5th International Conference on Mass Customization and Personalization in Central Europe (MCP-CE 2012)
Customer Co-Creation in Central Europe
September 19-21, 2012, Novi Sad, Serbia

HOUSE OF KNOWLEDGE MODEL: KNOWLEDGE, CO-CREATION, INNOVATION

Zeljko Tekic[1], Ilija Cosic[1], Branko Katalinic[2]
[1]University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Republic of Serbia
[2]Vienna University of Technology, Faculty of Mechanical and Industrial Engineering, Vienna, Austria

Abstract: *This paper describes a conceptual model which links knowledge and innovation. It is developed using chronology over a long period of time in order to gain deeper and fuller understanding of the knowledge-innovation cycle. The model describes not only how new knowledge is created through interactions and feedbacks, but also how different pieces of knowledge (new and old) become combined in new ways to produce innovations. It contributes to understanding the way in which various types of organizations recognize and access knowledge in order to mobilize and utilize it to produce a product, service or new knowledge. The application of the model should help in choosing the right knowledge management tools at the specific phase of the knowledge-innovation cycle, which is crucial for achieving sustainable results.*

Key Words: ***Knowledge co- creation, innovation, model, historiography***

1. INTRODUCTION

Today companies operate in a highly competitive, complex, and dynamic environment. To gain and sustain a competitive edge in such a turbulent business milieu companies have to commit themselves to continuous innovations, which heavily depend on the production and usage of advanced knowledge. Therefore, it is crucial for the success of organisations at all levels to build the capacity and capability to understand, process, and generate advanced knowledge and to transfer it into marketable innovations.

However, knowledge and knowledge assets are intangible and different from (tangible) assets that were the source of competitive advantage in the past. This makes companies inexperienced in understanding and managing knowledge. Additionally, although knowledge is understood as a key component of all forms of innovation [1, 2], the relationship between these two concepts is still not completely explored, especially how knowledge is transferred into innovation. Therefore, the key challenge for companies lies in their capacity to manage (i.e.: generate, access, store, identify, develop, protect, conserve and share) knowledge for innovation. This challenge is difficult, and companies have few tools available to assist them.

The purpose of the paper is to contribute to the better understanding of the knowledge – innovation interface. To this end the research looks at the development of knowledge and related innovations in land line, mobile and smart phone industry, based on primary (patent data, photos, interviews, industry memos and contracts) and secondary (scientific, technical and newspaper articles, books, PhD theses and market reports) evidence. In this case historiography has been considered to be a useful approach because there is a high possibility that the current situation is part of a cycle and that understanding the nature of the cycle could provide some insights on the current situation [3]. Consequently, the modelling of knowledge-based processes of innovation becomes a very useful analytical approach for this research; several models can be found in the literature [4, 5, 6]. These models explore the characteristics of knowledge highlight the role of various processes of knowledge creation and recombination for the generation of new knowledge. However, they usually fall short of defining what the outcome of a process of knowledge exchange and recombination is and how this outcome relates to innovation [7]. For example, the most influential model of knowledge creation developed by Nonaka and Takeuchi [4] implicitly views the creation of new knowledge as an innovation. But it is not clear whether all new knowledge, created either through exchange and recombination or by the various methods proposed in Nonaka's [4] model, is an innovation?

The remainder of the paper is structured as follows: a brief literature review on the subject of knowledge and innovation is followed by an explanation of the research methodology. The paper then describes the House of Knowledge model and its main characteristics followed by preliminary conclusions and implications.

2. LITERATURE REVIEW

The question "What is knowledge?" has intrigued some of the world's greatest thinkers since the classical Greek era. To explain and understand knowledge and knowledge creation, a variety of concepts and approaches are required and has been employed. And yet, there is not a clear consensus or definition on the concept of *knowledge* [8].

Knowledge is a complex, abstract and multifaceted phenomenon. It is context-specific in terms of time,

space, and relationship with others. Without a context, it is just information, not knowledge [4]. Information becomes knowledge when it is interpreted by individuals, given a context and anchored in the beliefs and commitments of individuals [8]. Knowledge is an ever changing phenomenon. The stock of knowledge that exists at any point in time represents combination of fast and slow changing parts of knowledge [9]. In order to capture the multifaceted nature of knowledge, we adopt the working definition of knowledge proposed by Davenport and Prusak [10]:

Knowledge is a mix of framed experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information.

On the other hand, innovation can be viewed as a process as well as the outcome of the process [11, 12]. Outcome oriented definitions see innovation as a product, process, organisational model, idea, etc., which are considered new in the environment into which they are introduced [7]. On the other hand, from the process perspective innovation is defined as a process of interrelated activities from idea to invention to its commercialization, where new knowledge is created and used through these activities [12]. This perspective highlights a strong relationship between knowledge and innovation. Therefore, it is logical that researchers see innovation and knowledge as two faces of the same coin. For example, Anand et al. [13] define innovation as generation and exploitation of new forms of knowledge, while Katila and Chen [14] see innovation as the problem-solving process in which organizations manipulate knowledge to create new products. Recently, Quintane et al. [7] describe innovation as duplicable knowledge which is new in the context it is introduced to and useful in practice. These views are mirrored in the suggestion that innovation and knowledge management should not be separated from each other [15] as well as, in the comprehensive conceptual model developed by Xu et al. [16] which demonstrates that various aspects of knowledge management support continuous innovation.

Although knowledge is essential to innovation, exposure to a problem is generally considered to be the initiator of the innovation process [4]. An innovation can come from the re-use of existing or creation of new knowledge. The knowledge needed to solve the problem is not created in one place or by a company in isolation. It is cumulatively co-created in a dialectical process, in which various contradictions are synthesized through dynamic interactions among individuals, the organization, and the environment [4]. While creation of the new knowledge provides a basis upon which the innovative actions of all kinds are developed in the organization [17], there is a subtle difference between process of knowledge creation and innovation. Knowledge creation refers primarily to the process of development of new ideas, while, as we sad, innovation is used in the literature to describe process of transforming an idea into commercial result as well as the result itself. In this particular paper the authors follow this distinction, using *knowledge creation* to identify the process of development of new knowledge, and innovation – to refer to the results of the successful application of this new knowledge. Consequently, we define innovation as a sustainable and value-adding solution (to a given problem) that is developed by creating and applying new knowledge or recombining the existing knowledge.

3. METHODOLOGY

Knowledge and innovations as well as their management emerge within a linear time frame as technologies, societies and organizations evolve in response to various internal and external forces. As a linear and, thus, historical concept, the knowledge – innovation interface can be studied using evidence of past events and decisions. Although not a common method of research in industrial engineering and management, there are some very important history and chronology-based research papers. For example, Clayton Christensen [18] sought the answer to the question "Why do great companies fail?" by looking at the historical development of hard disks and their acceptance at the market. The result of his study is the theoretical concept of disruptive and sustainable innovation which is often cited and applied in the innovation and technology management field. Similarly, Daniel Levinthal [19] develops a model for studying technological changes and demonstrated its functionality through the analysis of the history of wireless communications. It is clear that historiography is a powerful tool for creating new theories and models which can be applied to more specific theoretical constructions.

In the above mentioned examples, researchers used historiography as an empirical research model that employs interpretive or qualitative approaches based on chronology. The examples look at specific cases over a long period of time in order to gain a deeper and fuller understanding of a cycle, situation or a series of circumstances [3]. Following the same logic, our research focuses on a chronology of knowledge and innovation development in the telephone industry form the middle of 18th century until present time in order to obtain a fuller and richer understanding of knowledge – innovation links. Based on primary (patent data, photos, interviews, industry memos and contracts) and secondary (scientific, technical and newspaper articles, books, PhD thesis and market reports) evidence, we track development of knowledge and related innovations in fix, mobile and smart phone industry.

4. RESULTS

Based on the collected data, our analysis indicates the following:

- It is possible to represent the cyclic relation between knowledge and innovation by a model consisting of five phases, each of them resulting in a certain type of innovation;
- Each phase is based on several knowledge-creating mechanisms, with one dominating the others;
- Each of these mechanisms is essentially co-creative and involves the interaction of various interest groups (visionaries, competitors,

Table 1. Description of the Model phases

Ideation • Creation of *new to the world* and unstructured knowledge in order to solve an incompletely defined problem (the environment description and the purpose are incomplete). • Dominant mechanism: the visionaries' knowledge co-creation • The result is innovation as a concept • Creation of the first workable solution • Knowledge is created among individuals (Industry is not pre-existent)
Competition • Based on created concept, competitors add one upon another layer of new applicable knowledge in order to solve the key problem. (Key problems: signal attenuation over distance and network infrastructure for land line telephony; frequency reuse, phone size and energy efficiency for mobile telephony; network optimization for data transfer for smart phones) • Dominant knowledge creation mechanism: the competitors' knowledge co-creation • The result is innovation as a creation • Creation of the sustainable solution • Knowledge is created inside industry, among competitors. Created knowledge is new to the world and it develops structure based on the concept
Convergence • Created solution is advanced by application of knowledge originally developed in other industry and for other industry. (The most influential is integration with the main technology trend: microelectronics, digitalisation and microprocessors) • Dominant knowledge creation mechanism: the inter industry knowledge co-creation • The result is innovation as a integration • Advancement of original solution • Knowledge is structured and originally developed in other industries and for other industries (new for the industry).
Customisation • Solution is further developed by the application of new knowledge that is created through the intensive relationship with the user but led by the company • Dominant knowledge creation mechanism: the user - producer knowledge co-creation • The result is innovation as optimisation • Optimisation of original solution and adaptation to specific needs • Knowledge is created between company and users, it is structured and new to the company
Extension • Solution is getting the new functionality by applying knowledge created following user – user relationship (end-user community), • Company does not lead process • Dominant knowledge creation mechanism: the user – user knowledge co-creation • The result is innovation as an extension • Knowledge is unstructured and new to the company. Sometimes it can be new to the world

suppliers, other industries and end-users) in knowledge creation;

- Mechanisms that create knowledge resulting with innovation are the following: ideation (co-creation of knowledge among visionaries), competition (co-creation of knowledge among competitors), convergence (co-creation of knowledge among industries), customization (co-creation of knowledge among users and producers) and extension (co-creation of knowledge among end-users);
- The result of the process of knowledge development in each phase is a specific type of innovation. By moving from the beginning to the end in this model, innovation appears as culmination in each phase - concept, creation, integration, optimization and adaptation.

4.1. Model phases and knowledge creating mechanisms

Based on these findings, using a systematic approach, we were able to develop a model – House of knowledge (Table 1, Figure 1). The arrows (lines) in Figure 1 indicate the knowledge-creating phases of this model: ideation (arrow line coming to A), competition (arrow line between A and B), convergence (arrow line between B and C), customization (arrow line between C and D), and extension (arrow line between D and E). In each phase there are several knowledge creating mechanisms but none of them is exclusively present at any given phase. This means that every innovation results from the combination of several knowledge creating mechanisms. However, one of them always dominates. Table 1 summarises characteristics of the identified innovation phases and knowledge creating mechanisms.

A few important things, which are required for better understanding of the model, should be noted here. First, none of the phases in the development of knowledge is limited in time. This is especially true for the first two phases - ideation and competition. For example, in the development of telephones, the ideation phase covers visionary ideas reaching back several centuries before the actual invention of the telephone.

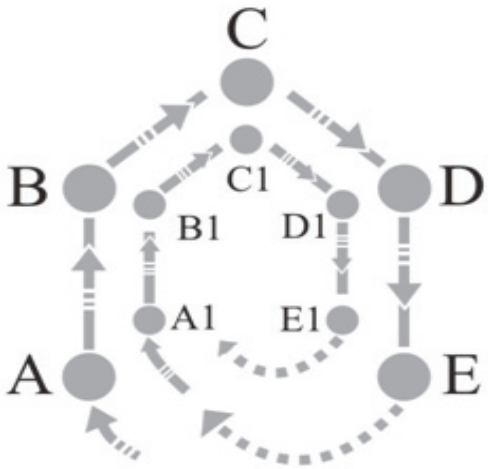

Fig. 1. Model House of Knowledge – Knowledge-Innovation Cycle

On the other hand, mobile telephones have their roots in the discoveries of Nikola Tesla from the end of the 19th century. Similarly, in the second phase, when the main element in forming new knowledge is competition, with the aim of confirming knowledge on the market (innovation as a creation), it depends on the possibility to solve the key problem efficiently.

Second, the completion of one and the beginning of the next cycle are not causally related. More precisely, they depend on each other, but the next cycle does not begin at the moment the previous is completed, but the phase of ideation starts much earlier, and the cycle itself is implemented upon the resolution of the key problem in phase II. This is clearly seen in the development of land line, mobile and smart phones. Also, it can be concluded that these cycles are partially unfolding in parallel and that the process of ideation of the cycle two can start virtually during the ideation of the cycle one, with the first (and perhaps the only) viable being the one where the key problem is first resolved.

Third, knowledge that is incompatible with the existing system may arise in any of the previous phases. This is the knowledge which provides basis for a new concept and which is waiting for its further development until a new structure is created in the knowledge – innovation system. This is due to the inability to quickly discard the old knowledge, to quickly "unlearn" what has provided good results for years and suddenly became insufficiently good. For instance, telegraphy-based companies failed to understand the knowledge on which the land line telephony was based, while it was changing the world. Similarly, the companies that dominated the era of land line phones failed to recognize and apply the knowledge which could have made them leaders in mobile telephony. In the same way Nokia was degraded within two years from a leader in the mobile phone market to a company with huge losses at the moment when knowledge on which smart phones were based became the basis for obtaining competitive advantage. As indicated by the above examples, knowledge generated in this way, by mutation of the previous knowledge, cannot be translated into innovations and successfully incorporated into the value chain of existing companies; instead, through a new phase of ideation, this knowledge will be incorporated into a new concept or invention.

4.2. Model phases and innovation

The model describes not only how new knowledge is created through interactions and feedbacks, but also how different pieces of knowledge (new and old) become combined in new ways to produce innovations. Through its application, each knowledge-creating phase results in corresponding innovation. In Figure 1 innovations are presented by points: innovation as a concept (point A), innovation as a creation (B), innovation as a integration (C), innovation as optimization (D) and innovation as an adaptation (E). Innovations are named in a descriptive way to indicate the different results to which the above mentioned knowledge creating phases are leading.

In this model all innovations are equally important. Although they might come in different forms, each innovation has a significant role in creating competitive advantages, fostering growth and increasing profitability. At the same time, as indicated by the analysis presented, companies that are successful in one phase may not be equally good in the next. This also means that at each phase there is an opportunity for new companies to penetrate the market through the materialization of a specific knowledge in innovation.

The above innovations can be viewed through the prism of a rough division between radical and incremental. In this case, a radical innovation corresponds to innovation as creation, while innovation as integration, innovation as optimization and innovation as adaptation are incremental innovations. Finally, innovation as a concept corresponds with invention.

5. CONCLUSION

In this paper we described conceptual model House of Knowledge, which links concepts of knowledge, co-creation and innovation into meaningful system. The model is developed tracking chronology of development of knowledge and related innovations in land line, mobile and smart phone industry over a long period of time in order to gain deeper and fuller understanding of a cycle. The model describes not only how new knowledge is created through interactions and feedbacks, but also how different pieces of knowledge (new and old) become combined in new ways to produce innovations. It also contributes to understanding the way in which companies recognize and access knowledge in order to mobilize and utilize it to develop a product, a service or new knowledge. The application of the model should help in choosing the right knowledge management tool at each phase of the knowledge-innovation cycle, which is crucial for achieving sustainable results.

The limitations of our research are inherent to the modelling task, the need to balance the degree of generalization and the available research sample size. Therefore, further research should explore recognized links and support model validity through case study evidence.

6. REFERENCES

[1] R.Chapman, M.Magnusson, ‘‘Continuous Innovation, Performance and Knowledge Management: An Introduction’’, *Knowledge and Process Management*, Vol. 13 No. 3, 2006, pp. 129-31.

[2] J.Tidd, J.Bessant, K.Pavitt, “*Managing Innovation: Integrating Technological, Market and Organizational Change*“, 3rd ed., Wiley, Chichester, 2005

[3] J.O’Brien, D.Remenyi, A.Keaney, “Historiography - A Neglected Research Method in Business and Management Studies”, *Electronic Journal of Business Research Methods,* Vol. 2, No 2, 2004, pp. 135-144,

[4] I. Nonaka, H.Takeuchi, “*The Knowledge Creating Company”*, Oxford University Press, Oxford, 1995

[5] C.Galunic, S.Rodan, “Resource recombination in the firm: Knowledge, structures and the potential for Schumpeterian innovation” *Strategic Management Journal*, Vol.19, 1998, pp.1193-1201.

[6] W.Tsai, S.Ghoshal, "Social Capital and Value Creation: The Role of IntraFirm Networks", *Academy of Management Journal*, Vol. 41, 1998, pp. 464-476.
[7] E.Quintane, M.Casselman, B.S.Reiche, P.Nylund, "Innovation as a Knowledge-Based Outcome", *Journal of Knowledge Management*, Vol.15, No6, 2011, pp. 928 – 947
[8] R.M.Grant, ''Toward a Knowledge-based Theory of the Firm'', *Strategic Management Journal*, Vol.17, 1996, pp. 109-22.
[9] Z.Tekic, B.Katalinic, I.Cosic, "Key Characteristics of Knowledge", *Annals of DAAAM for 2009 & Proceedings of the 20th International DAAAM Symposium*, Katalinic, B. (Ed), pp 1747-1749, DAAAM International, Vienna, Austria 2009
[10] T.H.Davenport, L.Prusak, "*Working Knowledge: How Organizations Manage What They Know*", Harvard Business Press, Boston, MA, 1998
[11] OSLO, *Guidelines for Collecting and Interpreting Innovation Data*, 3rd ed., OECD, Paris, 2005
[12] P.Trott, "*Innovation Management and New Product Development*", 3rd ed., Pearson Education Limited, New York, NY, 2005
[13] N.Anand, H.K.Gardner, T.Morris, "Knowledge-based Innovation: Emergence and Embedding of New Practice Areas in Management Consulting Firms". *Academy of Management Journal*, Vol.50, No.2, 2007, pp. 406-428.
[14] R.Katila, E.L.Chen, "Effects of Search Timing on Innovation: The Value of Not Being in Sync with Rival", *Administrative Science Quarterly*, Vol.53, 2008, pp. 593-625,
[15] A.Goh, ''Harnessing Knowledge for Innovation: An Integrated Management Framework'', *Journal of Knowledge Management*, Vol.9, No.4, 2005, pp. 6-18.
[16] J.Xu, R.Houssin, E.Caillaud, M.Gardoni, ''Macro Process of Knowledge Management for Continuous Innovation'', *Journal of Knowledge Management*, Vol.14, No.4, 2011, pp. 573-91.
[17] S.Popdiuk, C.W.Choo, ''Innovation and Knowledge Creation: How are These Concepts Related?'', *International Journal of Information Management*, Vol.26, No.4, 2006, pp. 302-12.
[18] C.Clayton, "*The Innovator's Dilemma*", Harvard Business School Press, Boston, 1997.
[19] D.A.Levinthal, "The Slow Pace of Rapid Technological Change: Gradualism and Punctuation in Technological Change". *Industrial and Corporate Change,* Vol.7, 1998, pp. 217–247

CORRESPONDENCE

Mr Zeljko Tekic, Teaching Assis.
University of Novi Sad
Faculty of Technical Sciences,
Trg Dositeja Obradovića 6
21000 Novi Sad, Serbia
tekicz@uns.ac.rs

Dr Ilija Cosic, Professor
University of Novi Sad
Faculty of Technical Sciences,
Trg Dositeja Obradovića 6
21000 Novi Sad, Serbia
ftndean@uns.ac.rs

Dr Branko Katalinic, Professor
Vienna University of Technology
Faculty of Mechanical and
Industrial Engineering,
Karlsplatz 13/311
1040 Wien, Austria
katalinic@mail.ift.tuwien.ac.at