distribution of Results for Q14

Question 15 follows on by asking how frequently respondents follow up their ideas when suggested to others. In both organisations, the answers are skewed towards 'frequently' and 'always', with the modal values for both organisations 4. Whilst, only 2 (5% at CSG and 6% at Prosidion) respondents selected 'rarely'. At CSG, a total of 23 respondents (62%) selected 'frequently' or 'always', whilst at Prosidion 23 respondents also selected 'frequently' or 'always', but with a percentage of 70%. At CSG, it could be argued that employees are not so willing to take the initiative to themselves change something but are more willing to suggest their ideas to others and then follow them up. At Prosidion, it is the opposite situation, employees prefer to take the initiative and make changes, and, as a result, they have fewer suggestions to follow up on. This difference is most likely because of the different organisation types: both are team work based organisations, however, Prosidion's average group size is only 4, as opposed to up to 30 for CSG.

Question 16 asked whether the respondent felt unwritten rules existed in their organisation. Considering CSG, only 20 % of respondents felt unwritten rules did not exist in their organisation, compared with 33% at Prosidion. Interestingly, these respondents came from the full range of positions at both companies. Whilst unwritten rules are generally undesirable in organisations,

their occurrence does indicate the presence of shared mental models, an integral part of the autopoietic model of organisational learning.

Question 17 concluded the questions on organisational learning by asking how frequently the unwritten rules affected working procedures and the results are summarised in Table 5.2. Whilst is encouraging to see the 'always' option was selected the least, the desirable situation would be to have no unwritten rules. The fact that unwritten rules have so much impact is not positive, and both organisations should be taking steps to remove both unwritten rules. Comparing modes and medians between both CSG and Prosidion draws out an interesting finding: that unwritten rules appear to have more of an impact at CSG than at Prosidion. At Prosidion the median value is only 2, or 'rarely' whereas it is 3, or 'sometimes' at CSG. There is a similar difference in the median values, at Prosidion it is 3, whereas at CSG it is 4. It is clear from these results that unwritten rules not only exist, but impact on organisational procedures.

Response	CSG	Prosidion
Never	2 (5.4%)	8 (24.2%)
Rarely	8 (21.6%)	10 (30.3%)
Sometimes	10 (27.0%)	10 (30.3%)
Frequently	17 (45.9%	4 (12.1%)
Always	0	1 (3.0%)

Table 5.2 Frequency with which Unwritten Rules Affect Organisational Routines

5.7 Shared Mental Models Results

The final set of questions asked the respondents about shared mental models. Organisational guidelines are the main aspect of shared mental models, and first, question 18 considers their impact. At Prosidion, 97% of respondents 'frequently' or 'always' followed guidelines when they existed for the job they

were performing. Only one respondent was less inclined to follow relevant organisational guidelines. Whilst at CSG, 87% of respondents 'frequently' or always' followed organisational guidelines where possible. At both organisations, both the mode and median were 4, indicating respondents followed guidelines where they existed on a weekly basis. The inter-quartile range of 0 for CSG and 1 for Prosidion again indicate a low spread of the data. However, it is possible to conclude from the demographic data that at CSG, all five respondents who were less liable to follow organisational guidelines were all from senior positions.

The final two questions around guidelines were how frequently the respondent questioned organisational guidelines (Q19) and how frequently the respondent attempted to change organisational guidelines (Q20). The results are shown in Table 5.3. The results show that respondents attempt to change guidelines less frequently than they question them, which is the intended result. This is also confirmed with the modal and median analysis, which shows the mode result for Q19 is 4 at CSG and 3 at Prosidion, whilst for Q20 it is 2 for CSG and 1 for Prosidion. Across Q19 and Q20 both organisations have an inter-quartile range of 1 for both questions.

	CSG		**Prosidion**	
	Questioning guidelines	Attempting to change guidelines	Questioning guidelines	Attempting to change guidelines
Yearly	4 (11%)	7 (19%)	1 (3%)	10 (30%)
6 Monthly	5 (14%)	12 (32%)	8 (24%)	10 (30%)
Monthly	11 (30%)	10 (27%)	16 (49%)	7 (21%)
Weekly	12 (32%)	7 (19%)	6 (18%)	4 (12%)
Daily	5 (13%)	1 (3%)	2 (6%)	0

Table 5.3 Results from Questions 19 and 20

Question 21 finished the questionnaire's closed questions by asking about agreement with the organisations' mission statement. At Prosidion, only 6% of respondents neither agreed or disagreed with the mission statement, with the rest of the sample either partly, or totally agreeing with the mission statement. At CSG, however, only 76% partly or totally agreed with their organisation's mission statement. More interestingly, 4 respondents neither agreed or disagreed with the mission statement, and 5 respondents (14%) completely disagreed with it. However, perhaps most disappointingly, the 5 respondents that responded negatively to the mission statement all held senior/executive positions.

5.8 Other Comments Made by Participants

The questionnaire concluded by asking whether the respondents would like to make any additional comment and a selection of the key comments received is shown in Figure 5.4. The first and second comments do not reveal any surprises; however the third comment raises an interesting issue. The questionnaire assumes that people want to be learning and helping the organisation grow and become prosperous however if people do not have the motivation to learn or improve the results from the questionnaire would be meaningless. The final comment about the mission statement from CSG is also interesting given the organisation has one and is published on all public facing aspects of the organisation. Perhaps that in itself is the problem perceived by the respondent, that the mission statement on the website is merely part of a public relations strategy and has tenuous links to work in the organisation.

Affecting change is not easy if you do have a certain rank within this organization - and that is an unwritten norm! Communication is key followed by follow through. It wasn't clear to me that the survey was specific to my employment. I purposefully choose to have a stable paycheck so I can devote my energy and problem solving abilities to out of work activities and groups. My job is boring as rocks... Thanks! Organization has no mission statement to rally around. Unless I create one.

Figure 5.4 Additional comments received from respondents.

5.9 Summary

The analysis from this chapter has shown all results obtained from the questionnaires can be explained using the autopoietic model of organisational learning. Regarding the Observe, Observe, Assess, Design and Implement cycle, the findings support both the original cycle, and the added Observe stage (added via applying autopoiesis to the model). With respect to the individual and shared mental models (neither of which were modified by applying autopoiesis) the evidence from the analysis overwhelmingly supports their presence in individual and the organisation. Finally, considering both autopoietic and allopoietic learning, despite being more of a semantic change, findings from the questionnaires do support the notion that characteristics of autopoietic learning are comparable to single loop learning and that allopoietic learning is comparable to double loop learning. This chapter has shown that, in general, the autopoietic model of organisational learning does reflect organisational working procedures. In the instances it does not, it has always been possible to explain why, and for the two companies in this research, it has always been an organisation specific reason. Analysing these results has helped to achieve objective 4 by showing that the autopoietic model does reflect organisational learning (Objective 4) in organisations.

Chapter 6 Evaluating the Living Model of Knowledge

Chapter four presented the development of an autopoietic model of knowledge in an attempt to provide the knowledge management domain with a sound theoretical foundation. An autopoietic model of knowledge goes someway to achieving this since it is the most biologically accurate understanding of knowledge. This is different from the autopoietic model of organisational learning, which took autopoietic principles and applied them to an existing model. This chapter presents the analysis of data obtained from the expert evaluation process used to critique the autopoietic model of knowledge. This chapter helps meet objective six and is the final analysis before all the results obtained in this research can be discussed together. The development of the evaluation process and the pilot study was successfully published in the proceedings of ECKM (Parboteeah et al., 2009a) and in the Electronic Journal of Knowledge Management (Parboteeah et al., 2010).

6.1 Introduction

First, this chapter presents the rationale to the questions used in the evaluation processes. Next, this chapter analyses the findings from the expert evaluation of the autopoietic model of knowledge. It was necessary to evaluate the model of knowledge to determine at an early stage the potential level of acceptance of an autopoietic foundation, the kind of issues that could be encountered in giving knowledge management a theoretical foundation as well as critiquing the model of knowledge itself. Evaluating the autopoietic model of knowledge is separate from the autopoietic model of organisational learning because the latter model was already in existence, and was modified by applying principles from autopoiesis. Together, the two models provide a comprehensive method of giving knowledge management a theoretical foundation: first by providing the autopoietic solution and second by providing a method of adapting existing systems and models. For the purposes of the expert evaluation, twenty experts were invited to participate in the evaluation process: ten from academia and ten from industry. Twelve experts responded in total (60%) with four being

from academia and eight from industry. There was a range of ages across all options and the time in knowledge management ranged from five years up to twenty.

6.2 Questions for the Expert Evaluation

Philosophical Positions on Knowledge

Five dimensions have been created to enable results from the evaluation to be categorised. There are two purposes to the questions: first to help contextualise the answers received, and secondly, but perhaps more importantly, to act as a checking device for Section A questions. This is important because it will help distinguish whether the respondents' theoretical and practical approaches to knowledge and its management are the same.

The first dimension asks the respondent to consider whether knowledge is more objective or more subjective in nature. This is important because it reveals whether the respondent feels knowledge can exist independent of personal opinion and beliefs. It would be reasonable to expect people working in technology based knowledge management to view knowledge as a very objective asset, whereas respondents working in 'softer' areas of knowledge management might view knowledge as more subjective and personal in nature.

Is knowledge objective or subjective in nature?				
Objective				Subjective
1	2	3	4	5

The second dimension derives from the popular distinction between tacit and explicit knowledge (Dienes and Perner, 1999, p. 735). It questions the respondent's understanding of the actual nature of knowledge: whether it is

explicit and can be codified or tacit and essentially unmanageable. This dimension is necessary because it will help determine whether the respondent thinks knowledge is accessible externally or not. This dimension would distinguish between, for instance, theorists who would be comfortable discussing tacit, unmanageable knowledge, and pragmatists who prefer a working, and practical definition of knowledge.

Is knowledge tacit or explicit in nature?				
Explicit				Tacit
1	2	3	4	5

The third dimension moves onto the potential origin of knowledge. At one end is the proposal that knowledge is based on truth, or facts, whilst the opposite end proposes that all knowledge is based on belief, either personal or shared. This is a vital dimension because it questions the respondent's view or understanding on the origin of knowledge. This dimension aims to distinguish between respondents following an interpretivist-based viewpoint, and those following a constructivist based viewpoint.

To what extent is knowledge based on truth or beliefs?				
Truth				Belief
1	2	3	4	5

The fourth dimension also considers the source of knowledge, but from a different angle. This dimension draws a distinction between whether knowledge can be gained independent of experience. This builds on the previous dimension because knowledge cannot successfully be built on belief without some experience, and for respondents believing knowledge is based on truth, knowledge should be obtainable without any direct experience. This dimension should help reinforce the previous dimension – any disparity would obviously require further exploration during the evaluation.

Is knowledge independent of (A priori) or dependent on (A posteriori) experience?				
A Priori				A Posteriori
1	2	3	4	5

The fifth dimension starts to assess the respondent's epistemological position with regards to an autopoietic epistemology. The dimension gets the respondent to consider whether knowledge can be stored in a system, technology based or otherwise, or whether it can only be stored in people's minds. It is necessary because it will help distinguish between respondents who think knowledge is a manageable asset through its transferability, and those who think knowledge can only be managed indirectly through the organisational environment and culture.

Does knowledge exist in IT or external systems (Embedded) or does it exist in people's minds (Embodied)?				
Embedded				Embodied
1	2	3	4	5

Evaluation Questions

A series of demographic questions were asked at the start as a means of adding background to the responses received. Respondents were asked their sex (Q1), age range (Q2), occupation (Q3) and the time they had spent in knowledge management (Q4). Respondents were also reminded of their rights under the ethical research policy.

Part A – Prerequisites

Part A questions were asked before showing the participant the autopoietic model of knowledge. The questions were used to determine the respondents' current perspective or understanding of the concepts involved in the new model of knowledge. Q5 was an important starting point because the new autopoietic model of knowledge removes the concept of information; and just

uses data and knowledge. Acceptance of the new model of knowledge depends heavily on the degree to which users are able to change long held beliefs. Q6 was a slightly more academic question because it returns to the notion that knowledge, truth and wisdom are three highly connected concepts, or indeed just three perspectives on the same object. Q7 started to make the link between theory and practice by exploring the potential for overlap, whilst Q8 started to look in more detail at the use for a model of knowledge in knowledge management.

Q5 – What is your understanding of data, information and knowledge and the relationship between them?

Q6 – Do you see a role for wisdom and truth in your previous answer?

Q7 – How important do you think a definition/model of knowledge is to knowledge management? (Cover definition of knowledge management)

Q8 – What use do you think a model/definition has in knowledge management? (Difference for theory/practice perspective?)

Part B – Introduction to Model

Part B was concerned with capturing the participants' first impressions about the autopoietic model of knowledge before it was explained in detail. This was a vital stage since it meant the participants' reaction and initial perspective on the model could be recorded. This stage also allowed the user to experiment with the model freely and determine whether, by themselves, they could apply the model to their own working practices. The model was then explained to the participant, covering details about the terms and concepts in the model, the relationships, its development and, finally, its potential uses.

Q9 – What are your first impressions of the model and why? (terms, definitions, relationships)

Explain model – terms, relationships, where it came from, use

Part C – Formative Evaluation

Part C was concerned with the participants' views on improving the autopoietic model of knowledge. Q10 started this process by first confirming the participants' understanding, and agreement with, all the concepts used in the model. Q11 followed by exploring the participants' views on the relationships in the model. This was a necessary step because knowledge management as a discipline already contains disagreements that stem from semantics, and to avoid terminology becoming a problem, it was necessary to tackle it as an issue early on in the evaluation process. Q12 started to look at shortfalls in the autopoietic model and knowledge, and asked the participant if they thought anything was wrong or missing from the model. By this stage, the questions were starting to help the participant place the new model of knowledge in the existing literature and their own view of it. Q13 started to address the issue of whether the potential exists to measure or test any of the elements of relationships in the model. Q14 ended by getting the participant to consider how the model might be different if other theoretical positions were considered. This question depended on answers previously given.

Q10 – Do you agree with the meanings associated with each term in the model and why?

Q11 – Do you agree with the relationships present in the model and why?

Q12 – Is there anything you think is missing from the model and why?

Q13 – Do you think any of the terms could be measured or tested?

Q14 – How do you think the model would be different if …? (question depends on answers given previously)

Part D – Summative Evaluation

The final set of questions follow a summative approach because of the focus in using the model as a way of explaining the working practices of participants. Q15 started by explicitly asking participants to consider how the model might explain their current working practices, with Q16 following up with examples.

The opposite to Q15 is Q17 which looked at where the autopoietic model of knowledge potentially fell short in its ability from explain working practices. Whilst Part D questions carried a different focus to Part C questions, both parts were necessary because Part C was concerned with testing and improving the autopoietic model of knowledge, but Part D was concerned with applying the autopoietic model of knowledge to the participants working practices.

Q15 – How do you think the model fits into your current working practices?

Q16 – Can you think of any examples of when you might/do follow the model?

Q17 – Is there anything in your working practices that is not, or cannot, be explained by the model?

6.3 Demographic Analysis

Having successfully conducted the expert evaluation process (final evaluation questions in Appendix 4) to evaluate the autopoietic model of knowledge, the next step was to analyse the demographic data in relation to the pre-evaluation questionnaire used to determine the respondent's philosophical position. The initial purpose of this stage was to try and control the selection of experts in order to obtain a range of experts with different initial beliefs about knowledge and its management. Considering the time each expert had spent in knowledge management, the range for this research was from 5 years up to 20 years, with an average of 10 years experience. The age range of the experts was slightly skewed however, with 1 expert in the 19 – 30 range, 3 experts in the 31 – 40 range, 2 experts in the 41 – 50 range, and 6 experts in the 51 – 60 range. The table of findings from the pre-evaluation questionnaire can be found in Appendix 5.

The pre-evaluation questionnaire asked five questions, all related to the autopoietic perspective on knowledge. The purpose of the questionnaire was to select a series of experts with a range of perspectives on knowledge:

supporting an autopoietic viewpoint at one extreme, to completely opposing it at the other. The rating scale was designed so a rating of 5 for one question meant the expert totally aligned themselves to the autopoietic perspective on knowledge for that aspect. No expert, across their five questions, ever rated a statement 1, despite several experts rating statements 5 at various times.

It is possible to conduct both regression and correlation analysis on the results obtained. Starting with regression analysis, it is possible to calculate the r^2 value for both age range and time in knowledge management against the experts' average rating (from across all five statements). It is not possible to conduct this for gender, or industry/academia perspective since they yield polar results that are not suitable for regression or correlation analysis. As shown in Table 6.1, the r^2 values are weak, but are still just significant. This suggests that more experience in knowledge management is most likely to lead to an autopoietic perspective on knowledge.

Variable	r^2 value
Age range	0.05788
Time practicing KM	0.05263

Table 6.1 r^2 Analysis on Age Range and Time in KM as Variables for Predicting Average Ratings

Correlation analysis, used to determine the ability of one variable to predict another, provided more substantial findings. There are several results worth of discussion: first, the relationship between age range and Q4. Question 4 of the pre-evaluation questionnaire asked the expert to rate whether they thought knowledge was a priori in nature (1) or a posteriori (5) in nature, or somewhere in between. The Pearson Product Moment Correlation Coefficient (PPMCC) value was 0.44, indicating a strong relationship, positive relationship. This means that as experts get older, there is a strong chance their position on

knowledge changes to a view that knowledge is completely dependent on experience. Second, is the coefficient value for the relationship between time in knowledge management and Q1, Q2 and Q5. These are all strong relationships, indicating they are potential indicators for how likely an expert is to have an autopoietic perspective on knowledge. What these findings seem to suggest, is that experts start their careers with standard, taught definitions of knowledge and knowledge management, and it takes a substantial length of time for the experts to realise the true nature of what they are managing.

	Q1	Q2	Q3	Q4	Q5
Age range	0.23221	-0.13029	0.09875	0.44520	0.10982
Time practicing KM	0.44242	0.44649	-0.18688	-0.25332	0.39602

Table 6.2 Correlation Analysis for the 5 Pre-Evaluation Questionnaire

6.4 The Prevailing Opinion on Knowledge

Part A of the evaluation sought to determine the prevailing opinion data, information and knowledge, along with truth and wisdom, and finished with the expert's opinion on the importance of definitions and models in knowledge management. Question five started with the expert's position on data, information and knowledge. All experts agreed that data was the 'lowest unit' analysable, with descriptors such as *'raw material', 'quantifiable stuff',* or just *'facts'*. However, expert 7, who was a management consultant for 15 years, took a slightly more holistic approach, saying that:

> *'data is anything, or stuff, detected from the surroundings'*

This is characteristic of an autopoietic perspective since it recognises that the human nervous system works as simple detection system. It is the brain that conducts the subsequent interpretation to create knowledge. This position is understandable however, since expert 7 has a significant background in cybernetics. As discussed in the literature review (Chapter 2), autopoiesis is a second order cybernetic theory, so it is not surprising for this similarity to arise.

Questioning the experts on their perspective of information becomes slightly more contentious since autopoiesis asserts that information is a misinterpretation of the process of informing that occurs in the translation of data into knowledge (von Krogh et al., 1996, p. 165). All experts agree information is some function of data, with definitions such as:

> *'Information is the combination of data'* (Expert 3)
>
> *'Information is data encapsulated and made presentable'* (Expert 4)
>
> *'Information is the subjective interpretation of data'* '(Expert 12)

With terms such as 'combination', 'organised', 'structured', embedded' and 'interpretation' being common. Only experts 8 and 12 (both academics) touch on autopoietic concepts: embedding and subjective interpretation, however, this still does not represent an autopoietic perspective since there is not one regarding the notion of information. So whilst all experts nearly concur, it actually represents a consensual misunderstanding of the process of informing.

Finally considering the concept of knowledge, the experts' perspectives diverge more distinctly, with definitions such as:

> *'Knowledge is using information in a useful way'* (Expert 4)
>
> *'Knowledge is making decisions based on information'* (Expert 5)

'Knowledge is interpretation of information and application of past experience' (Expert 9)

'Knowledge is the capability to make distinctions, which is the outcome of a combination of information, experience and action' (Expert 12)

All experts refer to more advanced cognitive activities, such as 'interpretation', 'decision making', 'understanding', and 'application'. Given the emphasis on action in the literature, it is not surprising that all experts include these terms. However, despite all experts agreeing information is conceptually higher than data, two experts still define knowledge as some function of data (experts 1 and 6). Whilst apparently contradictory to their beliefs, this is actually the autopoietic interpretation of knowledge. Since 'information' does not exist, knowledge is necessarily based on data, and its interpretation. It is also interesting to note that none of the experts make reference to the structure of knowledge, and that only one expert (8), who was also an academic, refers to the notion of tacit knowledge. Subsequently, this is the expert whose perspective on knowledge is most akin to the autopoietic perspective, since they define knowledge as 'embodying understanding and tacit concepts into action'. It is unknown why most experts only produced standard definitions of knowledge: perhaps they were unable to articulate their actual understanding of knowledge, although this is unlikely given they are knowledge management experts.

6.5 The Role of Wisdom and Truth

It was necessary to question the experts on the importance of wisdom and truth because various definitions of knowledge revolve around them; such as justified true belief (Gettier, 1963, p. 35) and the knowledge hierarchy (Ackoff, 1989, p. 3). There was no consensus among the experts about the definition of, or the role of, wisdom and truth in knowledge management. Responses ranged from both concepts being *'vague notions only useful to philosophers'* (Respondents 2 and 4), through to being notions which are important and should be understood (Respondents 1 and 11), up to the idea that *'wisdom is*

just another reinterpretation of knowledge' (Respondent 12). Reviewing responses from all experts, it is disappointing to discover such a disinterest in the concepts that actually define and characterise the domain of knowledge management. Perhaps if knowledge management was actually based on the philosophical notions of knowledge, wisdom and truth, any system developed would be much more accurate and successful. Instead, the definitions of the concepts underlying knowledge management appear to have come from the disciplines of computer science or management science. This was not through the biased selection of experts however,

> *'since unfortunately knowledge management appears to have been developed out of alleged need, and not as an academic discipline'* (Respondent 9).

6.6 Does the Need for a Model of Knowledge Exist?

Part A of the evaluation ended by questioning the experts on the use and importance of both a definition and a model of knowledge, and this is where the most polarisation of the answers occurred. Initial analysis of the results, as shown in Table 6.3, indicates the experts' opinions on the use of models does not appear to be linked to any other variable. The responses vary across age range, perspective and time in KM. Removing these variables can only reasonable leave two explanations: personal or organisation perspective on knowledge management.

Evaluating the experts' responses, three different positions emerge. First, the opinion that having a definition, or model, of knowledge is not of use (Experts 4 and 5) to knowledge management professionals, or is in fact a hindrance (expert 3). The second position is that models and definitions may be useful to help thinking about knowledge management issues, or for those designing systems, but that the majority of knowledge management professionals do not need to be aware of their existence (experts 9 and 12). The majority of experts

(1, 2, 6, 7, 8 and 11) support the position that a model of knowledge is vital to knowledge management, with one stating that without defining knowledge, there can be no knowledge management (expert 11). The experts supporting this viewpoint articulate several issues, outlined in Table 6.4.

Expert	Age Range	Perspective	Time in KM	Use for Models
1	31 - 40	Industry	10	Very important
2	31 - 40	Industry	3	Very important
3	51 - 60	Academic	5	Not important
4	31 - 40	Industry	7	Not important
5	19 - 30	Industry	7	Not important
6	41 - 50	Academic	6	Very important
7	51 - 60	Industry	15	Very important
8	51 - 60	Academic	9	Very important
9	41 - 50	Industry	10	Not important
10	51 - 60	Industry	20	Did not answer question
11	51 - 60	Industry	17	Very important
12	51 - 60	Academic	20	Not important

Table 6.3 Experts' Opinion on the Importance of Models for KM

Expert 2 starts with the claim that:

> *'organisations are too focused on any return they may get from knowledge management'*

which correlates with the expert's industry focus. The expert also recognises that models are important to the development of knowledge management. This also matches the opinion of experts 8 and 9, who both recognise knowledge management has grown out of perceived business need, as opposed to being

developed as a discipline. It is significant that experts 2, 8 and 9 all agree on this point, since two experts are from industry, one is from academia, and they all agree on the importance of models of knowledge as a foundation for knowledge management.

Models of Knowledge and KM: Selected Issues Raised by Experts
Models are indispensible in KM, however, problems arise when companies focus on the return on their investment. (Expert 2)
Problems we have in KM arise due to the lack of a consistent understanding of 'knowledge' - whatever it may be. (Expert 6)
Models of knowledge are essential to building KM systems. It is not necessary for everyone to be aware of their existence though. (Expert 7)
Not enough attention is paid to the foundation of KM – focus is too much on results. The development of KM as a discipline needs to be given priority over business uses, in order for businesses to gain. (Expert 8)

Table 6.4 Selected Issues Raised by Experts

Expert 6 raises a more serious concern, calling into question the actual nature of knowledge. Expert 6 immediately dispels the opinions those experts who see no need to actually define knowledge, by highlighting the fact that

> '*without an accurate definition knowledge management is essentially the management of the unknown'.*

Indeed, as noted by expert 6, knowledge management problems arise from the lack of a consistent definition of knowledge. Indirectly, this call for consensus on a definition of knowledge is asking for a common foundation for knowledge management. This also tallies with expert 1 who describes knowledge management as *'lost in too many identities'*. The perspective of expert 7, who recognises models of knowledge are essential, supports this view. However, expert 7 goes one step further, and says

'not everyone needs to be aware of the models of knowledge',

or put another way, the foundation of knowledge management.

Expert 8 is the only expert to fully appreciate the problem and the solution (Table 6.4), which is not surprising given their nine years of experience of knowledge management in academia. Expert 8 recognises that the foundation of knowledge management is key, and that:

> *'once it has been redeveloped (assuming one currently exists) organisations will be able to reap the benefits'.*

However, expert 8 also recognises the vicious circle that exists:

> *'encouraging organisations to fund research into something they allegedly do wrong is almost impossible'*.

The perspective of expert 8 does bring together most of the experts in the recognition that the foundation of knowledge management starts with a consistent definition of the thing being managed: knowledge.

6.7 First Impressions of the Autopoietic Model of Knowledge

Part B of the evaluation contained only one question, and asked for the experts' first impression of the model, before the terms were defined and the model explained. This part of the evaluation was not intended to collect a lot of data, but merely to record their initial reaction, if any, to the model. One expert chose not to offer their first impressions, deciding instead to move straight onto the next part of the evaluation. There were two main findings from this part. First, most experts had a trouble with the term 'Distinction' and how it was different from 'Observation'. This was of course later cleared up when the experts were presented with the definitions and example. The second finding was that two experts (2 and 7) recognised the cybernetic nature of the model, whilst expert 12 instantly recognised

'*the model conforms to the autopoietic notion of enacted knowledge*'.

The significance of this recognition is that expert 12 is a professor of knowledge management who has over ten years experience researching autopoiesis in organisations and information systems.

The experts also raised several minor points during Part B of the evaluation. Expert 2 commented on the *'black box nature of knowledge'*, applauding the fact that if the nature of something is not known, it should be modelled as such. Expert 4 raised the point that the model is very high level, and needs work before they could see how it may be used. Two experts also raised the issue of the starting point for the model.

6.8 Formative Evaluation of the Autopoietic Model of Knowledge

Part C of the evaluation, which was the most comprehensive, questioned the expert on the autopoietic model of knowledge. Part C was comprised of two parts: a formative evaluation and a summative evaluation. The formative evaluation focused on assessing the model, whether it was accurate and if it could be improved. While the summative evaluation focused on how the expert could use the autopoietic model of knowledge.

Question 10 started by asking whether the expert agreed with the meanings associated with the terms in the model, and the reasons behind their opinion. The purpose of this question was to clarify from the start whether any semantic disagreements existed, and what alternatives the expert proposed. The first finding worthy of further investigation was that *'the model needs to clarify what is an object'* (Expert 2). Defining what is an object requires defining in exact terms each of the labels in the model, and essentially creating a domain of reference for the model. Expert 7 who says *'the 'Knowledge' term needs qualifying'* reiterates this point. However, expert 7 also says that the definitions

are perhaps too strict, and could benefit from being looser. This contradiction is exactly one of the problems with knowledge management that this research attempts to resolve. A lack of clarity and coherence in the foundation of knowledge management arises from blurred definitions and models – something this research does not condone. Expert 2 raises an issue with the 'Action' term – suggesting that *'observation and asking a question are just different kinds of action'*. This once again reiterates the importance of exact definitions that do not leave any room for doubt.

The second finding from question 10 is that most experts seemed to agree with the definitions, but could not articulate the reasons why. With a random mix of experts from both academia and industry, it is not possible to suggest reasons for this inability to explain why they think the model is correct. It is possible however; that it is the fault of the evaluation itself – if the experts were given an extended time with the model perhaps this data might have been more forthcoming. Finally, expert 4 still did not understand the role of 'Distinction' and struggled to see why it was being separated from 'Observation'. Expert 4 thought separating 'Distinction' from 'Observation' was not necessary, despite being directly from autopoiesis (Maturana and Varela, 1998, p. 40).

Question 11 of the evaluation went on to question the expert on the relationships in the model. This question suffered even more than question 10 with the experts' inability to articulate reasons for their opinion. However, it would be too naïve to suggest the experts tacitly know why, but are not able to make explicit the reasons – experts by their very nature should be able to make explicit their knowledge. Two experts (4 and 5) thought *'all arrows should be bi-directional'* (currently all arrows flow in only one direction). Their reason was that any process should be reversible. However, following the model as presented does permit error correction: you re-follow the model.

Question 12 of the evaluation raised several interesting issues, asking whether the experts thought anything was missing from the model. Responses were categorised, and are shown in Table 6.5. The most significant suggestion was for the inclusion of 'Reflection' into the model of knowledge. Five different experts commented upon this. Interestingly, there was not agreement on how 'Reflection' should be integrated into the model – some experts suggested it should be in its own box, whilst other wanted it to be on one or more of the arrows. Returning to the original literature (Maturana and Varela, 1980, p. 119) provides clarification, stating that 'knowledge, then, is necessarily always a reflection of ontogeny of the knower'. Remembering that ontogeny is defined as the history of structural change in an entity without loss of autopoiesis (Maturana and Varela, 1998, p. 74), reflection can be defined as knowledge of the ontogenic changes that have previously occurred. Judgement and self-awareness can also be considered in the same respect: they are both fundamentally cognitive processes that, as far the model of knowledge is concerned, exist within the 'Knowledge' box of the model.

Model Part	Arrow	Other
Reflection as a new box in the model	Reflection as an arrow, or a series of arrows	The KM aspect
Judgement	Show on arrow changes from data to knowledge	Relationship to the environment
Self-awareness		Model is too high level
Another distinction between 'Observation' and 'Knowledge'		Motivation to follow model and gain knowledge
		Starting point
		Interaction with others
		Applicability needs to be made explicit

Table 6.5 Changes to the Autopoietic Model of Knowledge Suggested by KM Experts

Another serious point raised by the experts was

> '*the failure of the model to show any interaction with the environment, or other people'* (Expert 2).

This is again a direct result of the autopoietic nature of the model. As expected, it was not a point raised by expert 12, the expert with over 10 years experience in researching autopoiesis. The interaction with the environment (of which people are a part) is implied within the 'Distinction' part of the model. It is implied because the environment can only trigger a change in an autopoietic entity, change cannot be determined. In respect of the act of cognition, autopoietic entities only receive a series of triggers, which in other words, is a series of opportunities for distinctions to occur. Three experts also commented on the starting point for the model. However, out of the three, one expert simply queried that the layout of the model '*may give people the impression of a certain box being the starting point.*' (Expert 12). Finally, several experts (1, 4, 5 and 9) questioned the applicability of the model, and how it could be used in knowledge management. However, it is extremely likely these experts have slightly misunderstood the purpose of this research. The model itself was not, and should not be a complete, useable object – it is the foundation on which to start building knowledge management models.

When asked about testing the autopoietic model of knowledge, the experts suggested a range of options, from using scenarios as this research does, through to creating surveys and deploying them in organisations. First, no expert thought the model could not be tested, however five experts (2, 4, 5, 6, and 9) recognise that testing the model in a scientific way would be extremely difficult, mainly because of the speed one cycle takes and controlled conditions would not be achievable. Expert 2 identifies the approach needed, which is to try and *'determine whether the model is falsifiable'*. This concurs with expert 7 who advocates applying the model to situations and trying to make the model fail. Only expert 8 goes as far to suggest studying the research and

development process in organisations to try and map the model on top of the processes.

Part C of the evaluation ended by giving the experts an opportunity to make any further comments, prompted by asking how their answers might have been different given a different perspective on one of their previous answers. Expert 3 raised an important point that people might not always follow the complete cycle: sometimes people might forgo asking the question choosing instead to manage without or follow organisation culture. Expert 7 reconfirms the importance that this stage of the research needs to be developed further for individual domains to be useful. Finally, expert 8 put forward the notion that it will be impossible to get a model 'everybody' would agree on, regardless of whether the model is biologically accurate.

6.9 Summative Evaluation of the Autopoietic Model of Knowledge

The final part of the evaluation, Part D, asked experts to consider whether the autopoietic model of knowledge fitted with their working practices (Question 15), whether they could provide any examples (Question 16) and finally whether there was anywhere the model failed to explain working practices (Question 17). This section suffered some disappointing responses, mainly from experts who initially said the model was too high level, or needed or additional work to make it applicable.

Considering question 15 first, four experts (3, 5, 6 and 7) are aware that they continually follow the model, but are not able to see its purpose (Expert 3), or provide specific examples (Expert 7). Experts 4, 8, 9, 11 and 12 did not think the model was useful as it was presented, and could not see how it related to their work. This however, is not necessarily a disappointing find. The model was never intended to be a complete, or useable model; instead it is the foundation for knowledge management attempts. Only expert 1, a project manager with ten years knowledge management experience, saw a use for the

model: policymaking. Expert 1 was satisfied that the model was more than capable of explaining the process of policymaking and adaption from a knowledge management perspective. Expert 1 articulated that

> '*the apparent high-level nature of the model benefited the higher levels of management, where there is less focus on specific applications, and more focus on general patterns*'.

Question 16 did not yield much useful data. Expert 2 reiterates that the model ignores the social aspect of a situation by ignoring interaction with other people, a point that has been resolved. The evaluation ended with question 17, which asked the expert which situations the model failed to explain. Again, some previously made points were raised again, such as: the models lack of interaction with the environment (Expert 4 and 9), the model is too high level (Expert 5) and the issue of semantics (Expert 3). Finally, as expert 1 identified,

> *'the model should be applicable to any situation, but the challenge will be getting people to follow the model'*.

6.10 Summary

This chapter has presented the findings and analysis from the expert evaluation of the autopoietic model of knowledge. It has been shown that each expert essentially has their own definition of knowledge, with substantial variation among the experts and that there is no agreement on the need for a sound theoretical foundation, or even that a model of knowledge should provide that foundation. This is despite the literature review showing that the lack of a consensus on knowledge is a problem in knowledge management and that creating a theoretical foundation is entwined with providing sound, unequivocal definition of knowledge. First impressions of the model showed most experts considered the model very high level, and that there was a problem understanding the concept of making a distinction. Reflection was picked as the most problematic concept for experts to view, in terms of the

autopoietic model, and the summative evaluation only yielded a possible use for the model in policy making in organisations.

Chapter 7 Discussion of Findings

In an attempt to give knowledge management a sound theoretical foundation, two models were developed: an autopoietic model of organisational learning and an autopoietic model of knowledge. Having created the models, designed and deployed suitable testing instruments, the results obtained were analysed in Chapters 5 and 6. This chapter discusses all the results in the context of the current literature as well as considering the implications of the results and any contradictory findings.

7.1 Introduction

The over-riding theme, and indeed the trigger for this research, was to address the issue of a lack of foundation for knowledge management. Primary research by several authors (Johanessen et al., 1999, p. 24; Scholl et al., 2004, p. 24; Metaxiotis et al., 2005, p. 7) suggests that knowledge management is in need of a sound theoretical foundation, possibly from systems theory. Data obtained from testing the autopoietic model of organisational learning, and especially from the expert evaluations of the model of knowledge confirms this proposal. In particular, the questionnaire respondents' awareness of Kolb's (1984, p. 21) problem solving routine was average (with a mean of 3.5 for both organisations). This lack of awareness of founding ideas for knowledge management was also evident in the expert evaluations, with no consensus on the nature of knowledge, despite significant classical and modern literature (Magee, 2000, p. 14). Two experts (8 and 9) even claimed that knowledge management has no foundation since it developed from business need, as opposed to developing as an academic discipline. This is likely due to the ten and more disciplines that feed directly in knowledge management (Jashspara, 2004, p. 10). Whilst not a direct aim of this research, it has been shown that knowledge management does suffer from too many underlying disciplines, has problems with a lack of consensus on key topics and its development as an academic discipline has been largely ignored as a result of funding issues (Expert 8).

Continuing chronologically, the next theme was the applicability of autopoiesis outside the molecular domain. This theme was most prevalent in this research during the switch from applying autopoietic principles to models, to creating an autopoietic model of knowledge. As shown in Chapter 5, retrospectively applying principles to a model of organisational learning did make some improvements, but this still did not make the model, or the process it represented, autopoietic. That would require reworking the model from the bottom up. Applying autopoietic principles to a model would also imply the model, or the represented process, would be autopoietic, which is also incorrect. Continuing in this vain would be akin to research by Maula (2006, p. 47) and Thannhuber (2004, p. 314) who apply autopoiesis to the conceptual and meta cellular domains. The second phase of this research: creating the autopoietic model of knowledge, is a more comprehensive use of autopoiesis, and supports the propositions made by Hall (2005, p. 177) and Limone and Bastias (2006, p. 39) that knowledge is an emergent property of second order autopoietic entities (multi-cellular entities). Creating a model of autopoietic knowledge does not go imply however, that knowledge itself is autopoietic.

7.2 Key Themes in Current Autopoiesis and Knowledge Management Research

The current position of the literature, presented in Chapter 2, was that autopoiesis had been explored in the context of knowledge management, but few steps had been taken past this stage. As shown in Figure 2.5, only four case studies exist, two of which incorrectly assume organisations to be first order autopoietic entities (Maula, 2000, p. 158; Maula, 2006, p. 80). The remaining research only considered the conceptual implications of applying autopoiesis to knowledge management, with three distinct areas emerging: applying autopoiesis to knowledge, applying autopoiesis to information systems and applying autopoiesis to knowledge management. The originality of the steps taken in this research should be emphasised: First, it was necessary to synthesise the literature in order to develop the two models (Chapter 3). This

involved using the matching methodology, developed by von Krogh et al. (1996, p. 160) and has been used solely for autopoiesis based research. Second, it was necessary to design test instruments for the models of organisational learning and knowledge. This itself represented a challenge since philosophical models of knowledge remain untested, and more recently developed definitions of knowledge appear to be based on anecdotal evidence (Bixler, 2005, p. 51). The same is true for models of organisational learning: the models are generally untested. The underlying model of individual learning may have been tested: but the extrapolation of the model to the organisational level generally remains untested. The two models from Chapter 3 were tested (Chapters 4, 5 and 6) and this chapter discusses the results in the context of the existing literature on autopoiesis and knowledge management.

As identified in Chapter 2, five themes emerged from the literature. The first was whether knowledge management as a discipline was progressing satisfactorily, and if it could benefit by learning from other disciplines. The first study by Johanessen et al. (1999, p. 24) suggested that knowledge management could benefit from systems theory in general, but did not go as far to specify autopoiesis. It would be a further five years until a Delphi study by Scholl et al. (2004, p. 25) would identify autopoiesis as having something to offer knowledge management. This approach validated by Metaxiotis et al. (2005, p. 12) who outlined the lack of a common framework for knowledge management.

The second theme, related to the first, was whether autopoiesis is restricted to the molecular domain. This debate can be traced back to the original authors (Maturana and Varela) and has still not been resolved. However, two positions were developed within the literature: one proposing autopoiesis can only exist in the molecular domain (Mingers, 1995, p. 44; Romesin, 2002, p. 8) and the other proposing autopoiesis can be applied to any domain, be it physical or conceptual (Maula, 2006, p. 80; Thannhuber et al., 2001, p. 314; Varela, 1974,

p. 187). Most authors applying autopoiesis to knowledge management follow the position that autopoiesis can exist in any domain, by considering organisations as first order autopoietic entities (Maula, 2006, p. 80), designing knowledge management systems as autopoietic themselves (Abou-Zeid, 2007, p. 614) and by attempting to build autopoietic knowledge management systems (Thannhuber et al., 2001, p. 314).

Authors accepting that autopoiesis can only exist in the molecular domain arrive at a different conclusion for the use of autopoiesis in knowledge management: developing an autopoietic epistemology (Hall, 2005, p. 171; Limone and Bastias, 2006, p. 39; Luisi, 2003, p. 53). Developing an autopoietic epistemology recognises that even though autopoiesis can only exist in the molecular domain, through the use of structural coupling, explanations can be built up to third order autopoietic entities. This theme is also related to the theme that learning, both individual and organisational, is an autopoietic process (Hall, 2005, p. 169; Jackson, 2007, p. 78; Maula, 2006, p. 80).

The final theme identified by the literature is the lack of literature, especially empirical work, in the area of autopoiesis and knowledge management. As previously identified, there are three main reasons for this. First, the dense nature of the language, coupled with the effects of translation, makes the primary literature (Maturana and Varela, 1980; Maturana and Varela, 1998) very difficult to engage with. Second, the disagreement whether autopoiesis can exist outside the molecular domain adds to the negative appearance. Finally, it was possible that the inability of autopoiesis to be accepted into the science domain meant it would never be held in high regard by any other domain. However, the results obtained in this research start to reverse this trend, as will be discussed.

7.3 Key Results Obtained

Without duplicating Chapters 5 and 6, which contains the analysis from the empirical work, this section outlines the key results obtained from both the questionnaire (Table 7.1) and the expert evaluation (Table 7.2). Taking the key findings and then eliciting the themes has enabled the implication of the findings for the themes to be discussed.

Low awareness of problem solving routine. The importance of reflection. Willingness to improve a process. Frequency with which ideas are followed up.
Presence of individual mental models confirmed, but no strong relationships. Past experience as an indicator for individual mental models.
Time in organisation as main factor affecting ability to affect organisational action. Frequency with which facts are accepted without checking – difference between CSG and Prosidion.
Employees question more than they attempt to change organisation guidelines. 3 employees could always identify the cause of organisational action at CSG. Unwritten rules do affect organisational procedures.

Table 7.1 Key Results Obtained from the Questionnaires

7.4 Individual Learning in the Autopoietic Model of Organisational Learning

The OOADI loop is a modified version of Kolb's (1984, p. 21) OADI loop. As indicated in Section 5.4, there was a low awareness of a general problem solving routine, indicated by the low median values and the low inter-quartile ranges. Even at this level of detail, such findings reinforce the notion that knowledge management is a results focused, endeavour, based on anecdotal evidence (Stankosky, 2005, p. 3) and that most employees are unaware of the principles guiding their work as knowledge workers. The finding that the

Information as a function (embedded, organised, combined or interpretation) of data. No awareness of/issue with the actual structure of knowledge. Wisdom and truth as concepts with no real value to knowledge management. Selected issues on creating a model of knowledge- • Lack of a consistent understanding • Essential, but not all employees need to be aware • Not enough attention is paid to foundation of knowledge management – focus is on business need
First impressions of autopoietic model of knowledge- • Distinction as a problem area • 2 experts recognised cybernetic nature of model • Black box approach to modelling knowledge • Appears to be very high level
Definitions appear too restrictive. Bi-directional arrows for error correction were suggested. 'Reflection' as a missing function from the model. The motivation to follow model is absent/unclear. Interaction with others/environment needs including.
Inability of most experts to see use for autopoietic model of knowledge. Possible use for model in policy making within organisations.

Table 7.2 Key Results Obtained from the Expert Evaluation

respondents' age, time or position in their organisation does not affect their perspective on problem solving routines implies there is a failure in knowledge management to make users aware of the fundamental ideas and notions. Indeed, Limone and Bastias (2006, p. 40) show that knowledge management suffers from the Tower of Babel effect, whereby new theories are continually built on models which themselves are new and untested. This also correlates with a comment made by Expert 9 during the evaluation process that knowledge management grew purely out of need, and was not developed as an academic discipline. This matches Johanessen et al. (1999, p. 24) in their

conclusion that autopoiesis can be used to retrospectively give knowledge management a foundation.

The second finding from the questionnaires was regarding reflection on the part of the participant. The responses indicated that reflection was a necessary part, but the frequency was unimportant. Reflection, defined as reviewing and assessing the need for improvement (Mingers, 2006, p. 233), was discovered to be a vital part of the autopoietic organisational learning model as confirmed by the responses to Question 6 of the questionnaire. However, comparing this to the autopoietic definition of reflection: knowledge of historic ontogenic changes (Maturana and Varela, 1998, p. 74) one fact becomes apparent: reflection is an assessment of the past, but there is no quantifying or qualifying factor.

As outlined in chapter 5, an interesting relationship was discovered between the frequency of employees following up their ideas and how frequently employees were willing to take the initiative to change something. At Prosidion, employees were more likely to make changes themselves, leaving little to follow up on, whereas at CSG, employees were more likely to suggest ideas to others, and subsequently follow up ideas more aggressively than Prosidion employees. This finding however, is not prevalent in the literature, supporting the notion of a lack of literature on key topics surrounding, not just autopoiesis, but foundational knowledge management concepts.

7.5 Mental Models in the Autopoietic Model of Organisational Learning

Numerous results in Chapter 5 confirm the presence of mental models, both individual and organisational. Originally developed by Johnson-Laird (1983, p. 3), their use has permeated most learning literature. However, from the outset there appears to be a problem reconciling autopoiesis with the concept of mental models. Mental models, by their very nature propose a

representationalist view of the perception: that is we construct models in our minds, designed to represent the real world. However, this directly conflicts with autopoiesis theory, which states that we bring forth the world in which we live (Maturana and Varela, 1998, p. 248). In other words, we do not construct models in our mind, to then go outside and interact with what ever situation we are in; rather we simultaneously interact with the situation and create a complex picture of distinctions, based on observation and prior knowledge; knowledge previously obtained in a similar manner. Past experience was also determined to be a reasonable indicator for individual mental models.

The more contentious issue however, was the ability of organisations to have a shared mental memory. Results from the questionnaire do support the presence of the alleged shared mental models, but perhaps it is the lexis that is at fault here. Most of the facets of the shared mental models are externally stored items, mostly on paper. The only true elements of identified by Kim (1993, p. 44) which form the shared mental models are the unwritten rules, which by their very nature are consensual and exist only in the mental models of individuals comprising the organisation. However, the results demonstrate that with the majority of respondents agreeing to the mission statement in both organisations that having a mission statement employees agree with is important to the organisational learning process (Snyman and Kruger, 2004, p. 15).

7.6 Organisational Learning in the Autopoietic Model of Organisational Learning

The first finding from this section of the autopoietic model of organisational learning was the relationship between the time an employee had been in the organisation and their ability to affect organisational action. As explained in Chapter 5, the implication here is that, assuming promotion takes place, there is an emphasis switch from taking personal action to empowering other

employees to take action, or perhaps directly taking organisational action. This appears to contradict Kim's original model (1993, p. 44) because there is no indication of how an employee's ability to cause organisational action over time changes. Whilst not syntactically accurate, it is possible to argue that encouraging and empowering others to take action is a form of internal organisational action

The other significant finding from this section of the questionnaire was the frequency with which facts were accepted without checking. Responses from CSG were spread among never (8%), rarely (60%) and sometimes (32%). Prosidion however, had a larger spread: never (12%), rarely (24%), sometimes (49%) and frequently (15%). The reason, as previously identified was the dependence of Prosidion's employees on published papers in academic journals. It is a generally a safe assumption that papers coming from academic journals, which are fully refereed, are a reliable source of information, that on the whole should not need checking. At CSG, on the other hand, opportunity for reliance on journals or similar materials does not exist. However, the autopoietic model of organisational learning in fact explains this apparent contradiction: under the labels of autopoietic and allopoietic learning as developed in Chapter 3.

7.7 The Autopoietic Model of Knowledge

Overall, the first impressions given by the experts suggest a vague, undecided view of the model. As discussed, the concept of observing by making distinctions (Maturana and Varela, 1998, p. 40) presented the most problems. Possible reasons include: it is a new term, one which is not in every day use and it is also a slightly foreign concept, when no difference is usually made between the acts of observing and making distinctions. Most experts who view the model as too high level (Experts 1, 3 and 4) in nature also echo this uncertainty. It appears that a general unwillingness to engage with the fundamental issues and ideas of knowledge management is creating a vicious

circle, akin to the tower of Babel problem (Limone and Bastias, 2006, p. 40). Regarding the autopoietic model of knowledge's interaction with the surroundings, this was another point of contention among the experts, and their instance on its inclusion indicates a general misunderstanding on the concept of making distinctions. The cybernetic nature of the model was apparent to two experts (2 and 7), which is correct given autopoiesis is a second order cybernetic theory, as outlined in the Literature Review.

The 'black box' approach to the nature of knowledge, as identified by expert 2, appears to be a new concept, but has previously existed under different labels. For instance, the popular notions of tacit and explicit knowledge (Polanyi, 1966, p. 10) describe differences between two alleged types of knowledge, but still falls short of defining the actual nature of knowledge. The closest approximation to defining the actual nature of knowledge is from Plato's Justified True Belief. It is possible to compare the position of knowledge as a series of beliefs, to the position that knowledge is a series of distinctions (or personalised interpretations about something, i.e. a belief).

The most significant findings from the expert evaluation, as shown in Table 7.2, is the role of reflection, the motivation for following the model and the interaction with the environment (of which other people are a part). It is slightly contradictory that nearly all experts raised reflection as an issue, however, in results from the questionnaire testing the autopoietic model of organisational learning, showed reflection as an activity occurring 'sometimes'. From the data collected, there are no apparent reasons for this: frequency of reflection does not increase with either age, time in organisation or seniority (at CSG or Prosidion). It is possible that whilst the experts are almost preaching the use of reflection, there is not the evidence from the questionnaire results to support the claim. However, as detailed in Chapter 6, reflection can be explained in terms of the model: which is knowledge of previous ontogenic changes.

The motivation to follow the autopoietic model of knowledge was also a point raised by the experts. This is a valid point, but one which is perhaps better served in a model of knowledge management, or organisational learning, than the model of knowledge itself. Motivation as a psychological concept is broad and complex issue, outside the scope of this research. However, considering Herzberg et al.'s (1959, p. 107) theory of motivation and Maslow's (1954, p. 15) hierarchy of needs it is possible to partially examine this claim. Herzberg et al. (1959, p. 107) claimed that two factors affect employee performance: hygiene factors and motivators. Hygiene factors are things such as salary and company policies, whilst motivators are factors that enhance an employee's job. Maslow (1954, p. 15), further complemented this by developing a five-tier hierarchy of needs, starting with physiological at the bottom, followed by safety, love, esteem, and ending with self-actualisation. Considering Maslow's hierarchy, participating in knowledge sharing and knowledge management activities can be categorised on the border between levels four and five: esteem and self actualisation. It is entirely possible that Herzberg's distinction between hygiene factors and motivators could be one of the problems with knowledge management in organisations: as a hygiene factor it is likely to fail. Knowledge management needs to become associated with motivational factors to be successful. Returning to the experts' postulations on motivation, it is possible to deduce that motivation needs building into knowledge management at this fundamental level in order that it becomes a motivator, rather than being added at the end and remaining a hygiene factor.

The significant finding from the last section of the expert evaluation was most experts did not see any use for the autopoietic model of knowledge. This was except expert 1 who saw a clear use in policy making in organisations. This was a slightly unexpected result, possibly arising from experts having a limited time with the model. However, returning to expert 1, demographic analysis reveals they have the longest industrial experience in knowledge management, which

is not consultancy based, and held a senior position in their organisation. It is entirely plausible that experience along with seniority permits a high level view of organisations, to the extent that the model of knowledge becomes applicable.

7.8 Do Findings Support or Contradict Each Other?

Having collected and analysed all the results, it was possible to correlate the findings to determine to what degree they either support or contradict each other. This was achieved by examining all results obtained, and cross referencing different key words. This was also done with key notions, for instance, in situations where the same underlying problem was being alluded. Finally, cross referencing was conducted across opposite findings, for instance where opposite terms or concept were used. Initially, the each set of results were sorted into categories (Tables 7.1 and 7.2) and then matched to relevant findings from the other set (Table 7.3). For the purposes of findings supporting or contradictory findings, where no overlap exists, the entries have been removed.

The first set of complementary results is the low awareness of Kolb's (1984, p. 21) problem solving routine and the lack of awareness on the structure of knowledge. This could indicate a lack of time, or desire, on the part of the participants to understand the founding ideas of knowledge management. These results are complementary because they both show employees are unaware of key ideas vital to the success of knowledge management. This however contradicts the findings from the evaluation process that not all employees need to be aware of the foundation for knowledge management: this should be reserved for those working directly in the field. This contradiction could in fact be an insight into the reasons for the lack of interest in, or misunderstanding of, the fundamental ideas in knowledge management. It is not possible to conclude from the results, but it is possible that a vicious circle formed whereby employees, who may or may not have been interested in or aware of the founding ideas, were encouraged that they did not need this

awareness. This would then feedback into the upper levels of the organisation, finally encouraging this behaviour further. The lack of awareness of the founding ideas has also been correlated with the finding that knowledge management has developed as a business need as opposed to as an academic discipline. It could be suggested that knowledge management suffers some of the problems it does simply because it was not developed as a rigorous, academic subject, but instead grew and developed to fit different business needs and problems.

Autopoietic Model of Organisational Learning Findings	**Autopoietic Model of Knowledge Findings**
Low awareness of problem solving routine.	No awareness of/issue with the actual structure of knowledge. Model of knowledge is essential, but not all employees need to be aware Not enough attention is paid to foundation of knowledge management – focus is on business need
The importance of reflection.	'Reflection' as a missing function from the model. Wisdom and truth as concepts with no real value to knowledge management.
3 employees could always identify the cause of organisational action at CSG.	Appears to be very high level Inability of most experts to see use for autopoietic model of knowledge.
Unwritten rules do affect organisational procedures.	Interaction with others/environment needs including.

Table 7.3 Comparing Supportive and Contradictory Findings

The issue of reflection was a significant finding from both the questionnaire and the evaluation, and as such necessitates further discussion. Findings from

the questionnaire suggest that reflection was occasionally carried out (median of 4 for CSG and 3 for Prosidion). The expert evaluation found that most experts thought the process of reflection was missing as an element from the model. These two findings do appear to contradict each other. Looking at the spread of results from the questionnaires, there is no correlation between the seniority of the respondent and their answer. At CSG three managers and one director said they rarely reflected on their work, and at Prosidion, one director and the vice president both said they frequently reflected on their work. With such contradiction even within the questionnaire results, resolving the issue of reflection looks to be outside the reach of this research. However, it is possible to speculate that several factors affect reflection: industry, seniority, age and that a separate study could be warranted to look at reflection in more detail.

The finding from the expert evaluation that wisdom and truth are overlooked and underused concepts in knowledge management was also matched to a lack of clarity on the role of reflection because the concepts of wisdom and truth can be considered meta cognitive process, much like reflection (Sternberg, 2003, p. 157). Experts were almost unanimous in thinking that both wisdom and truth were not well covered or even understood in knowledge management. Only three experts (1, 8 and 9) recognised that understanding truth and wisdom was vital for successful knowledge management, but that there would be significant implementation issues. The importance of truth and wisdom in knowledge management has been assessed by Zeleny (2006, p. 13) who advocates the need to evolve knowledge management systems into wisdom management systems. This approach, whilst recognising and integrating these important concepts, does not entirely fit with an autopoietic perspective. Autopoiesis theory argues that wisdom is an external concept used by an observer of a second order autopoietic entity, and that truth is subordinated to personal experience.

The perceived high-level nature of the autopoietic model of knowledge has been matched to the results from the questionnaire that three respondents from CSG could always determine the cause of organisational action. It could be argued that the ability to always determine the cause of any action requires a high level view of the organisation, an awareness of the shared mental models and the internal learning processes that occur. The ability of those employees to always determine the cause of action, coupled with the inability of most experts to see a use for the autopoietic model of knowledge, could support the notion that the model of knowledge is a high level model.

The final pairing shown in Table 7.3: unwritten rules affecting organisational procedures and environmental interaction as missing from the model of knowledge appear to be complementary findings. Indeed, it is not possible for unwritten rules to affect procedures without any form of interaction among employees. Both findings suggest environmental (i.e. everything external to second order autopoietic entities) influences are necessary, however their exact nature is not known or elaborated upon. This pairing was made because the common factor is that change can only be triggered, not determined (Maturana and Varela, 1998, p. 96).

7.9 Creating Guidelines?

Objective 8, the final objective of this research, was to create guidelines to help organisations apply autopoiesis to their own knowledge management practices. However, objective 8 has needed to be changed because of the change in the path of this research, a change that only arises with an increased understanding of autopoiesis.

Initially, the plan was to develop guidelines to help organisations apply the autopoietic principles to their own knowledge management practices/model, as was done to Kim's model (1993, p. 44) in Chapter 3. These guidelines would

have helped organisations identify where the autopoietic principles could have been applied, which principles to apply, how to apply them and what to expect having applied them. This would essentially be the matching process, except a more constrained version given the principles of autopoiesis would have already been made explicit. However, there is a problem with this approach, which prompted the change in direction of this research. The issue comes down to the applicability of autopoiesis outside the molecular domain. Whilst the autopoietic principles can still be applied to models of knowledge management, and it is important to recognise this does not make them living, this does not instil the model with an autopoietic nature. The model could still have a biologically incorrect model of knowledge at its centre, the model could still assume change can be determined and not just triggered and the model could still misrepresent the biological nature of the people who comprise the knowledge management system.

With the potential for these failures to occur, a change in approach was needed that could address these issues and this change in approach would certainly affect the guidelines that could be produced. The change in approach was to develop an autopoietic model of knowledge, so any knowledge management attempt would be at least accurately identifying what it was attempting to manage. This is a different method of giving knowledge management a foundation because it is inherently proactive, providing the starting point to build on, as opposed to being reactive and trying to fix, or improve, existing models. Developing the autopoietic model of knowledge has two implications for the developing the guidelines. First, it can be argued that no guidelines can be produced, since the model is the starting point to be built on, and that it is not possible to predict the model to be developed around it. Second, the original guidelines that would have been produced would no longer be relevant, instead the organisation would be free to design any knowledge management system so long as it permits the autopoietic activity of first, second and their order autopoietic systems.

Returning back to the original objective, the conclusion needs to be that whilst it is entirely possible to develop a set of autopoietic guidelines, it is not a truly autopoietic approach, and leaves numerous problems still outstanding. As identified, the better approach was to start from an autopoietic definition of knowledge, and build autopoietically compliant systems on top. The essence of an autopoietically compliant system in this context is that is allows for the natural, emergent behaviour of second order autopoietic entities (people).

7.10 Discussion of Methods Used to Test and Evaluate the Models

During the course of this research, it was necessary to create two new test instruments: a questionnaire to test the autopoietic model of organisational learning, and an evaluation framework for use in the expert evaluation of the autopoietic model of knowledge. Both testing instruments were created because of a lack of suitable or available instruments in the existing literature. This was partly due to a perceived reluctance among authors to publish their actual test instruments. Creating new instruments for this research was undoubtedly advantageous however because it meant both the questionnaire and evaluation framework could be tailored exactly to the requirements of this research: determine the accuracy of the two models developed. Working from a blank canvas in this case also had a disadvantage: that existing questionnaires and evaluation techniques were not available to at least inform the process of creating new test methods. A wider implication of no previous testing methods was that there was less of a baseline to compare the results obtained from this research. In other words, it was not possible to compare the findings of this research with other research testing knowledge management models because the variation in testing instruments was too great.

Concerning the reusability of the test questionnaire and evaluation framework, both can be reused, but with conditions. First, the questionnaire to test the

autopoietic model of organisational learning can be reused to test how well the model reflects autopoietic organisational learning in other organisations. The questionnaire was only used in SMEs in this research, but with a new pilot, it should be possible to extend its use to large organisations. Second, the evaluation framework used by experts to evaluate the autopoietic model of knowledge cannot be so easily reused. The evaluation framework was developed to determine whether the autopoietic model of knowledge could be used to create a theoretical foundation. The evaluation framework could of course be used to extend the research to more experts; however, its reuse in other areas is limited.

7.11 Summary

This chapter has provided a discussion of all the results obtained in the context of the existing literature on autopoiesis and knowledge management. First, the themes from the literature were identified, followed by the key results from the empirical work. The implications of the results in the key themes were discussed along with both complementary and contradictory results. This chapter ended with the consideration of developing guidelines for use in organisations, but concluded that the best strategy was to take the autopoietic model of knowledge as the base, and then build from there.

Completing this chapter, it is possible to outline the three main contributions this research makes to the domain of applying autopoiesis to knowledge management. First, there is clearly a need to a theoretical foundation for knowledge management as supported by: the lack of consensus on the nature of knowledge, the lack of awareness on the part of employees about learning cycles and organisational learning theories and the notion that knowledge management has grown from need rather than an academic discipline. Second, this research has shown that creating a theoretical foundation will encounter several obstacles, most noticeable among the knowledge management experts that do not see the need for a theoretical foundation or even the need for a

clear, concise definition of knowledge. Finally, this research has shown that creating the autopoietic model of knowledge and eliciting the autopoietic principles is the start of giving knowledge management a theoretical foundation; more work is required to overcome the barriers to the implementation of such a foundation.

Chapter 8 Conclusions and Further Work

This thesis has shown how autopoiesis theory can be used to give knowledge management a theoretical foundation. Both the models of organisational learning and knowledge were tested using suitable instruments and the results analysed and discussed in the context of the current literature in the area. This final chapter presents an overview of the entire research process, reiterating how each of the initial objectives have been met, and presents the limitations of the work along with the opportunities for further work.

8.1 Research Overview

This research set out with the aim of trying to adapt autopoiesis into a theoretical foundation for knowledge management, a need articulated by Limone and Bastias (2006, p. 44), Scholl et al. (2004, p. 25) and Metaxiotis et al. (2005, p. 7). The first objective was to complete a literature review, which brought to light several issues. First was the apparent lack of literature, and second was the issue that the majority of papers in the field of autopoiesis and knowledge management remained completely theoretical, with only four case studies. The implication of this was there existed very little empirical work in the field of autopoiesis and knowledge management, a problem that can only be remedied with increasing numbers of studies in the research area. Finally, the literature review concluded with a discussion on the nature of the key source literature in autopoiesis (Maturana and Varela, 1980; Maturana and Varela, 1998). The discussion concluded that the dense, self-referential lexis of the key texts made even approaching autopoiesis a challenging task, and the Spanish to English translation that also took place further complicated the language.

Linked to objective one was objective two, which was necessary to clarify the position regarding organisations and autopoiesis. Several positions had been developed in the literature, and centre around the issue of whether autopoiesis

can exist outside the molecular domain. The first position was that organisations were capable of existing as first order autopoietic entities (Maula, 2006, p. 47; Zeleny and Hufford, 1992, p. 156) and the implication of this was that by definition, organisations became living. A less popular position was that organisations were not autopoietic, and aspects of autopoiesis could not be applied. The final position, which was identified as the correct application in Chapter Two, was that organisations are third order autopoietic entities (Limone and Bastias, 2006, p. 44). This distinction arose from a clarification from Maturana and Varela (1980) in which they confirmed the initial position that autopoiesis could exist in any domain (Varela et al., 1974, p. 187) was not correct. Chapter Two concluded with the latest correct interpretation (Maturana, 2002, p. 11) that autopoiesis cannot exist outside the molecular domain, but by virtue of being comprised of people (second order autopoietic entities), organisations exist as third order autopoietic entities.

Objective three of this research started the move of applying autopoiesis to knowledge management by applying autopoietic principles to Kim's (1993, p. 44) model of organisational learning. The strategy employed used the matching methodology to make the connection between the different languages of the domains and create the new model. Use of the matching methodology was imperative because it ensured that the model creating the model was an ordered process, otherwise the merging of the two theories into the new model could have ended up a random process. Objective four of this research set out to test the autopoietic model of organisational learning to determine whether it accurately reflected the process as it occurs in organisations. This part of the research employed a positivist approach because of its model checking nature, and was conducted using a website based questionnaire. It was concluded that the model did reflect organisational learning in the organisations selected because all results obtained were explainable using the autopoietic model of organisational learning. The change of adding an observe stage to the Observe, Assess, Design and Implement loop was also supported by the findings. The findings from both organisations

overwhelming supported the presence of both individual and shared mental models and there was support from the findings that single loop learning can be renamed as autopoietic, and double loop learning as allopoietic.

Objective five of this research took a different approach to applying autopoiesis to knowledge management by creating a model of knowledge. The autopoietic model of knowledge created in Chapter Three is based entirely on an autopoietic epistemology, and was also developed using a matching methodology. It was necessary to use the matching methodology because autopoiesis theory uses very strict definitions for terms that are invariably different from the definitions generally associated with those terms. Objective six of this research was to evaluate the autopoietic model of knowledge and along with objective five, was conducted under an interpretivist approach. Expert evaluation was the instrument chosen and the experts were selected across a number of factors: academia and industry, age ranges, position in organisation and time in knowledge management. There were several findings from the evaluation process. First, there existed a range of ideas from the experts on what constituted knowledge, and it became apparent no consensus existed. Whilst that finding supports this research, only some of the experts thought knowledge management needed a new model of knowledge to act as a theoretical foundation. The second key finding was the experts viewed the model as very high level, and struggled to see its applicability to knowledge management.

Finally, objective seven of this research was to determine if guidelines could be developed to aid organisations apply autopoiesis to their own knowledge management models/practices. As discussed in Chapter Seven, this objective was most susceptible to the applicability of autopoiesis to the molecular domain. The original approach was to develop a toolkit of principles that organisations could use to improve their knowledge management practices. Whilst recognising that the knowledge management models or systems would

not become autopoietic, or living, it was hoped that applying autopoiesis would benefit in some ways to making the model more accurate. However, it was not until the second part of this research was underway, creating the autopoietic model of knowledge, that it became apparent that whilst it was possible to apply the autopoietic principles to models of knowledge management, if the underlying model of knowledge was incorrect, then building on that incorrect understanding of knowledge would be contradictory to the aim of giving knowledge management a sound theoretical foundation. Hence the recommendation coming from objective seven was that the starting point for giving a model an autopoietic foundation is to ensure the underlying model of knowledge is the autopoietic model of knowledge. Building on top of this model, but ensuring its integrity, will be force the model of knowledge management to be inherently autopoietic.

8.2 Limitations of the Study

Reviewing the research, there are several limitations that come to light. First, the theory of autopoiesis presents some issues. For instance, whilst the theory was developed as a scientific endeavour, it is still possible that as our understanding of living systems, and what makes them living, increases, the theory of autopoiesis may need to be changed. This could have consequences for the research presented here for two reasons. First, the autopoietic model of knowledge would come under scrutiny because any change in the model of the living could affect cognition, and therefore the autopoietic model of knowledge. Second, the autopoietic principles could be adapted, or completely changed, and this would affect the principles available when building a knowledge management system on top of the autopoietic model of knowledge.

The second limitation of this research was the restriction to only study SMEs when testing the autopoietic model of organisational learning. The findings cannot be extrapolated to large organisations because SMEs, as identified in Chapter Two, possess several unique characteristics. The research would need

to be repeated in large organisations in order for conclusions to be drawn about them. Another limitation affecting the research at this point was the fact that there was no immediate gain for organisations participating in this research. This made it difficult to get organisations involved when the only benefit would come from further research. This problem also affected the expert evaluation because there was no immediate gain for the experts.

The sample sizes used for both testing the autopoietic model of organisational learning and evaluating the autopoietic model of knowledge could be increased in future studies to make the conclusions drawn in this research more reliable. Whilst the sample sizes in this study are above the minimum for the correlation and regression analysis, larger sample sizes would permit other tests to be conducted such as factor analysis. This again would enable more accurate conclusions to be drawn from the data.

8.3 Contributions to Research

This research makes numerous contributions to knowledge management, supported by the author's publications in conference proceedings, journals and books. The paper presented at the Information Resources Management Association Conference (Parboteeah and Jackson, 2007a) presented an overview of the existing research, an analysis of the problem with the field as it stood, as well as discussing potential routes through the research aim. As the paper outlined, there was common acceptance that knowledge management needed a theoretical foundation, but that most research has stopped at a theoretical stage, with very little empirical work being conducted in the field. This finding was also published in a peer-reviewed volume: Autopoiesis in Organization Theory and Practice (Parboteeah et al., 2009b). The paper presented at the Enterprise System Theory conference (Parboteeah and Jackson, 2007b) presented the opportunities from the autopoietic perspective rather than from the knowledge management perspective.

The application of autopoietic principles to an existing model of organisational learning also made significant contributions to knowledge management research. The paper presented at the Knowledge Management Aston Conference (Parboteeah and Jackson, 2006), and the paper published in the journal Knowledge and Process Management (Parboteeah and Jackson, 2007c) present in detail the selection of an appropriate model from the literature, in this case Kim's model of organisational learning (Kim, 1993, p. 44), the application of autopoietic principles and finally presented the new model, as adapted by autopoiesis. The development of the autopoietic model of organisational learning formed the second half the chapter in the peer-reviewed volume on autopoiesis (Parboteeah et al., 2009b).

The paper presented at the European Conference on Knowledge Management (Parboteeah et al., 2007) documented in detail the process of creating a suitable testing instrument to test the autopoietic model of organisational learning in organisations. The paper also presented the outcome of the pilot study and the potential methods for analysing the data collected. Final findings from testing the autopoietic model of organisational learning in both the Conservation Services Group and Prosidion is being prepared for potential publication in the journal Knowledge and Process Management.

The purpose, requirement for, and development of, the autopoietic model of knowledge was presented at the Australasian Conference on Information Systems (Parboteeah et al., 2009c). The paper presented the motivation for the research: a lack of understanding and consensus on the nature of knowledge, along with potential benefit of enhanced understanding of the nature of knowledge, along with the ability to build knowledge management systems on an accurate definition of knowledge. The next phase of testing the autopoietic model of organisational learning was presented at the European Conference on Knowledge Management (Parboteeah et al., 2009a). This paper outlined the

motivation for using expert evaluation, the selection and modification of the evaluation framework and the successful pilot of the evaluation framework. This paper was subsequently selected for a special issue of the Electronic Journal of Knowledge Management (Parboteeah et al., 2010). The final findings from the expert evaluation are currently being prepared for publication in the Electronic Journal of Knowledge Management.

8.4 Further Work

This research has shown that autopoiesis can be successfully applied to knowledge management with the aim of creating a sound theoretical foundation. It has successfully moved past the theoretical stage most previous work has stopped at to generate empirical evidence to back up the claims of the theoretical research. However, there still exists several opportunities to conduct further work. First, it would be prudent for any future work to first address the current limitations of this study. For instance, repeating the questionnaire and evaluation process with larger sample sizes and conducting the research at large organisations, as opposed to only SMEs.

As has been identified throughout the thesis, there are several opportunities for deeper theoretical, or even philosophical, studies. First, the autopoietic epistemology identified in Chapter 2, and used in the creation of the autopoietic model of knowledge, bears several similarities to Kantian philosophy. For example, not being able to observe an independent reality, or knowledge as a property of action. One direction for future research could simply be a re-evaluation of the role philosophical studies such as Kant can play in knowledge management. It could be argued that current knowledge management research only superficially interacts with philosophy and epistemology, for example focusing on tacit and explicit knowledge. Related to this is also the opportunity to position the autopoietic model of knowledge among the current definitions/models of knowledge. This would help

demonstrate similarities and differences as well as showing what advancements the autopoietic model can offer.

Maturana and Varela's concept of third order autopoiesis, or social autopoiesis, is also worthy of further research because as noted by Mingers (2006, p. 178), autopoiesis at the social level strikes resonance with Giddens' Theory of Structuration. Whilst third order autopoiesis is not used in this research, it becomes important when considering building up the autopoietic model of knowledge into a model of knowledge management. The role of cybernetics could also be examined in more detail at this stage, especially the role of Beer's Viable System Model (1984). Whilst this research has made a suitable argument for the following of autopoiesis as opposed to cybernetics, it would not make sense to undertake detailed research at the social (third order) level and completely ignore what the discipline of cybernetics could offer.

Perhaps the most exciting extension of this research would be the incorporation of the autopoietic model of knowledge into an autopoietic model of knowledge management and doing so would give organisations their first experience of biological knowledge management. Keeping in mind the autopoietic epistemology, the proposed system would need to ensure the notion that knowledge can only exist in peoples' minds is adhered to. While only speculation, it is entirely possible semantic technology could be the way forward because it would be a method of trying to capture meaning in the data stored. The system would also need a 'phonebook' aspect to it, to facilitate the direct sharing of knowledge among employees. Also of significance is the importance enterprise architecting could play in autopoietic knowledge management. Implementing autopoietic knowledge management will require organisations to become effective third order autopoietic entities, and a detailed study of the shared 'identity' is imperative in future work.

8.5 Overall Summary

To conclude, this research has assessed the current field of autopoiesis and knowledge management with the intention of using autopoiesis theory to provide a conceptual foundation. Two models were developed: an autopoietic model of organisational learning based on Kim (1993, p. 44) and an autopoietic model of knowledge. The autopoietic model of organisational learning was tested in two organisations, whilst the autopoietic model of knowledge was evaluated using a panel of knowledge management experts. In terms of meeting the objectives originally set out in Chapter 1, Table 8.1 presents an overview of each objective, where and how it was met.

Objective	Where Objective Was Met	How Objective Was Met
1. To critically review the current literature to understand the extent of research on autopoiesis and knowledge management.	Chapter 2	A thorough and comprehensive review of all relevant literature especially publications considering both knowledge management and autopoiesis.
2. To evaluate if organisations can be autopoietic.	Chapter 2	After a review of all literature on autopoiesis, its updates and its applications, it can be deduced that organisations are third order autopoietic entities.
3. To investigate whether autopoiesis, or its principles, can be applied to an existing model of organisational learning.	Chapter 4	The successful application of autopoietic principles to Kim's model of organisational learning.
4. To establish if the autopoietic model of organisational learning is reflected in an organisational setting.	Chapter 5	Successfully testing the model in two organisations, to determine that autopoiesis can give knowledge management a foundation, but is not the best application of autopoiesis.

5. To develop a new model of knowledge using the epistemological insights from autopoiesis.	Chapter 4	The successful creation of an autopoietic based model of knowledge.
6. To evaluate whether the new model of knowledge is an accurate representation of knowledge.	Chapter 6	The successful expert evaluation of the model proved the need exists, and that the model of knowledge is definitely the first step towards a true autopoietic foundation.
7. To determine if guidelines can be developed on how to apply autopoiesis to knowledge management in organisations.	Chapter 7	Following the discussion of all the results it became apparent that guidelines in the original sense cannot be developed and that more work is required with the model of knowledge to create a comprehensive foundation for knowledge management.

Table 8.1 An Overview Showing how Each Objective was met.

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Appendix 1 Questionnaire to Test the Autopoietic Model of Organisational Learning

Introduction

I am a research student in the Department of Information Science at Loughborough University and my research is exploring how autopoiesis (the self reproducing feature of living systems) can be applied to organisational learning. It is hoped that models which are validated using autopoiesis have more chance of being successfully implemented because they are more closely aligned to the nature of people and their behaviour.

This questionnaire aims to evaluate an autopoietic model of organisational learning which takes individual learning as the focus of attention. Once autopoiesis has been applied successfully to one model, a set of guidelines will be developed, which should make any model inherently autopoietic in nature.

Further Information

Your contribution is valued and all responses from this questionnaire will be kept anonymous and confidential. If you have any questions or would just like more information, please contact me at: p.parboteeah@lboro.ac.uk.

Thank you for completing this questionnaire

Paul Parboteeah

Please only tick (√) one box per question

1. Please select your age range			
☐	18 or under	☐	19 to 30
☐	31 to 40	☐	41 to 50
☐	51 to 60	☐	61 or over

2. How many years have you been working in this organisation?

- ☐ Under 1 Year
- ☐ 1 - 5 Years
- ☐ 6 - 10 Years
- ☐ 11 - 20 Years
- ☐ Over 20 Years

3. What position do you hold?

4. How frequently do you reflect (think back) on why things happen at your organisation?

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

5. How often can you work out what caused something to happen in your organisation?

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

6. When you do reflect why things happen in your organisation, does it impact on your work?

- ☐ Never
- ☐ Rarely

- [ ] Sometimes
- [ ] Frequently
- [ ] Always

7. What percentage of your work would you estimate as routine?

- [ ] 0% - 19%
- [ ] 20% - 39%
- [ ] 40% - 59%
- [ ] 60% - 79%
- [ ] 80% - 100%

8. For aspects of your work which are routine, how frequently do you encounter problems?

- [ ] Daily
- [ ] Weekly
- [ ] Monthly
- [ ] 6 Monthly
- [ ] Yearly

9. Do you often accept facts without checking if they are correct?

- [ ] Never
- [ ] Rarely
- [ ] Sometimes
- [ ] Frequently
- [ ] Always

10. How often do you use past experience when facing a new situation?

- [ ] Never
- [ ] Rarely
- [ ] Sometimes
- [ ] Frequently

☐ Always

11. How often do you follow the same process when you problem solve?

☐ Never

☐ Rarely

☐ Sometimes

☐ Frequently

☐ Always

12. Do you have ideas about how your work could be done better?

☐ Yes ☐ No

13. To what extent do you agree with the following statement? 'I would attempt to make something better even if there was no problem with it'

☐ Strongly Disagree

☐ Disagree

☐ Neutral

☐ Agree

☐ Strongly Agree

14. When have you or your colleagues last had an idea that has been formally implemented?

☐ More than one year ago

☐ In the last year

☐ In the last six months

☐ In the last month

☐ In the last week

15. How often do you follow up what happens to your ideas when you suggest them to others?

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

16. Do unwritten rules exist within your organisation?

- ☐ Yes
- ☐ No

17. How often do unwritten rules affect working procedures in your organisation?

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

18. How much do you agree the following values?

Innovation is about more than just research

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly Agree

There is a culture of creativity

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly Agree

Success is based on a commitment to discovery

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly Agree

A global organisation should have a global responsibility

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly Agree

19. How frequently do you follow guidelines when they exist for what you do?

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

20. How frequently do you question guidelines that affect your work?

- ☐ Yearly
- ☐ 6 Monthly
- ☐ Monthly
- ☐ Weekly
- ☐ Daily

21. How frequently do you attempt to change the guidelines that affect your work?

- ☐ Yearly
- ☐ 6 Monthly
- ☐ Monthly
- ☐ Weekly
- ☐ Daily

22. Are there any other comments you would like to make?

Thank you for completing this questionnaire. Please return in the envelope provided.

Appendix 2 Coded Raw Data from Questionnaire

Q1	1	2	3	4	5
CSG	0	2	8	11	12
Prosidion	0	12	9	8	3

Q2	1	2	3	4	5
CSG	5	21	7	2	2
Prosidion	12	11	10	0	0

Q3	1	2	3	4	5
CSG	Open ended question				
Prosidion					

Q4	1	2	3	4	5
CSG	0	1	6	26	4
Prosidion	0	4	12	12	3

Q5	1	2	3	4	5
CSG	0	1	19	14	3
Prosidion	1	4	16	12	0

Q6	1	2	3	4	5
CSG	0	5	20	10	2
Prosidion	3	13	12	5	0

Q7	1	2	3	4	5
CSG	1	9	8	15	4
Prosidion	3	11	9	5	5

Q8	1	2	3	4	5
CSG	0	2	12	15	8
Prosidion	1	2	13	16	1

Q9	1	2	3	4	5
CSG	3	22	12	0	0
Prosidion	4	8	16	5	0

Q10	1	2	3	4	5
CSG	0	0	5	24	8
Prosidion	0	1	0	23	9

Q11	1	2	3	4	5
CSG	0	1	13	22	1
Prosidion	0	1	6	24	2

Q12	1	2	3	4	5
CSG	0	0	0	0	37
Prosidion	2	0	0	0	29

Q13	1	2	3	4	5
CSG	8	0	5	12	12
Prosidion	1	4	10	13	5

Q14	1	2	3	4	5
CSG	3	0	8	12	14
Prosidion	1	4	8	9	11

Q15	1	2	3	4	5
CSG	0	2	12	18	5
Prosidion	0	2	8	18	5

Q16	1	2	3	4	5
CSG	4	0	0	0	33
Prosidion	11	0	0	0	22

Q17	1	2	3	4	5
CSG	2	8	10	17	0
Prosidion	8	10	10	4	1

Q18	1	2	3	4	5
CSG	0	0	5	25	7
Prosidion	0	0	1	21	11

Q19	1	2	3	4	5
CSG	4	5	11	12	5
Prosidion	1	8	16	6	2

Q20	1	2	3	4	5
CSG	7	12	10	7	1
Prosidion	10	10	7	4	0

Q21	1	2	3	4	5
CSG	5	0	5	6	21
Prosidion	0	0	1	9	1

Q22	1	2	3	4	5
CSG	Open ended question				
Prosidion					

Appendix 3 Additional Comments Received in Questionnaire

Affecting change is not easy if you do have a certain rank within this organization - and that is an unwritten norm!

Communication is key followed by follow through.

I work in a changing environment to see what works and want does not work - to help improve the industry we are helping to build. My duties involve the direct science and technology, but I deal with program changes that effect how the technology works.

It wasn't clear to me that the survey was specific to my employment. I purposefully choose to have a stable paycheck so I can devote my energy and problem solving abilities to out of work activities and groups. My job is boring as rocks... Thanks!

Organization has no mission statement to rally around. Unless I create one.

Depending on the nature of the Politics or politics within the organization will impact the flow of the job and your accomplishments.

Appendix 4 Evaluation Framework

Please rate the following statements based on your own personal belief (ie, not your organisation's perspective or your teaching perspective).

Is knowledge objective or subjective in nature?				
Objective				Subjective
1	2	3	4	5

Is knowledge tacit or explicit in nature?				
Explicit				Tacit
1	2	3	4	5

To what extent is knowledge based on truth or beliefs?				
Truth				Belief
1	2	3	4	5

Is knowledge independent of (A priori) or dependent on (A posteriori) experience?				
A Priori				A Posteriori
1	2	3	4	5

Does knowledge exist in IT or external systems (Embedded) or does it exist in peoples' minds (Embodied)?				
Embedded				Embodied
1	2	3	4	5

Q1 – Gender

Q2 – Age range

[18 or under] [19 – 30] [31 – 40] [41 – 50] [51 – 60] [61 – 70] [71 or over]

Q3 – Occupation

Q4 – Time in Knowledge Management

Part A – Prerequisites

Q5 – What is your understanding of data, information and knowledge and the relationship between them?

Q6 – Do you see a role for wisdom and truth in your previous answer?

Q7 – How important do you think a definition/model of knowledge is to knowledge management?

Q8 – What use do you think a model/definition has in knowledge management? (Difference for theory/practice perspective?)

Part B – Introduction to Model

Q9 – What are your first impressions of the model and why? (terms, definitions, relationships)

Explain model – terms, relationships, where it came from, use

Part C – Formative Evaluation

Q10 – Do you agree with the meanings associated with each term in the model and why?

Q11 – Do you agree with the relationships present in the model and why?

Q12 – Is there anything you think is missing from the model and why?

Q13 – Do you think any of the terms could be measured or tested?

Q14 – How do you think the model would be different if …? (question depends on answers given previously)

Part D – Summative Evaluation

Q15 – How do you think the model fits into your current working practices?

Q16 – Can you think of any examples of when you might/do follow the model?

Q17 – Is there anything in your working practices that is not, or cannot be explained by the model?

Appendix 5 Demographic Results from Expert Evaluation

ID	Gender	Age Range	Perspective	Occupation	Time in KM	Q1	Q2	Q3	Q4	Q5
1	M	3	Industry	Project Manager	10	4	3	2	2	3
2	M	3	Industry	IT Consultant	5	4	4	5	3	3
3	M	5	Academic	Professor	5	2	3	3	4	3
4	F	3	Industry	IM Specialist	7	3	4	3	4	4
5	F	2	Industry	KM Specialist	7	3	5	3	3	5
6	M	4	Academic	Lecturer	6	4	3	3	4	4
7	M	5	Industry	Consultant	15	4	4	3	3	5
8	F	5	Academic	Lecturer	9	4	4	3	4	4
9	F	4	Industry	Systems Engineer	10	4	4	4	4	5
10	M	5	Industry	Consultant	20					
11	M	5	Industry	Enterprise Architect	17	4	5	3	3	4
12	M	5	Academic	Professor	10	5	4	5	5	5

Appendix 6 Author Publications

Parboteeah, P., Jackson, T.W. and Ragsdell, G. “Evaluating a Living Model of Knowledge”, *Electronic Journal of Knowledge Management*, 8(1) January 2010, pp 128-138

Parboteeah, P., Jackson, T.W. and Ragsdell, G., ''Using Autopoiesis to Redefine Data, Information and Knowledge'', *Proceedings of the 20th Australasian Conference on Information Systems*, Helana Scheepers and Michael Davern, ACIS 2009, Melbourne, Australia, December 2009*c*, pp 1045-1054.

Parboteeah, P., Jackson, T.W. and Ragsdell, G., ''Autopoiesis as the foundation for Knowledge Management'', in *Autopoiesis in Organization: Theory and Practice*, Rodrigo Magalhaes and Ron Sanchez, Emerald, UK, 2009*b*, pp 243-262, ISBN 978 1 84855 832 8.

Parboteeah, P., Jackson, T.W. & Ragsdell, G., ''Evaluating a Living Model of Knowledge'', *10th European Conference on Knowledge Management Conference Proceedings*, Martins, B. (ed), Academic Conferences International, UK, ECKM 2009, Vicenza, Italy, September 2009*a*, pp 609-616.

Parboteeah, P. & Jackson, T.W., ''An Autopoietic Framework for Organisational Learning'', *Knowledge and Process Management*, 14(4), November 2007*c*, pp 248-259, ISSN: 1092-4604. DOI: 10.1002/kpm.291

Parboteeah, P. & Jackson, T.W., ''Knowledge Management in the Living Organisation'', *Proceedings of the International Conference on Enterprise as Systems: Theory and Theory in Action*, Hettinger, M. (ed), Mathet Consulting Inc.,

International Conference on Enterprise as Systems: Theory and Theory in Action, Illinois, USA, 2007*b* pp 1-9.

Parboteeah, P., Jackson, T.W. & Ragsdell, G., ''Developing an Autopoietic Model of Organisational Learning'', *Proceedings of the 8th European Conference on Knowledge Management*, Martins, B. (ed), Academic Conferences Ltd, European Conference on Knowledge Management, Consorci Escola Industrial de Barcelona, Spain, September 2007, pp 744-749, ISBN: 978-1-905305-53-7.

Parboteeah, P. & Jackson, T.W., ''Time for Reflection: Going Back to Autopoiesis to Understand KM'', *IRMA - Managing Worldwide Operations with Communications with Information Technology*, Khosrow-Pour, M., IGI Publishing, Vancouver, British Columbia, Canada, May 2007*a*, pp 49-52, ISBN 978 159904 9298.

Parboteeah, P. & Jackson, T.W., ''Building a Scientific Foundation for Organisational Learning Within the KM Paradigm'', *The Knowledge Management Aston Conference*, Edwards, J (ed), Operational Research Society, The Knowledge Management Aston Conference, The Lakeside Conference Centre, Aston, UK, July 2006, pp 76-91, ISBN 0 903440 37 7.

Appendix 7 Research Ethics Statement

All data collected during the course of this research was in accordance with Loughborough University's Ethical clearance policy:

All results will be kept confidential and remain anonymous in the write up.

Participants are free to request written notes.

Data will not be kept longer than necessary.

Participants are free to not answer any question.

Participants are free to withdraw from study at anytime

Participants are free to keep their organisation confidential.