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UDK: 005.94:001.895 **Research paper**

Knowledge Creation and Emergence of Innovations

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Abstract

This paper tackles the question: What determines the direction and intensity of the innovation activities from the perspective of knowledge? Research is based on a chronology of knowledge and innovation development in the remote communication in order to obtain a fuller and richer understanding of knowledge – innovation cycles. The results show that knowledge always tends to develop towards the idea of the ideal, while the direction of development of knowledge is determined by the difference between what is needed and what is currently possible. The intensity of converting knowledge into innovation is defined by the limitations arising from the condition of society (profitability, legality, ethics) and compliance with nature (sustainability).

Key words: *knowledge, innovation, idea of the ideal, conditions*

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.

Knowledge is understood to be the key component of all forms of innovation. However, while different knowledge processes have a beneficial impact on innovation, it has been recently shown that the knowledge creation impacts innovation the most and fully mediates the impact of other knowledge processes (intra-organizational knowledge sharing, external knowledge acquisition and documentation) on innovation performance [1]. Therefore, understanding the link between knowledge creation and innovation in product lifecycle becomes crucial for better understanding how competitive advantage is created and sustained at the beginning of 21st century [2]. The purpose of this paper is to contribute to this goal by providing insight in the knowledge – innovation interface. To this end the research looks at the knowledge development and related innovations in remote communication over time. In this case historiography has been considered to be a useful approach because there is a high possibility that the current situation is a part of a development cycle and that understanding the nature of the cycle could provide some insights into the current situation [3]. The remainder of the paper is structured as follows: a brief literature review on the subject of knowledge and innovation is followed by research questions and an explanation of the research methodology. The paper then presents results, describes the 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* [4].

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 [5]. Information becomes knowledge when it is interpreted by individuals, given a context and anchored in the beliefs and commitments of individuals [4]. 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 [6]. In order to capture the multifaceted nature of knowledge, we adopt the working definition of knowledge proposed by Davenport and Prusak [7]:

> *"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 [8, 9]. 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 [10]. On the other hand, from the process perspective innovation can be defined as a process of interrelated activities from idea to invention to its commercialization, where new knowledge is created and used through these activities [8]. Knowledge creation and innovation are thus often seen in the literature as two faces of the same coin. For example, Anand et al. [11] define innovation as generation and exploitation of new forms of knowledge, while Katila and Chen [12] see innovation as the problem-solving process in which organizations manipulate knowledge to create new products. Recently, Quintane et al. [10] describe innovation as duplicable knowledge which is new in the context it is introduced to and useful in practice. However, in this particular paper the authors make a subtle difference between the processes of knowledge creation and innovation, using the term *knowledge creation* to identify the process of development of new knowledge, and the term *innovation* – to refer to the results of the successful application of this new knowledge.

Although knowledge is essential to innovation, exposure to a problem is generally considered to be the initiator of the innovation process [5]. These initial problems are mainly sourced from outside of organizations [13] and are almost exclusively viewed through the prism of technology and market [14], [15]. Namely, a number of authors have combined technological and market perspectives to develop theoretical models of innovation, based on the qualitative and quantitative differences introduced by an innovation compared to the existing technology and market [14], [16] and [17]. The differences arise only in the way how these two elements (technology push and market pull) are interrelated [15]. Recently the notion of eco or green innovation has emerged. It is based on the need for sustainable development – the ability of current generations to meet their needs without compromising the opportunities of future generations to meet theirs. The aim of green innovations is to provide value to users and businesses, but also to significantly reduce the impact on the environment and to contribute to balancing financial, social and environmental performance. Similarly, the influences of culture and learned thought patterns are important for innovation. Although globalisation increases mobility of goods, services, labour, technology and capital throughout the world making differences of all kind smaller, national cultural values seem to be less influenced by these tremendous changes [18]. As a consequence, success of new products and other innovations depends on the consideration of customers' and users' cultural values in development processes. Thus, it is clear that innovations should be viewed from a broader perspective than technology / market framework. On the other hand, the most influential model of knowledge creation developed by Nonaka [5] views knowledge creation as the interaction between tacit and explicit knowledge which is amplified through the four modes of knowledge conversion. The movement through the four modes of knowledge conversion forms a spiral that becomes larger in scale as it moves up through the ontological levels [5]. However, it is not clear what is axis around which spiral cycles of knowledge improvement have been implemented? The research question we ask in this paper is: *What determines the direction and intensity of the innovation activities from the perspective of 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, Christensen [19] 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, Levinthal [20] 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 remote communication in order to obtain a fuller and richer understanding of knowledge – innovation links.

4. IDEA OF THE IDEAL

The development of remote communication takes place over the past several thousand years and went through several phases. In the first phase people used smoke

Table 1. The analysis of the development of remote communication

Type of remote communication	Features	Approaching to ideal communication
Smoke signals, fire	The first form of remote information transfer using simple signals, enables the transmission of very short messages in real time, conditioned by weather conditions, encrypted, and easily visible	The first form of remote communication, transmission of discrete messages
Letter, mail	Remote information transfer in the form of a written text, enables the non-real-time transmission of both long and short messages	Transmission of complex messages, information and emotions
Telegraph	Remote transmission of text messages, with the messages transmitted between two devices in the form of coded electrical signals, enables the real-time transmission of both long and short messages, with the existence of intermediaries (telegraphers)	Real-time transmission
Telephone	Remote voice transmission, with the messages transmitted between two devices in the form of electrical signals, enables the real-time transmission of messages of arbitrary length without mediator	Real-time transmission without a mediator
Video telephone	Transmission of both voice and images between the speakers, with the messages between two devices transmitted in the form of electrical signals, enables the real-time transmission of messages of arbitrary length, without mediator	Inclusion of additional senses
Mobile telephone	Transmission of both voice and images while the speakers are still mobile, messages between two devices are transmitted in the form of electrical signals, enables the real-time transmission of messages of arbitrary length, without mediator	Mobility, Available at all places in all times
Internet	Transmission of different types of data, enables the real time transmission of multimedia messages of arbitrary length, messages are also available later, without mediator	Low expenses, Multi medial
Smart phone	Integration, data and voice transmission, inclusion of several senses, simplicity, multi media	Integration

signals and fire to communicate between distant locations. This way of communication enabled the transfer of a limited set of discrete messages. Then, in later phases the message complexity increased, enabling real-time communication without mediators and using more senses. Today, there are no obvious restrictions in remote communication. Looking at the development of remote communication over the time, it can be observed that the guiding principle was to make remote communication as similar as possible to face-to-face communication. This means that remote communication should enable natural and confidential exchange of information in real time; include more senses; do not require much effort and expenditure; be simple and allows mobility. The described remote communication is desirable, but hardly achievable in all elements (for example, today confidentiality of communication is hot topic). It represents the *idea of an ideal* remote communication. In order to provide arguments for this hypothesis, Table 1 summarizes the most important steps and how they contributed to the achievement of ideal remote communication.

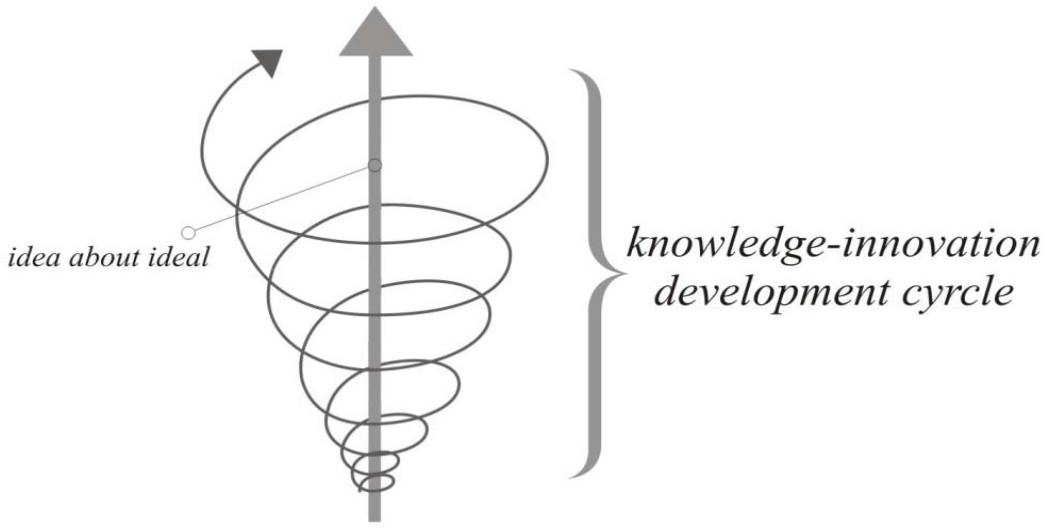

Figure 1. Idea of the ideal

As indicated by the presented analysis, it is common to the development of all the listed forms of remote communication that they represent stages in the development of an ideal remote communication. That means the idea of remote communication is the vertical line along which the cycles of communication improvement are implemented (Figure 1). This is not something specific to development of remote communication. When looking around, we notice that in every area of human activity an idea of the ideal can be identified that leads and directs the development of knowledge in the given area. For example, the idea of ideal transport can be traced as a tendency towards transporting people and goods from point A to point B in a faster, safer and cheaper manner. The development of this idea can be traced from the primitive use of animals, through the first carriages and ships, the occurrence of railways, the first car, overseas ship, to the development of air transport and space programmes. We have a similar situation with ideas of an ideal medical care, ideal of education, ideal material and so on. The idea of the ideal directly or indirectly drives all the other ideas that occur in a given area.

4. CONDITIONS FOR THE EMERGENCE OF INNOVATIONS

The conversion of knowledge into innovation must be discussed in the relation among systems of humans, artefacts, society and nature. The conditions and limitations that influence and shape this process arise from the interaction of the same systems. The *system of humans* sets a limit of what is the desired state, driven by the idea of living a more comfortable life and satisfying the own needs. This system is dynamic; changes in what people believe, what they want and expect, how much they earn, create opportunities, as well as limitations. To meet their needs, people make artefacts – from primitive tools and weapons to today's super computers, spacecrafts and artificial materials. All known technologies and existing products form the second important system in our consideration – the s*ystem of artefacts*. This system provides a framework of what is (technically) feasible, what can be accomplished at the specific moment of time.

On the other hand, the *system of society*, personified in the market, legal norms, culture and public policy, determines the limits of what is permissible and profitable. This system is also far from being static. For example, with changing the law a new option could be created or an existing one removed. Thus, for example, the deregulation of the telecommunications market has led to the emergence of a multitude of companies offering services of fixed and mobile telephony and internet providers. Although this system varies from country to country (due to differences in culture, legislation and political organization), these variations are now less under the influence of globalization.

The interaction between these three systems has long been a framework for understanding the development of innovations. However, satisfaction of human needs requires the consumption of limited resources that are either slowly or non-renewable. In addition, abuses in the systems of artefacts (e.g. modern wars, nuclear energy, genetically modified food, etc.) and society (global economic crises) have put the system of people in a disadvantageous position. All this contributed to the growing need of maintaining harmony between the individual and its environment, making this need one of the leading future forces. Thus, by the end of the twentieth century the issue of sustainability of the planet has become particularly relevant and inevitable in considerations regarding the development of innovations. The *system of nature* became the fourth element that affects the creation of knowledge and its conversion into innovations. This system leads to the type of development that meets the needs of the present, while not imperilling the ability of future generations to meet their own needs. This system makes the exploitation of resources, direction of investments, orientation of technological development and institutional changes are more balanced in order to enable the use of current and future resources for meeting human needs and aspirations. It seeks to ensure the long-term survival and prosperity of human civilization.

Interaction of these four systems results in limitations as the intersection of sets of what human need, what is technically feasible, what it is profitable and permissible, and what is in harmony with nature. These limitations are not static, but shadow the dynamic of the systems which condition them - they are constantly changing, as they do, opening new opportunities for the application of knowledge and the emergence of innovation.

6. THE IDEA OF THE IDEAL, KNOWLEDGE AND INNOVATION

Based on the above, it can be conclude that innovations occur as a result of materialization of knowledge under the existing conditions and limitations arising from the interaction of the system of people, society, artefacts and nature. This is graphically presented in Figure 2.

The relationship between what is currently possible and what humans need, drives the materialization of knowledge. On the other hand, the conversion of the materialized knowledge into an innovation, i.e. its acceptance on the market and among people, depends on the limitations arising from the social conditions (culture, profitability, law) and the compliance with nature (sustainability). While these two factors are still not equally weighted at the emergence of innovation, in the near future they will inevitably become. Namely, the growing awareness of the need for environmental protection leads to higher environmental standards in the use of resources, thus providing a niche for the development of new industries (green energy, healthy food).

New ideas are sometimes accepted and scientifically grounded, but not technically feasible at the given moment. On the other hand, sometimes it is necessary to understand how to apply all that is possible for meeting people's needs. Both situations – when human needs are higher than what is technically feasible and when the level of technical capabilities exceeds the human needs – are the drivers of innovation:

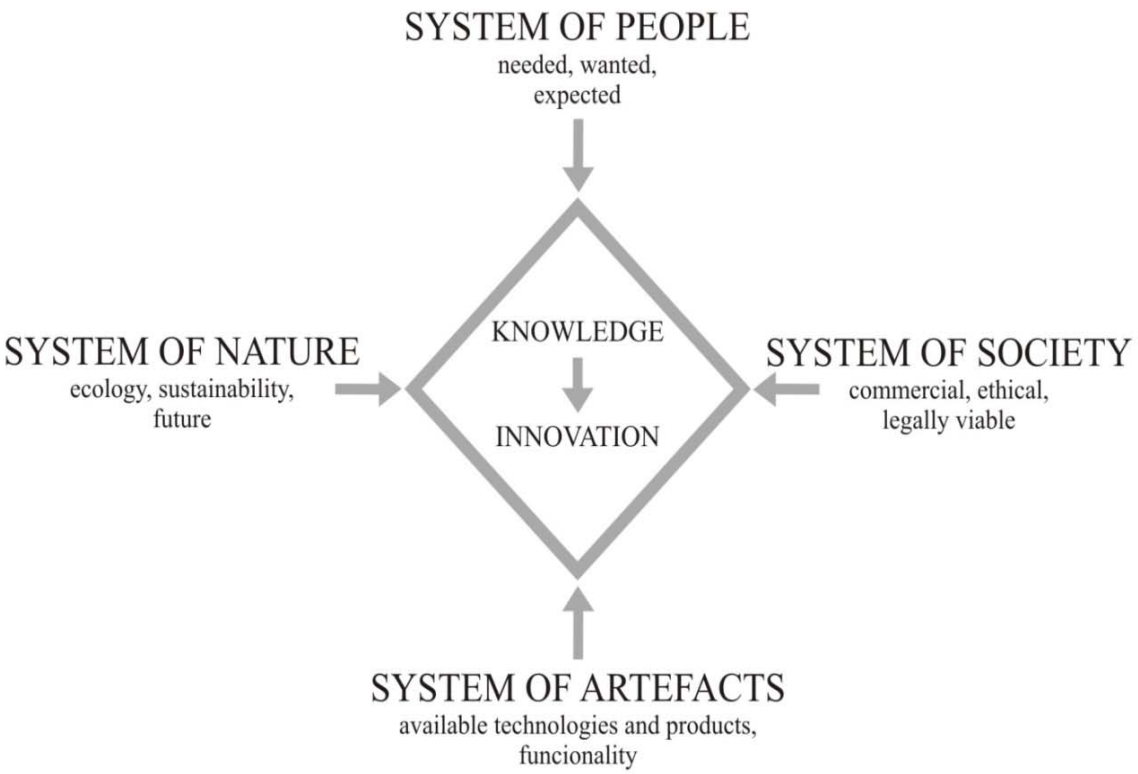

Figure 2. Emergence of innovations as the interaction of the systems of people, society, artefacts and nature

in the first case it is a technology push, in the second a market pull [14]. For example, as today's speed of technology development exceeded the immediate needs of people (more than needed is possible) in many areas, people need to learn how to adapt the existing technology to the existing needs in order to get the maximum benefit from them [21].

7. CONCLUSIONS

This paper addressed the gap in understanding the link between knowledge creation and innovation. It refers to the question: *What determines the direction and intensity of the innovation activities from the perspective of knowledge?* In view of a wider perspective and the accompanying overall historical development of remote communication, it has been shown that the guiding premise was the pursuit toward an ideal communication at a distance. Because in every sphere of life one *idea of the ideal* may be recognized, the final conclusion is that the *idea of the ideal* represents an abstract vertical axis around which cycles of knowledge improvement have been implemented. *The idea of the ideal* represents a hypothetical construct which summarizes, abstracts and stylizes many observations on a specific object or phenomenon, so as to obtain a coherent and logical reflective whole. The idea of the ideal is an abstract, utopian notion about a phenomenon that does not exist as such in reality, but only some of its attributes may be found.

Although a useful concept, the idea of an ideal was only the first step toward a more complete understanding of the link between knowledge creation and the occurrence of innovation. The next focus of research, was the issue of conditions and restrictions under which newly-formed (or existing) knowledge turns into innovation. Based on theoretical discussions, complete with examples, it has been shown that restrictions and conditions stem from the interaction of four systems: humans, society, artefacts, and nature, as a cross section of sets of man's needs, those that are technically possible, that are profitable and permissible, and those that are in harmony with nature. These restrictions are not static, but shadow the dynamic of the systems which condition them - they are constantly changing, as they do, opening new opportunities for the application of knowledge and the emergence of innovation.

Finally, based on this framework, it is possible to conclude that knowledge always tends to develop towards the idea of the ideal, and the direction of development of knowledge is determined by the difference between what is needed and what is currently possible (creating new knowledge or adapting what is currently known). The higher is the difference between what is needed and what is possible, the higher is the potential for converting knowledge into innovation, but the actual intensity of converting knowledge into innovation is defined by the limitations arising from the condition of society (profitability, legality, ethical) and compliance with nature (sustainability). This means that the process of innovation consists of the generation of new knowledge (when needs are higher than possibilities) and/or the recombination of the existing knowledge (when possibilities are higher than needs) in a new way and its application in order to create a sustainable (profitable and compliant with nature) and value-adding solution (to a given problem).

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Kreiranje znanja i nastanak inovacija

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Primljen (25. oktobar 2012.); Recenziran (25. decembar 2012.); Prihvaćen (16. januar 2013.)

Rezime:

Ovaj rad se bavi pitanjem: Šta determiniše pravac i intenzitet inovativnih aktivnosti iz perspektive znanja? Istraživanje se bazira na praćenju hronologije razvoja znanja i inovacija u razvoju komunikaciji na daljinu sa ciljem da se dobije potpunije razumevanje ciklusa i veze znanja i inovacija. Rezultati pokazuju da znanje uvek teži da se razvija u smeru ideje o idealnom, dok je pravac razvoja znanja determinisan razlikom između onoga što je potrebno i što je trenutno moguće. Intenzitet prevođenja znanja u inovacije definisan je ograničenjima koji potiču iz društvenih uslova (profitabilnost, zakonistost, etika) i iz saglasnosti sa prirodom (održivost).

Ključne reči: *Znanje, Inovacija, Ideja o idealnom, Uslovi nastanka*