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Using Autopoiesis to Redefine Data, Information and Knowledge

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Abstract

The definition of knowledge has always been a contentious issue in knowledge management. Effective knowledge management requires a definition of knowledge that is consistent, useful and true. Whilst most definitions today fulfil the first two criteria, none accurately address all three, including the true, biological nature of knowledge. This is where autopoiesis can help. Autopoiesis was developed to try answer the question of what makes something living, using a scientific methodology. It proposes living things are discrete, self-producing entities and constantly cognising entities. Autopoiesis has long inspired definitions of knowledge, with ideas such as: knowledge cannot be transferred, or knowledge can only be created by the potential 'knower'. Using the theory of autopoiesis, it is possible to create a biologically grounded model of knowledge, representing the latest thinking in neuroscience. However, before this new, biologically grounded model of knowledge can be integrated into new or existing knowledge management theories, it needs to be tested, else it falls into the trap of being conceptual, and remaining that way. This paper uses the theory of autopoiesis to redefine the concepts of data, information and, most importantly, knowledge, and goes on to develop a model of knowledge that has the potential to be used as a new foundation for knowledge management.

Keywords

Autopoiesis, Epistemology, Information, Knowledge Management, Systems Theory

THE FOUNDATION OF KNOWLEDGE MANAGEMENT

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 a core strategic resource in these organisations, a new approach was needed that could help to effectively manage this new resource. Knowledge management (KM) 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 resulting from different academic paradigms, such as strategic management, business process re-engineering, philosophy, information management and economics.

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 (IT) in KM (Metaxiotis et al., 2005, p. 12) can never be resolved. The different disciplines may always keep their perspective, but in order for KM to develop as a discipline in its own right, its foundation needs to work from a consistent, and correct understanding of knowledge. Subsequently, both industry and academia will be able to benefit from advances that can then take place.

What is needed is a way to give KM a new foundation (Wong and Aspinwall, 2005, p. 70) that is capable of encompassing all the underlying disciplines and perspectives, while at the same time not becoming just another perspective on KM. The use of systems theory has been suggested (Johanessen et al., 1999, p. 26; Scholl et al., 2004, p. 25), arguing it has the potential to combine the different perspectives that underlie KM. The notion that systems theory could be applied to KM is clearly very attractive, and in line with integrating KM to business processes, systems theory also has the potential to develop an organisation wide model of existence (Johanessen et al., 1999, p. 38). As identified by Scholl et al. (1999, p. 25) autopoiesis is a systems theory that could be applied to KM for the new foundation necessary.

Numerous authors have begun applying autopoiesis to KM (Maula, 2000; Hall, 2005; Limone and Bastias, 2006), and it does appear that there are commonalities between the numerous KM theories and autopoiesis. However, these studies have been very focused and narrow in scope, essentially going against the nonreductionist approach demanded by systems theory. A new need can be identified, whereby autopoiesis is applied to KM but at the same time recognising the inherent systems nature of autopoiesis. With this in mind, this paper explores the previously developed concept of autopoiesis, before extracting the five epistemological insights, generating a definition of knowledge and creating a new model of knowledge. The implications of the new model for KM are then considered.

AN INTRODUCTION TO 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' (Luisi, 2003, p. 49). The main idea is that the components of an autopoietic system are capable of producing new components, and their relationships, so as to recreate the system (Koskinen, 2009 p. 15). However, the formal definition of autopoiesis is more complex than this, and defines 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 formal definition from the original literature on autopoiesis defines living systems as a network of processes (processes which produce components), which continually realise the system as a tangible, real entity in the space that the network of processes exists.

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 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, research tends to associate with only one view.

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 systems 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.

There are four consequences of an entity being autopoietic: autonomy, individuality, organizational closure and self-specification of boundaries (Maturana and Varela, 1980). Autonomy is the ability of an entity to specify its own laws and the behaviour it exhibits (Maturana and Varela, 1998). Maintaining their organization as autopoietic, living entities are also actively maintaining their identity (Maturana and Varela, 1980). Organizational closure is an essential feature of autopoietic entities, if they are going to remain living; if they did not maintain their autopoietic organization, they would disintegrate, and die. However, just because a system is organizationally closed, does not mean it cannot receive physical inputs (Mingers, 1995). 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). 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.

Having defined autopoiesis in the cellular domain, explored the immediate criticisms and the implications of being autopoietic, a gap remains when it comes to explain living systems above the cellular level. 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), and become known as second order autopoietic entities. Third order structural coupling occurs when two or more second order autopoietic entities have a history of recurrent interactions. 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).

AN AUTOPOIETIC EPISTEMOLOGY

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. The emergent view arises from the position that autopoiesis cannot exist outside of the molecular domain. This means 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 becomes 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.

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) suggests 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 systems 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.

The position that knowledge itself is autopoietic 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.

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, that 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 a 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 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, explicit knowledge is not actually knowledge; rather it acts as a descriptor for tacit knowledge. This notion also then supports the idea that knowledge is a personal asset that cannot be transferred, or indeed transformed into so called tacit knowledge. Defining explicit knowledge as an oxymoron challenges most theories of knowledge, especially those based on explicit knowledge because it discredits the founding idea that explicit knowledge exists. 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.

AUTOPOIESIS AND KNOWLEDGE MANAGEMENT

Autopoiesis also provides numerous insights into knowledge, undoubtedly the foundation of any knowledge management initiative (Limone and Bastias, 2006; Luisi, 2003; Maturana and Varela, 1980; Maturana and Varela, 1998; Mingers, 1995), and these are:

1. Without a question, or apparent lack of knowledge, no new knowledge will be admitted (Maturana and Varela, 1998, p. 174). 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.

2. Knowledge gives certainty to acts (Maturana and Varela, 1998, p. 174). This insight confirms the notion that knowledge is linked to action, and that any action is necessarily based on knowledge of the actor.

3. Objective knowledge constitutes a description of that which is known i.e. there is no such knowledge (Biggiero, 2007, p. 8). The third insight attempts to objectify the problem with 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.

4. There is only personal knowledge (Limone and Bastias, 2006, p. 47). This 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.

5. Informing is the process of converting data into knowledge (von Krogh et al., 1996, p. 165). 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. This viewpoint can be explained by considering the nervous system in relation to autopoiesis: all inputs, or perturbations, from the environment are received by one of the five senses. At this stage, an electrical signal is sent to the brain, comprised of 'on' and 'off' signals (data). On reaching the brain, the activity of the neurons permit the generation of what is termed 'knowledge'. The data/information/knowledge hierarchy (Ackoff, 1989, p. 28) that is so popular is, in fact, a misrepresentation of the process, and attempts to make information an entity, as opposed to a process.

These five insights can be combined to create a new, autopoietic definition of knowledge (based on that given by Maturana and Varela, 1998, p. 174): '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.' It is not necessary to define the actual nature of knowledge, since it is necessarily embodied in the knower (Abou-Zeid, 2007, p. 617). Knowledge as embodied in a knower stems from the 'all knowledge is personal' notion, and proposes that one person's realization of a piece of knowledge is unique to that person, based on their experiences to that date.

A MATCHING METHODOLOGY

Using the insights provided by autopoiesis, it is possible to go one stage further and develop an autopoietic model of knowledge and a suitable methodology was needed. Research methodologies typically fall into two categories: positivism and interpretivism. Positivists believe that all knowledge arises from observing phenomena in a real and objective world (Cornford and Smithson, 1996). Interpretivism, on the other hand, seeks to 'understand reality through the realm of individual consciousness and subjectivity' (Jashapara, 2004). Such an approach recognises that researchers affect the object they are researching, simply by researching it. However, neither a purely positivit or interpretivist approach is 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 new methodology developed by von Krogh et al. (1996) 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).

The matching process used to develop the model of knowledge in this paper took place over the course of several meetings between a PhD student and the supervisory team. All potential terms to be used in the model 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 model were also explored to ensure terminology being used was not inherently restrictive. The second stage of the process involved the creation of the model of knowledge. After the initial model was created, it was subject to two reviews prior to being finalised.

CREATING THE AUTOPOIETIC MODEL OF KNOWLEDGE

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 1. The arrow indicates the flow of data containing the criterion for the distinction, which feeds into the observation stage.

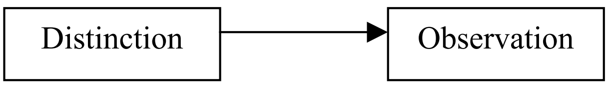

Figure 1: Distinction and Observation

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 2. The arrow in this instance carries the data obtained from the act of observing. In the case of p2, this data would only be carried up to the p2 stage.

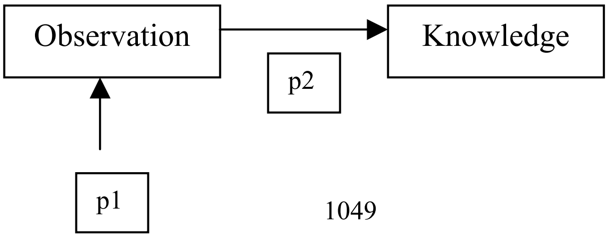

Figure 2: Potential Relationship Between Observation and Knowledge

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 (Drucker, 1988; Orlikowski, 2002). 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, however the quality will vary. If those 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.

Questions and Knowledge

Without a question, or apparent lack of knowledge, no new knowledge will be acquired (Maturana and Varela, 1980). 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 2 now changes as shown to Figure 3. The arrow from question to observation represents the flow of data that contains the need for the observation to occur.

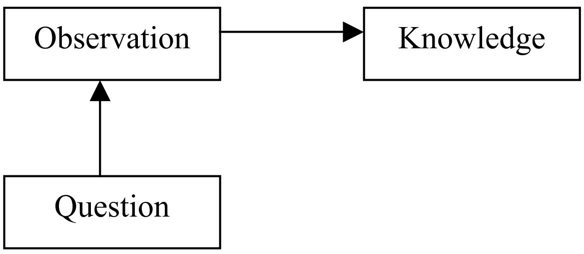

Figure 3: Observations, Questions and Knowledge

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 'Distinctions'. However, a special case exists where a person observes 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.

THE AUTOPOIETIC MODEL OF KNOWLEDGE

Having explored all aspects of autopoietic insights into knowledge, the final model can be presented (Figure 4). It shows how distinctions allow observations to take place and how those observations can lead to knowledge. It also shows that admitting 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. The arrow from knowledge to question represents the flow of data indicating a gap, or a lack of knowledge, which goes onto form the question required to fill the gap.

Having created the new autopoietic model of knowledge, the final stage is to compare the model back to the autopoietic epistemology and the foundation issues presented at the start. The primary aim of the paper was to create a model of knowledge, which was consistent, useful and true, and the autopoietic model of knowledge fulfils all three criteria. First, the model is consistent because, based entirely on autopoiesis, it has just one philosophical base, and does not need to resolve different positions. The model is as true as possible since it is based on the latest biological understanding on the nature of knowledge and cognition in general. Until a greater understanding of cognition is developed, the model will remain the most accurate. Finally, the model can be considered useful because it starts to address the issue of a lack of consensus on the nature of knowledge (Metaxiotis et al., 1999, p. 11). The model is also useful because it can serve as a foundation for KM by being the underlying model of knowledge when developing models of KM.

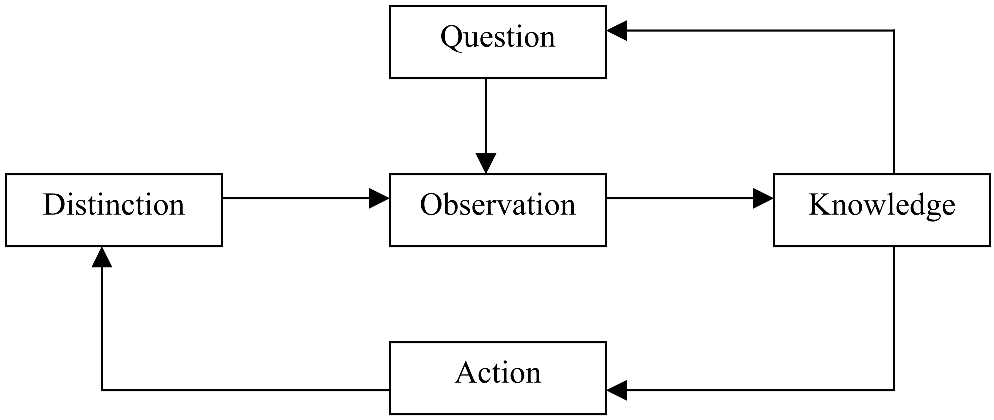

Figure 4: The Autopoietic Model of Knowledge

After developing the model of knowledge, the next step is to consider it applications in knowledge management. Since autopoiesis considers knowledge as embodied in the knower (Abou-Zeid, 2007, p. 617) 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 KM. With this achieved, it should become easier for organizations to identify what KM can achieve, what it is capable of doing and what limitations it may have.

Considering further implications, there could be significant disruption trying to implement this model in a KM system where the current underlying model of knowledge is not compatible with the new autopoietic model. In these cases, a redesign of the system would be required, although there could be substantial cost and disruption to the organisation concerned. Also, the model does not suggest the best KM approach for a given situation, be it Information Technology based, Community of Practice based, or some other alternative. This shortfall clearly shows developing the model of knowledge is only the start and more work is needed to create an autopoietic foundation that is adequate for KM. However, the act of developing the model does bring to the forefront the issue of clearly defining the underlying concepts in KM, to avoid any vagueness.

Testing the model is also another issue now the original model has been created. Ideally, the model would be tested to ensure all the elements of the model existed, along with determining the strength of the relationships between them. However, as previous research on epistemology has taught, testing models of knowledge is extremely difficult and fraught with pitfalls and no win situations. Different methods for testing this model could include placing it inside a larger model, which essentially acts as a testing rig. Alternatively, interviews could be used to test people in different scenarios, during which different aspects of the model would be tested. However, both methods of testing introduce at the start numerous assumptions and other unknown factors that could influence any results. If this model is to be tested, any approach taken will need to be carefully evaluated to ensure as unbiased a result as possible is obtained.

Finally, 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. This is a vital stage because KM will not get the autopoietic foundation it needs if only theoretical aspects get the foundation, and not the practical.

CONCLUSION

This paper has attempted to show that the foundation concepts of data, information and knowledge are radically overhauled using the concept of autopoiesis. The method taken was to use the principles and insights from autopoiesis to create a new model of knowledge that could be used as the future foundation for knowledge management. Whilst successful in creating this model, there were numerous considerations. Firstly, care was taken to show that autopoiesis is not just another perspective on KM, it is the underlying perspective, which is based on what makes a system living. Perhaps future work could outline in more details the foundation autopoiesis provides to the different perspectives on KM. Secondly, it was noted that whilst theoretical models should be tested after development, that testing models of knowledge presented unique problems which needed to be overcome before any testing could occur. Finally, it was identified that a set of guidelines would probably need developing to help users apply the model, and gain the benefits of having an autopoietic foundation to their KM system.

Creating a new model of knowledge based on autopoiesis is a big step, especially in the context of applying it to KM, but it is only the start. More work is needed in testing and refining the model, as well as evaluating the different uses for the model. Work, which if successful will ensure that some of the problems facing KM can start to be addressed since a common framework will exist for understanding and developing knowledge management in organisations.

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