

Knowledge Flows in Complex Systems – Relevance to Knowledge-Intensive Organisations

Harri Laihonen

Researcher, Tampere University of Technology, harri.laihonen@tut.fi

Abstract

This paper introduces complexity-based knowledge management (CBKM) as a framework for analysis. The framework is composed of three theoretical backgrounds: knowledge management, complexity thinking and organisation theory. Based on CBKM, knowledge flows are seen as enabling infrastructures for knowledge-intensive organisations and their role in self-organisation and co-evolution processes are studied on the conceptual level. Main emphasis of CBKM is on knowledge management and, within that domain, the framework sees knowledge as a process and the emphasis of knowledge management is therefore on routing knowledge flows and on encouraging knowledge creation and knowledge sharing activities. This paper aims to conceptually analyse the shift from the micro-level to the macro-level – from the internal knowledge flows of self-organising organisations to the co-evolution of an organisation population. The paper seeks answers to the questions: What kind of role does knowledge flows have for knowledge-intensive organisations and how does their role change when our view of resolution changes.

Keywords

knowledge flow, knowledge management, knowledge-intensive organisations, self-organisation, co-evolution, complexity thinking

Acknowledgements

This paper was produced as part of the TIP Research Program (Knowledge and Information Management in Knowledge Intensive Services), which is funded primarily by The National Technology Agency of Finland. The research was conducted at the Institute of Business Information Management at Tampere University of Technology. The work was supervised by Professor Marjatta Maula, who is also the director of the program.

Introduction

This paper is based on an assumption that self-organisation in an organisational context can be regarded as letting the group of individuals define the rules of their interaction. This allows them to control their own working methods and leaves them without continuous management control. In most cases management or some other instance is setting the goals or purpose of an organisation, but the group can define the way to attain those targets. In knowledge-intensive organisation this kind of working methods are quite normal, professionals are making the decisions without strict management control. Although, this definition does not fully follow the exact definition of self-organising behaviour, it could be regarded as its application in an organisational context.

Knowledge flows can be seen as important enablers of self-organisation process within an organisation (Laihonen forthcoming). This paper develops on this assumption and argues that the importance of knowledge flows is not restricted by organizational boundaries. Knowledge and the flows that are used for transferring it between different parties are important resources for knowledge-intensive organisations also externally and in a larger context. Complexity sciences use the concept of co-evolution that could be linked into this phenomenon of sharing knowledge across organisational boundaries. On the system level, knowledge-intensive organisations could be seen in the centre of a complex network of knowledge flows, processes and agents. Those countless acts of interaction, internal and external, that create and exchange knowledge in an ongoing dialogue between the agents in the network are interpreted as knowledge flows. Knowledge flows are essential for knowledge-intensive organisations because those flows enable the utilisation of their most valuable asset (knowledge) and also the commercialisation of their services (knowledge).

In complexity literature, the essence of flows has been underlined in many circumstances. It has been argued that different properties of these flows essentially define the structure and characters of an organisation (Clippinger 1999). To link the Clippinger's argument into the context of knowledge-intensive organisations, we can argue that knowledge flows are those flows that characterise knowledge-intensive organisations and also their cooperation with the environment.

This paper has two objectives. First, it assesses the complexity-based knowledge management as a framework for analysis. Second, it points out the importance of knowledge flows in the operations of knowledge-intensive organisations.

Framework for analysis

This study has been carried out within a Complexity-based Knowledge Management (CBKM) framework that is described in Figure 1. The basic ideas of the framework have been utilised in several earlier publications (Koivuaho and Laihonen forthcoming, Laihonen and Koivuaho 2005, Laihonen forthcoming and Koivuaho 2005) although this is the first explicit presentation of the framework. There are many open questions concerning the framework, but still it could be seen as a starting point for further research in the multidisciplinary field of knowledge management.

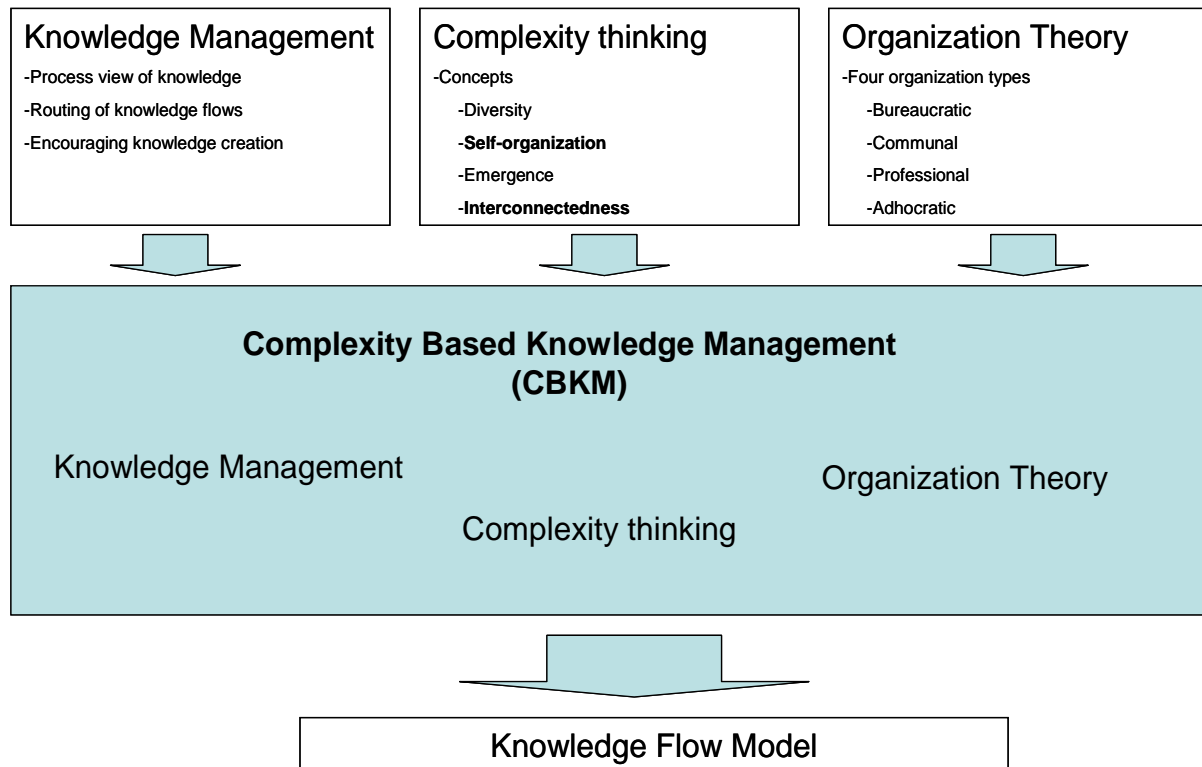


Figure 1. Complexity-based knowledge management (CBKM).

The framework is composed of three theoretical backgrounds. The most important part of the framework is knowledge management, because the main research questions of this study arise from the knowledge management domain. Other domains are complexity thinking and organisation theory.

Knowledge Management: To position this framework in the field of knowledge management, the framework takes the process view of knowledge. Alavi and Leidner (2001) have separated five different viewpoints towards knowledge, in which process view is one. According to Alavi and Leidner, this process perspective of knowledge management concentrates on routing knowledge flows and on encouraging knowledge creation and sharing activities (Alavi and Leidner 2001, 111). This view of knowledge seems to fit very well to the study of knowledge flows and communication processes.

Complexity thinking: Another important background theory for the framework is complexity thinking. It could be described that the framework aims to understand knowledge flows from the complexity thinking perspective. Clippinger (1999) argues that: “In a business enterprise, the management of internal and external flows is an important source of value creation”. Within the complexity-based knowledge management framework, complexity thinking is brought into the discussion through concepts such as self-organisation, diversity, emergence and interconnectedness. In this paper the self-organisation, interconnectedness and co-evolution are studied more deeply.

Organisation theory: This part of the framework is not discussed in this paper, but since the study is carried out in an organisational context organisation theory can not be ignored.

CBKM framework has been developed for studying organisations and their knowledge flows and from that viewpoint, it is worthwhile to keep in mind also this aspect of the framework.

CBKM framework highlights the importance of interconnectedness i.e. knowledge flows for organisations. It has been pointed out in several discussions how important interconnectedness and relationships are for contemporary organisations and based on these discussions, the framework focuses on knowledge flows and communication processes. Framework has already been used for constructing a knowledge flow model that could be used for conceptualising knowledge flows of an organisation.

Next chapters will turn the discussion to the definition of knowledge flows and to their meaning from the CBKM perspective.

Understanding complexity through knowledge flows

Authors in complexity research have argued that flows of people, natural resources, orders, goods, capital and products characterize the complex behaviour of an enterprise (e.g. Holland 1995 and Clippinger 1999). According to these views, different properties of these flows essentially define the structure and characters of an organisation. Although, all the above mentioned flows are, with no doubt, important, this paper concentrates on knowledge flows that form the structure of a knowledge-intensive organisation.

In this article the term 'knowledge flow' refers to the process where knowledge is transferred from one person or place to another. Stacey (2002, 19) claims that knowledge is understood to move through the interplay of individual and group/organisational/social levels. New knowledge is formed in these interplays, in which the receiver, an organisation or more precise an individual in an organisation, relates the received knowledge to his/her own understanding and makes his/her own interpretations from this knowledge. This can be understood as a learning process where knowledge-intensive organisation learns new ways of operating and more practically, finds new business opportunities. These new ideas, technologies, practices and other kind of accumulation of expertise are what customers expect from knowledge-intensive organisations. Customers should be able to concentrate to their own core business and therefore they are buying services and outsourcing them. This continuous interaction at the bottom level affects the way the organisations operate and how their knowledge flows are formed. These processes ensure that all existing knowledge and previous experiences could be used and effectively utilised.

The actors of a network, processes, flows and relationships between them constitute a complex adaptive system. Complex adaptive system is capable of self-organising and these self-organising systems evolve in an interaction, they co-evolve. Co-evolution will be discussed in a more detail later, but to shortly prompt the meaning of the concept, we can think it as a continuous and simultaneous cooperation and competition of organisation and its external interest groups, for example, customers, supply chain members, competitors and different kind of partners. Actors are connected through different kind of flows. Commonly used concepts such as business intelligence and customer relationship management could be depicted as concrete examples for conceptualising this interaction. There are, of course, lot of more intangible flows too, which are definitely very important.

Although this article deals with complexity and nonlinearity, knowledge flows could be understood as a flow of knowledge between the sender and the receiver – a linear relationship. Knowledge is transferred from point to point. System or organisation level complexity arises from this connectivity and these relationships. At the organisational level, linear knowledge flows constitute a complex decision system. Human interaction and communication between humans is not a simple phenomenon. Social systems self-organise and create emergent phenomena that cannot be modelled with linear models.

Next we will study self-organisation and co-evolution process from the view point of knowledge flows, because they seem to lie in the core of understanding complexity.

Self-organisation and knowledge flows

Based on the description of knowledge flows presented in the previous chapter, the purpose of this chapter is to introduce some new aspects for the study of organisational knowledge flows. The ideas origin from the complexity thinking and especially from the self-organising processes of complex adaptive systems.

According to Anderson, *self-organisation* means that patterns and regularity emerge without intervention of a central controller (Anderson 1999, 221). Heyligen defines self-organisation as a spontaneous (no steering by any external system or authority) process of organisation. In this process, according to Heyligen, an organised whole is created spontaneously out of the disordered collection of interacting parts. (Heyligen 1989, 1.) Fuchs (2003) argues that self-organisation can be detected in a system that has parts, interactions, structural relationships, behaviour, state and a border that delimits it from its environment. According to Fuchs, self-organising systems are complex and open systems. They are open in the way that they import energy (for example information) which is transformed within the system, and as a result, energy is exported. (Fuchs 2003, 3-4) A close relation between self-organisation and complex systems can also be seen in Clippinger's (1999) way of using these concepts as synonyms.

According to Buckle, self-organisation occurs in the social context when people are interacting with each other, either face-to-face or across distance. In these situations, self-organisation refers to the phenomenon whereby the interactions develop into highly ordered relating patterns that were not designed or intended by members of the system. (Buckle 2004, 2.) In organisational context, self-organisation in most cases refers to a situation, in which within certain boundaries employees or a group of employees are allowed to make their own decisions.

A fictional example of self-organisation in organisational context could be an independent profit centre that is responsible to the organisation as large, but which makes its own decisions about how to organise and how to fulfil the targets that have been set for it. The profit centre is responsible to the company management, but the management is not controlling how the things should be done. This gives a lot of freedom; centre should find its customers, it should define the working methods and to build up its organisational structure that it finds most suitable for its purposes. It has been seen in practice that this kind of working encourages and maintains the interest toward the work. Boundaries and enabling infrastructure must be there, but management should not restrict the working habits too much,

or otherwise employees might feel restricted. Especially, in knowledge-intensive organisations, in which employees are normally highly educated experts on their field, too many restrictions might present conflicts. Self-organisation clearly has a lot in common with the concept of de-centralisation, but self-organisation has more to do with the actual organising process after the de-centralisation.

Above mentioned definitions, as well as many other definitions in self-organisation literature, indicate that interaction, knowledge sharing and knowledge flows have an important role in self-organising processes. Self-organisation could not happen without them. Based on this assumption, Laihonen (forthcoming) has studied the basic characteristics of self-organisation (Holland 1995) from the knowledge flows point of view.

Laihonen (forthcoming) argues that knowledge flows in self-organising processes can be studied by dividing the self-organisation process into sub-processes like Holland has done. According to Holland, there are four properties and three mechanisms that are common to all self-organising systems. The properties are: aggregation, nonlinearity, flows and diversity. The mechanisms are: tagging, internal models and building blocks. (Holland 1995, 10-37.) According to Laihonen (forthcoming), these characteristics can be described from knowledge flow perspective as presented in Table 1.

Table 1. Seven basic characteristics of self-organisation (Holland 1995) and their implications for knowledge flows (Laihonen forthcoming).

Characteristic	Implication for knowledge flows
Aggregation	Knowledge flows and active interaction between agents enable large-scale organised activity and aggregation.
Nonlinearity	Knowledge flows are those relationships and interactions by which different parts of the system (or different systems) interact and by which this interaction creates nonlinear behaviour at the system level.
Flows	Knowledge flows are the major source of value creation in knowledge intensive organisations. Knowledge can be effectively utilised only by knowledge sharing through knowledge flows.
Diversity	Variety of knowledge creates new business possibilities and knowledge flows enable the use of this resource. Dialogue – knowledge flows – between people with different backgrounds creates new ideas.
Tagging	Tagging is used for channelling knowledge flows. Tags can also be used for defining who should have access to knowledge and further they can be used for defining boundaries of the organisation.
Internal models	Knowledge sharing and knowledge flows are a way to mobilise internal models and to initialise them in new situations. They can be compared to organisation memory, a way to use previous experience.
Building blocks	Knowledge sharing and knowledge flows are a way to formulate building blocks through feedback loops and to practise using them in real situations. Modularity is an effective way to respond to rapidly changing requirements.

As Table 1 demonstrates, self-organisation can be considered as a promising concept when studying knowledge flows and their effects to the adaptability of an organisation. Especially in the case of knowledge-intensive organisations, where experts have a high degree of freedom and a lot of decision power, self-organisation can be seen as a promising way for organising work.

Based on his analysis Laihonen (forthcoming) has concluded that, self-organisation and its characteristics can offer new ways of observing and analysing organisations from the viewpoint of knowledge management. Laihonen also argues that knowledge flows can act as an enabling factor and facilitator for self-organising processes. Without adequate knowledge flows, innovativeness will be stifled already in the beginning. Laihonen also reminds that self-organisation is not a general solution to everything and to exploit self-organisation we should first understand factors that enable and facilitate it. (Laihonen forthcoming.)

Co-evolution of self-organising entities and knowledge flows

Previous chapter discussed about self-organisation and knowledge flows mainly from the viewpoint of one organisation and its internal processes. This chapter changes the focus to group of organisations. In today's highly connected business environment it is important to recognise that self-organisation always takes place in a certain context and in relation to the environment. Complex adaptive systems self-organise in relation to other complex adaptive systems and their self-organisation processes. This kind of interactive evolution is known as co-evolution in complexity literature. This can be presented with an example given by Miller *"each of us, as a complex adaptive system, simultaneously adapts or responds to change and contributes to change. We all respond together as one large ecosystem; each of us (person, family, or practice) is continually seeking to maintain our shape."* (Miller 1998)

It could be seen that organisations as complex adaptive systems are operating in an environment, in which other organisations and their actions have a great influence to the operation of any other organisation. Connectedness, competition and also co-operation are finding new manifestations. Specialisation leads to a co-evolution of a certain group of organisations. Each organisation is struggling to find their own niche, in which they can attain and maintain tolerable fitness (Peltoniemi, Vuori and Laihonen 2005) and survive in the competition. This kind of thinking has been utilised within a conceptual framework of business ecosystem (e.g. Peltoniemi 2005).

Peltoniemi, Vuori and Laihonen argue that in a population of organisations, i.e. business ecosystem, organisations, as parts of business ecosystem, pursue for satisfying behaviour. Organisations operate within the bounds of rationality with the given resources and the existing information. According to Peltoniemi, Vuori and Laihonen bounded rationality is associated with "satisficing" rather than maximising. Thus, an organisation does not optimise its profit or its goal in more general terms, but it "satisfices" by performing well enough. (Peltoniemi, Vuori and Laihonen 2005.) This self-organisation process leads to a co-evolution within a business ecosystem.

Figure 2 presents a simplified picture about the co-evolutionary process in organisational context. Organisations are in a continuous co-evolution with their environment through

feedback loops. Peltoniemi describes the role of these feedback loops so that “changes of an organisation trigger changes in other organisations which then echo back to the original organisation triggering it to augment its original changes” (Peltoniemi 2005, 36).

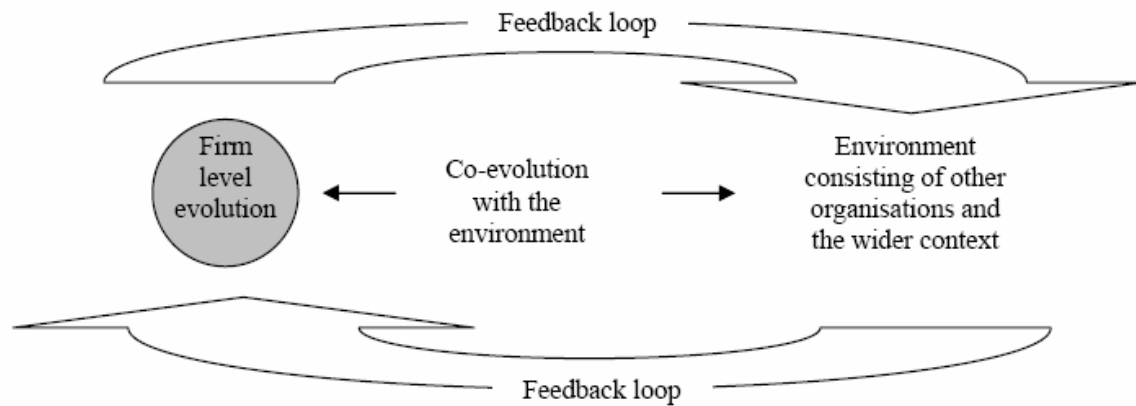


Figure 2. Organisation level model of self-organising entities interconnected to their environment (Peltoniemi 2005, 35).

Theoretically, co-evolution is seen to emerge from the interaction of self-organising agents. Kauffman argues that “in an ecosystem in biology: each kind of organism has, as parts of its environment, other organisms of the same and of different kinds. ... Adaptation by one kind of organism alters both the fitness and the fitness landscape of the other organisms” (Kauffman 1993, 242). Mitleton-Kelly relates this statement of Kauffman to the social context and she argues that “no individual or organisation is powerless – as each action permeates through the intricate web of inter-relationships and affects the social ecosystem” (Mitleton-Kelly 2004, 5-6).

According to Mitleton-Kelly, co-evolution affects both individuals and systems and is operational at different levels, scales or domains (Mitleton-Kelly 2003, 6). In practice, this means that individuals, groups of individuals as well as group of organisations could be co-evolving. Mitleton-Kelly makes a distinction between different levels of co-evolution by defining that endogenous co-evolution applies to co-evolution of individuals and groups within the organisation and exogenous co-evolution to the co-evolution of organisations with the broader ecosystem.

In this discussion the exogenous co-evolution is more interesting, because it studies the co-evolution of an organisation and its environment. Practical example of this kind of co-evolution could be regional development, in which organisations within a certain area are at the same time co-operating to develop their surroundings, but on the other hand also competing for maintaining the tolerable fitness.

From co-evolution point of view, knowledge flows can be seen as a knowledge sharing between organisations or systems and as their way to interact and adapt to the environment. Above discussion points out that complexity thinking and especially the concept of co-evolution might offer some new ideas and even some tools for conceptualising and understanding these knowledge flows between co-evolving parties.

Table 2 connects earlier discussion about characteristics of self-organising processes to the discussion of co-evolution. It could be argued that when self-organising systems are co-evolving their self-organising processes become interconnected. This causes the situation, in which the knowledge flows of each individual organisation also become interlinked. It could be suggested that the concept self-organisation as a conceptual model might be more appropriate at this level than at the lower levels. This is because group of organisations is not as manageable as a single organisation. Each organisation is making its own decisions and together a group of organisations constitute a self-organising system that cannot be managed.

Table 2. Seven basic characteristics of self-organisation (Holland 1995) in co-evolutionary processes of self-organising entities.

Characteristic	Implication for knowledge flows in co-evolutionary processes
Aggregation	Knowledge flows (demand and supply) and the interactions between organisations form the markets for knowledge-intensive organisations. Different specialities (supply) fulfil the requirements (demand).
Nonlinearity	Markets are composed of linear knowledge flows, interactions between organisations, and together these knowledge flows create emergent and nonlinear behaviour at the system level.
Flows	Knowledge flows are the major enabler of any business activities for knowledge-intensive organisation. Income is generated through commercialising these knowledge flows – selling the expertise.
Diversity	In co-evolutionary processes, diversity is essential. Diversity creates business possibilities and knowledge flows are needed for finding them. Knowledge flows also enable the utilisation of different specialties.
Tagging	Tagging is used for labelling organisations and through that, channelling knowledge flows. Tags can be used for defining boundaries of the organisation.
Internal models	Through knowledge flows, organisations are able to define standards and therefore to cooperate with commonly accepted rules. By sharing e.g. best practices, organisations can foster the development of their business.
Building blocks	Modularity is an effective way to build service concepts that can be utilised also among group of organisations. Knowledge sharing and knowledge flows enable the building of modules i.e. building blocks.

According to Mitleton-Kelly, especially in the social context the concept of co-evolution is important. In social ecosystem, interaction between humans is affected by the social, cultural, technical, geographic and economic milieu. Therefore, it is hardly ever possible that an individual could adapt to the environment without these variables affecting the evolution. Mitleton-Kelly also refers to Allen (1997) who argues that the notion of co-evolution, places the emphasis on the relationship i.e. knowledge flows between entities and on the evolution of those interactions. (Mitleton-Kelly 2004, 5.) This is an important notion from the knowledge flow point of view, because it argues that knowledge flows can act as an enabling factor and facilitator also for co-evolution. The potential advantages of a co-evolution, although, will not be attained without active knowledge sharing and effective knowledge flows.

Discussion

This paper studied knowledge flows of knowledge intensive organisations within a framework of complexity-based knowledge management. Complexity-based knowledge management builds up from three domains: knowledge management, complexity thinking and organisation theory. Knowledge is seen as a process and the emphasis of knowledge management is therefore on routing knowledge flows and on encouraging knowledge creation and knowledge sharing activities.

Complexity thinking applied in this paper looks at organisations as self-organising complex systems and their interconnectedness and relationships as knowledge flows. Self-organisation always happens in a certain context and in a relation to the environment. Complex adaptive systems self-organise in a relation to other complex adaptive systems and their self-organisation processes. Therefore, the study of knowledge flows should not be restrained to organisational boundaries. Co-evolution of self-organising processes should be seen as an asset, organisations should acknowledge that they are part of a larger context, in which their decisions affect all the decisions that other organisations are making.

Based on these ideas it could be seen that most of the organisations that we see around us are actually operating as parts of different organisation populations. Within these populations, organisations form business ecosystems where they compete and co-operate at the same time. They co-operate, share knowledge and form partnerships, but at the same time, competition is fierce and each organisation must operate at the sufficient efficiency level to survive. There is no central controller who makes decisions on behalf of organisations. Organisations are finding their own solutions and as a system they self-organise, new order will emerge through the co-evolution and self-organising processes of organisations.

This paper studied knowledge flows of a self-organising group of organisations. It might be hard to see how these systems could be managed, but if that is possible, the management of knowledge flows should have a role in those management processes. Although each organisation has its own possibilities to influence how the population or the business ecosystem operates, it is not able to make inclusive decisions on behalf of other organisations. This fact sets the requirement for the study of knowledge flows within an organisation population i.e. business ecosystem.

References

- Allen, P.M. 1997. *Cities & Regions As Self-Organizing Systems: Model of Complexity*. Environmental Problems & Social Dynamics Series. Vol 1.
- Anderson, P. 1999, *Complexity Theory and Organisation Science*. Organisation Science. Vol. 10. No. 3, 216-232.
- Clippinger, J. III (ed.) 1999, *The Biology of Business: decoding the natural laws of enterprise*. Jossey-Bass Publishers, San Francisco.
- Holland, J. 1995. *Hidden Order: How Adaptation Builds Complexity*. Cambridge, Perseus Books.
- Kauffman, S. 1993. *The Origins of Order: Self-Organisation and Selection in Evolution*. Oxford University Press, New York.
- Koivuaho, M. 2005. Management of communication networks in knowledge intensive service organizations – The perspectives of conduit and language game models. *Frontiers of e-Business Research 2004*, Tampere 21-22.9.2004.
- Koivuaho, M. and Laihonen, H. (forthcoming). A Complexity Theory Approach to Knowledge Management – Towards a Better Understanding of Communication and Knowledge Flows in Software Development. *Electronic Journal of Knowledge Management*.
- Laihonen, H. (forthcoming). Knowledge flows in self-organising processes. *Journal of Knowledge Management*.
- Laihonen, H. and Koivuaho, M. 2005. The Management of Internal Diversity in Knowledge Intensive Organizations. A paper presented at the Complexity, Science and Society Conference, 11-14 September 2005, Liverpool, Great Britain. Available at http://cpapadopoulos.dyndns.org/various/gnosis/events/20050911_discs/submitted/laihonen.pdf
- Miller, W. 1998. Understanding change in primary care practice using complexity theory. *Journal of Family Practice*. Vol. 46. Issue 5, 369-376.
- Mitleton-Kelly, E. 2004. Complex systems and evolutionary perspectives on organisations: The Application of Complexity Theory to Organisations. http://www.psych.lse.ac.uk/complexity/PDFfiles/publication/EMK_The_Principles_of_Complexity.pdf, 25.11.2004.
- Peltoniemi, M. 2005. Business ecosystem: a conceptual model of an organisation population from the perspectives of complexity and evolution. *eBRC Research Reports 18*.
- Peltoniemi, M., Vuori, E. & Laihonen, H. 2005. Business ecosystem as a tool for the conceptualisation of the external diversity of an organisation. *Proceedings of the Complexity, Science and Society Conference, 11-14 September 2005, Liverpool, Great Britain*.
- Stacey, R. D. 2002. *Complex Responsive Process in Organisations: Learning and Knowledge Creation*. Routledge. London and New York.