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Knowledge management in open innovation paradigm context: high tech sector perspective

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Abstract

Open innovation paradigm is new contemporary innovation phenomena. Innovation activities in high tech sector require broad level of collaborative, creative efforts and effective knowledge management models for the companies. Theories of knowledge creation inside organisation are based on systematic ways to create procedures and tools for collecting knowledge. Although new communication paradigms and collaborative working environments are not enough reflected as possible tools for creation of knowledge for innovation processes. Fast and successful development of high technology companies requires non-linear thinking and disruptive creative solutions for the market. Main aim of this article is to propose practical framework for knowledge exchange inside companies, using new interdisciplinary communicative learning tools.

Keywords: open innovation; high tech; knowledge management; knowledge transfer; serious play; tacit knowledge;

1. Introduction

The rapid grow of open innovation research, since 2003 demonstrates importance of this research direction in modern business management theory. The initial open innovation concept was vague and lacked concrete adoption frameworks for business context. The new findings and theoretical analysis fill this gap (Eelko, 2011; Dahlander and Gann, 2010).

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The open innovation research focuses on the knowledge transfer directions (inward, outward) and importance of openness level for the innovative companies. There is lack of the research on the practical approaches for the knowledge absorption from the open environments. Knowledge discipline research focuses on the knowledge typology and transfer (Nonnaka and Konno, 1998), but it lacks the new tools to enhance knowledge acquisition and learning for the innovation development activities. The rapid grow of the new radical technological collaboration tools, social networks and applications raises question about their usage for the knowledge acquisition and transfer, especially for the high tech companies, which have short product life cycles and requires quick innovative response to the market.

The main aim of this article is to propose practical framework for knowledge exchange inside companies, using new interdisciplinary communicative learning tools. The purpose of this framework is to combine traditional knowledge exchange frameworks with new communication technologies for better absorption of innovative knowledge. Main attention will be focused on the new interdisciplinary communication tools and their usage for exchange of knowledge inside R&D department. In this article open innovation and knowledge management disciplines will be analyzed. Also conceptual knowledge transfer model, based on interdisciplinary communication issues, will be presented.

2. Theoretical developments of open innovation paradigm and knowledge management

Contemporary innovation management research is highly involved in the open innovation concept. The open innovation paradigm is widely discussed at the academic level. From 2006 there was found 533 articles on Science direct database with the open innovation title. The open innovation idea is based on the new evolutionary business model, which encompasses opening of company innovation process to the external environment actors. In other words it discusses purposive inflows and outflows of the knowledge to accelerate the internal innovations, and to expand the markets for the external use of the innovation Chesbrough (2011). This broad description of open innovation points towards effective transfer of knowledge to both directions (inward and outward). Open innovation processes combine internal and external ideas into architectures and systems Chesbrough et al. (2006). Main studies on open innovation are focused on externalization of R&D activities (Enkel et al., 2009).

Outbound open innovation refers to the outward technology transfer, and it suggests that firms can look for the external organizations with business models that are suited to commercialize the technology for outside organisations Chesbrough and Crowther (2006). Outbound open innovation points to actively pursuing external technology exploitation, which refers to the commercialization of technological knowledge using licensing and other transfer means Lichtenthaler and Ernst (2006). Open innovation concept is mostly used for enhancing of the R&D input and output inside the company.

Open innovation can be categorized by using firm's process perspective Enkel et al. (2009):

(1) The outside-in process: enriching the companies own knowledge base through the integration of suppliers, customers and external knowledge sourcing. This process can be described as knowledge internalization. The ability to access knowledge, technology, and information through relationships with other firms facilitates open innovation, which helps the firm effectively implement it Sisodiya et al. (2013). There is positive relationship between firm performance and open innovation through effective engagement in boundary spanning with other firms. It means that effective knowledge internalization of knowledge stimulates innovative non-linear ideas.

(2) the inside-out process, which refers to earning profits by bringing ideas to market, selling IP, and multiplying technology by transferring ideas to the outside environment. This process could be referred as knowledge externalization. In this case environmental pressures could be strong influencers into company performance Lichtenthaler (2009). Inside out process and results generally are characterised as high tech sector descriptive criteria or output measurements (Glasson et al., 2006). In the context of this article detailed analysis of innovation activity external output is not considered for detailed analysis

(3) The coupled process refers to co-creation with complementary partners through alliances, cooperation, and joint ventures during which give and take are crucial for success. This process can be described as knowledge co-creation. Selection of strategic alliance partners requires multiple criteria evaluation. Wan et al. (2009) identify 5 main categories of important criteria: *characteristics of partner* (unique competencies, compatible management styles, compatible strategic objectives, higher or equal level of technical capabilities), *degree of fitness* (compatible

organization cultures, willingness to share expertise, equivalent of control, willingness to be flexible*), intangible assets* (trademarks, patents, licenses or other proprietary knowledge, reputation, previous alliance experiences, technically skilled employees), *marketing knowledge capabilities* (increased market share, better export opportunities, knowledge of local business practice), *complementary capabilities* (managerial capabilities, wider market coverage, diverse customer, the quality of distribution system). Open innovation stresses the abundant landscape of external knowledge outside firms waiting to be captured by them and converted into profitable innovating products and services Chesbrough et al. (2006). Open innovation paradigm describes direction of possible knowledge flow and organization research and development partnership degree. Although knowledge is available and partnership networks create value, effective knowledge management frameworks are needed to enhance knowledge absorption capacities.

Knowledge management is an emerging field that has commanded attention and support from the industrial community. Many organizations currently engage in knowledge management in order to leverage knowledge both within their organization and externally to their shareholders and customers. First, knowledge management encompasses much more than technologies for facilitating knowledge sharing. In fact, practitioners are beginning to realize that people and the culture of the workplace are the driving factors that ultimately determine the success or failure of knowledge management initiatives. Second, emphasis on technology forces a narrow view that may inhibit the growth and staying power of knowledge management Rubenstein-Montano et al. (2001). Knowledge management is very important for any organization active in environment full of large amount of information. Main task for any company is transform information into valuable knowledge. Main research directions in knowledge management field focused in 3 main areas.

First research direction is based on knowledge types: tacit and explicit knowledge (Nonaka and von Krogh, 2009; Nonaka, 1994). Also knowledge classification into tacit and explicit raises possible research direction in open innovation context. There are 2 kinds of knowledge: *explicit and tacit knowledge*. Explicit knowledge can be expressed in words and numbers and shared in the form of data, scientific formulas, specifications and manuals Nonaka (1998). There are two dimensions of tacit knowledge. The first is the technical dimension, which encompasses the kind of informal personal skills often referred to as “know how”. The second is cognitive dimension. It consists of beliefs, ideals, values and mental models, which are deeply integrated. Nonaka and Konno propose spiral evolution of knowledge and conversion self- transcending process Nonnaka and Konno (1998). This process describes knowledge transformation into different knowledge types between companies and individuals. The enterprise tacit knowledge includes technical element, cognitive element, experience element, emotional element and faith element Liu (2012). Tacit knowledge is the main body of enterprise knowledge with a clear priority Liu, Ciu (2012). Spiral knowledge model (SECI) (Nonaka, 1998) represents ways of interaction between knowledge types and localization. Socialization, externalization, combination and internationalization knowledge sharing models will be included in final theoretical framework.

In the theory, tacit and explicit knowledge are not separate but “mutually complementary in that they dynamically interact with each other in creative activities by individuals and groups (Nonaka, 1994; Alavi and Leidner, 2001).

The individuals shift awareness between the task and the tools, reflect on their own experiences, use language to remind themselves of what they already know, thematize certain circumstances, and discusses them with others Tsoukas (2003).

In this view of knowledge as social practice, Cook and Brown (1999) point out that new knowledge and novel ways of knowing are generated through the interplay between reflection, thematization, and experience within situated interaction. This points to innovative communication technologies for enhanced socialization effects, like serious play (Connolly et al., 2012; Myer, 2012) or gamification tools (Dominguez et al., 2013). It also complements the notions that tacit knowledge represents emotional, cognitive elements, which could be externalized via new communication tools. Use of imagination tools for exchange of knowledge is not yet discussed. A new model of strategy making as play is presented in response to increasing calls for a deeper theory of strategy making Roos and Victor (1999). Serious game classification and conceptual research reveals complexity of this new phenomena (March, 2011). Also fast and rapid development of the new media technologies, expands serious games application field, which could be adopted for the knowledge development and sharing purpose. Especially this issue is important

in the high R&D intensity sectors, which require radically new innovation combination approaches. This question should be discussed more deeply.

Second direction is focused on knowledge localization: individual and organizational knowledge (Ipe, 2003).

Third direction focused on knowledge sharing inside and between organizations. Factors, which influence knowledge sharing: nature of knowledge, motivation to share and opportunities to share (Ipe, 2003). Main task of the companies is to create effective environment to encourage communication flow by strengthening factors listed above. The constant knowledge flow inside organization is important to keep the knowledge absorption process effective and avoid knowledge decrease (see fig 1.)

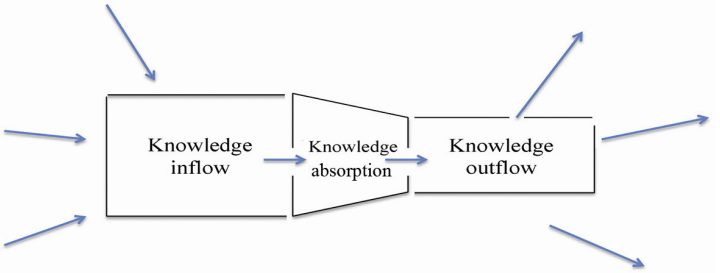

Fig. 1. Knowledge flow directions in company based on open innovation approach

Appropriate organizational culture and structure are more capable of developing high knowledge absorption effectiveness, which can facilitate the positive effects on innovation process Yao et al. (2013). Development of collaborative culture, using social media tools and serious play tools could create innovation friendly knowledge exchange system.

Contemporary research in open innovation knowledge exchange points on sectorial differences. Comparison between business service sector and manufacturing sector shows some different practices (Mina et al., 2013). Engagement in open innovation increases with firm size and R&D expenditure. Manufacturing companies are more likely to engage in formal knowledge exchange practice, service providers in informal Mina et al. (2013). In this context analysis of informal knowledge exchange practices and their application on the manufacturing sector is important. External knowledge acquisition can influence the R&D performance. Although knowledge resources influence innovation performance, it is the capability for converting such resources into innovative products and processes that best explains differences in firms' innovation performance (Urgal, 2013)

Research results also show that depending on its source, external knowledge differently influences the R&D activity. The knowledge that firms acquire from domestic organizations has an adverse effect on their internal R&D, use of foreign ideas and technologies assists firms considerably in enhancing the effects of their own R&D Kafouros and Forsans (2012). It's important to participate in international networks to enhance company internal R&D capabilities. It is important point to specific knowledge exchange systems and global knowledge transfer networks (Ye and Kankanhalli, 2013). The use of the broad range of open innovation networks and interaction between knowledge exchange subjects (seekers, solvers) is important knowledge management practice for companies. Analysis of transformation from closed innovation to open innovation in traditional sectors shows that information technologies and social networks are very important for this process (Westergren and Holmstrom, 2012). It is also important to pay attention for knowledge context. Open innovation performance is even greater in information rich contexts Sisodiya et al. (2013). It is very important for companies to create information and knowledge surrounding by including various actors (scientific, industrial, multidisciplinary) in networks. The social networks development and their influence on the knowledge exchange is new scientific research direction. Social media comprise the set of tools identified as blogs, wikis, and other social networking platforms that "enable people to connect, communicate, and collaborate." These tools create a dynamic, complex information infrastructure that enables easier, faster, and more widespread sharing of information Hemsley (2013). Usage of social media platforms can create tension between knowledge management and social media. Tensions result when individuals or organizations seek to maintain rigidity in their roles in knowledge management, even as technology affordances point toward the need for more flexibility and possible changes Ford (2013). New social media tools could be used for horizon broadening

activities, new business and technology trends development. These social technologies both mediate social interactions with other people and facilitate knowledge-sharing practices within and across organizational boundaries Jarrachi (2013).

The main open innovation paradigm research focuses on the knowledge flow directions (inward, outward). The knowledge management research directions are focused on the knowledge typology and openness. It is important to provide integrated knowledge acquisition framework to reduce knowledge decrease from initial input to its application for particular context. In this article learning concept, based on knowledge map methodology and gamified tools will be integrated in possible framework. Knowledge sources are important for analysis of open innovation context. Next part of the article will focus on the practical knowledge sourcing activities of the Lithuanian innovative companies.

3. Practical knowledge sharing perspective of the innovative companies and high tech sector.

The definition of the main characteristics of high-tech firms could include activity, human and technological parameters Glasson et al. (2006): involvement in innovative activity, R&D intensity, R&D employment, qualified personnel, intensive use of technologies, intellectual property.

Many high-tech firms are relatively new high growth businesses, but they can also include more established businesses in mature sectors, and indeed such firms appear to account for a disproportionate share of high-tech employment. Those characteristics are very important for knowledge management inside those companies.

The innovation activities and expenditures of Lithuanian companies in the innovation field indicate low involvement in external knowledge acquisitions. Also systematic R&D activities are low, which points out to weak internal knowledge creation systems. This shows lack of effective knowledge acquisition practices and systematic procedures.

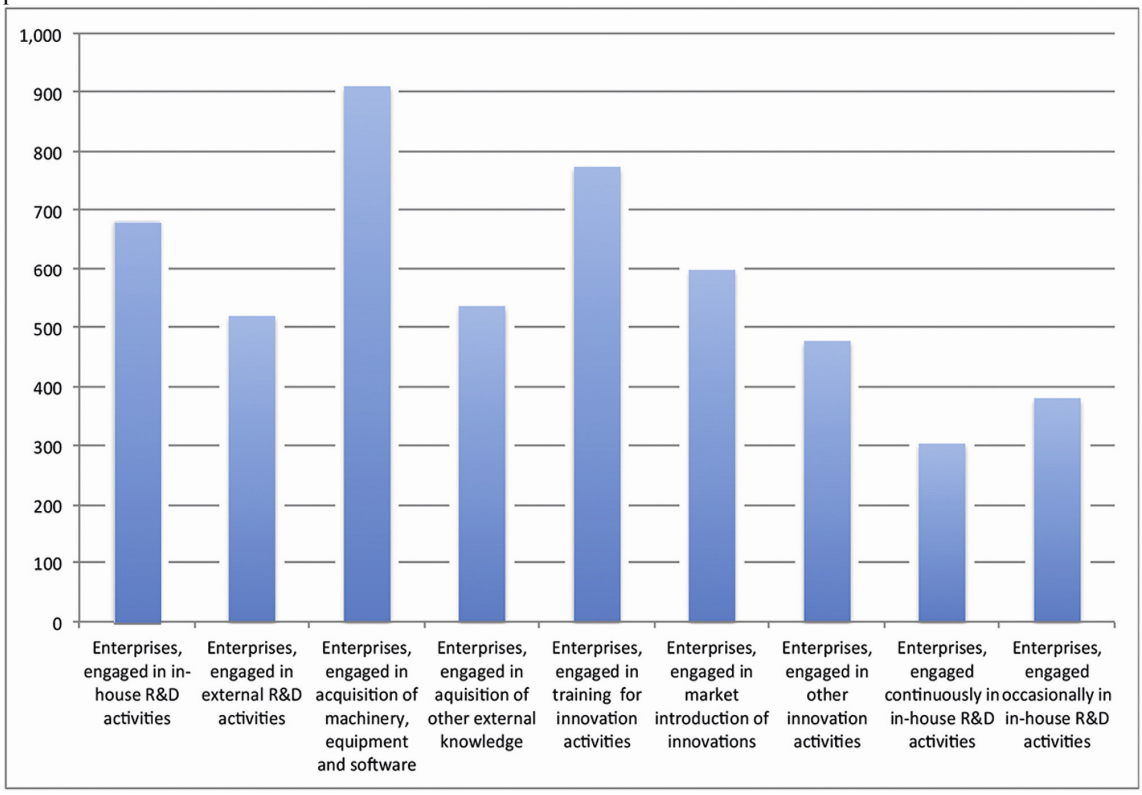

Fig. 2. Innovation activities and expenditures of Lithuanian companies in 2010 (Community innovation survey 2010)

Figure 2 indicates high level of engagement on the acquisition of machinery and software. This shows a clear direction towards the process efficiency. Results showed in figure give new possibilities for the development of the external collaboration tools. High level of the innovation training activities can foster innovation culture and create friendly knowledge absorption systems. The new statistical information (Innovation union scoreboard 2013) shows decreasing collaboration activity of innovative companies by 3.9%. This indicates the slowing rate of open innovation practice. It is important to stress that innovation activities decreased by 3%. Those figures represent the slowing innovation activity rate among innovative companies. From the statistics it is not clear how companies adopt knowledge for the development of innovation.

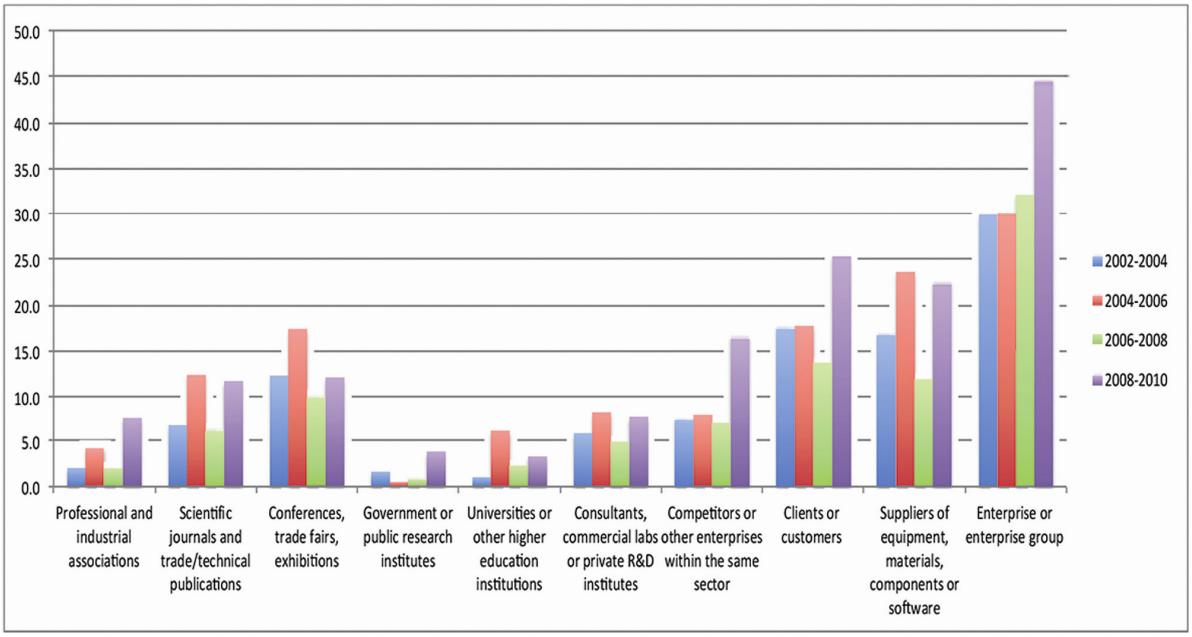

Fig. 3. Information sources for innovative activities (Statistical yearbook of Lithuania 2012)

The main sources for the innovation activity are the companies from the same enterprise group, suppliers of equipment, materials, components and also clients and customers (see Figure 3). This indicates only moderate knowledge networking space by the limited microenvironment actors. The universities and research institutions are moderately involved in the knowledge acquisition process. The use of competitors or other enterprises in the same sector is interesting new trend for the information search. But this can be related with the "understandable" knowledge acquisition, since scientific or interdisciplinary knowledge is more diverse. These findings show very weak connections between the science and business, which is common problem for the countries with the weak innovation support infrastructure and culture. The lack of the multidisciplinary absorption systems inside the organizations could be perspective research direction. In the part 4 of the article, multidisciplinary knowledge acquisition tool will be included in the theoretical framework. On the other hand close relations with customers and suppliers supports user involvement in innovation process theory (Jong et al., 2009).

4. Theoretical framework for knowledge transfer activities inside company

Theoretical analysis identified the main contemporary open innovation and knowledge management directions. Overview of innovative knowledge sharing activities among Lithuanian companies showed the knowledge sourcing activities. It is important to point that another important open innovation factor is effective knowledge usage.

The proposed knowledge transfer framework (see Figure 4) emphasizes new internal knowledge generation process based on communication tools and practices. The scouting activities, which split into three main search categories, represents inward knowledge search: scientific knowledge, technology (equipment) knowledge and customer trends knowledge. For the development of the new products those knowledge sources are crucial. The proposed categories are presented as maps, which are combined with the interconnected networks and virtual knowledge maps. An increasing amount of knowledge limits access to knowledge of users who may be lost due to their lack of understanding of relations and connections of stored knowledge. Knowledge maps is methodology, which is good for the management of the ever-increasing knowledge and for the creation of knowledge relations, by connecting and explaining related materials using association values to consider knowledge content (Watthananon and Mingkhwan, 2012). Knowledge mapping methodology is very important for learning process.

Systemic scouting activities allow companies, systematically get newest information and transform this information into valuable solutions. It is important to stress that external knowledge search effectively could be implemented by using integrated knowledge networks (special, technical, community, etc.). Networks are very important for inward and outward knowledge transfer activities.

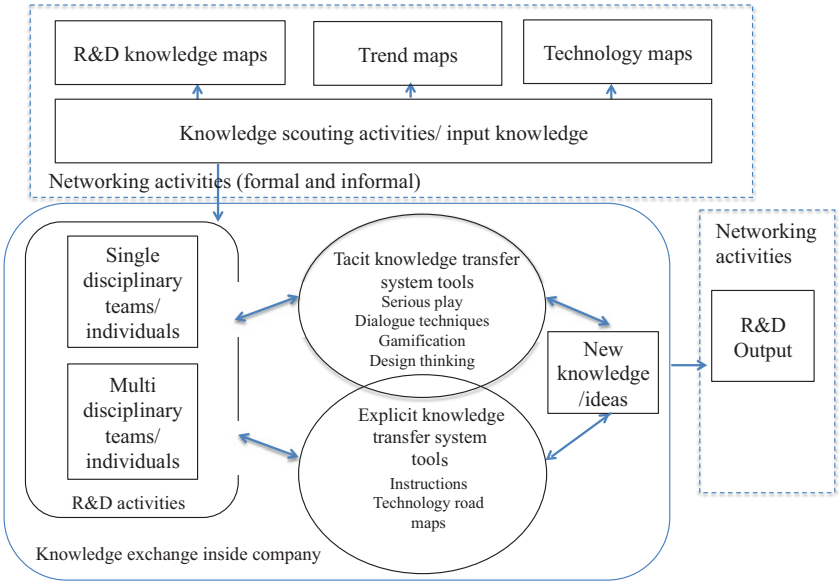

Fig. 4. Basic theoretical framework for knowledge management

Important element in knowledge transfer inside company is collaboration between different teams (see fig. 4): specialised and multidisciplinary. Specialised or single disciplinary teams represent functional departments or specialised individuals, which focus on clear special activities. Interaction and knowledge exchange between multiple teams could be implemented via new communication methods and tools. High tech companies usually have formalised knowledge exchanges system, based on reports, reviews and instructions and employees like to share knowledge between their team colleagues Min (2008). These formalized channels represent explicit knowledge nature and could be transferred and shared via electronic or traditional reporting systems. The tacit knowledge context requires non-traditional communication tools, which could be used for the exchange of personalized tacit knowledge among the team members. The serious play concept allows identification of the embedded metaphors for the construction of new knowledge. This concept is new and needs a deeper research. The research has also associated serious play activities with various processes and outcomes, such as strategic thinking, strategic innovation, and the development of ethical leadership habits (Statler et al., 2011). Comprehensive research shows that frequently occurring outcomes of the serious games are: knowledge acquisition/ content understanding,

cognitive skills and behavior change (Connolly et al., 2012). Researchers also identify serious play design models and frameworks, which could be applied in the learning contexts (Mayer, 2012)

The dialogue techniques are widely described as potentially effective means for the communications and knowledge sharing (Goranzon, 2006). Gamification concept describes application of game design tools for non-game contexts (Dominguez et al., 2013). Also this methodology could be applied for the generation of the effective innovative solutions. Design thinking (Kees, 2011) methodology identifies the new ways of knowledge creation, based on consumer-oriented approach. This lets companies, especially working in high tech environment effectively extract knowledge, which is accumulated in multidisciplinary teams.

Socialization Emotion sharing Feelings Mental models Tools: *Personal communication* *Serious play (Statler 2011, March 2011, Connolly et al 2012)* Results: New knowledge, views	**Externalisation** Sharing of individual models and skills Reflection and analysis Tools: *Dialogue techniques (Goranzon et al 2006)* Results: Understanding of different mental models
Internalization Training with senior mentors, exercise Tools: *Dialogue techniques (Goranzon et al 2006)* *Serious play(Statler 2011, March 2011)* *Design thinking (Kees 2011)* Results: Expert knowledge	**Combination** Combination of explicit knowledge with information Thematization of the knowledge Tools: *Virtual instruments* *Gamification (Dominguez 2013)* *Design thinking (Kees 2011)* *Technology road map (Geum et al 2013)* Results Categorization of knowledge inside organization

Fig. 5. Integration of new communication tools in to SECI model (adopted from Nonaka, 1998)

By using SECI model (Nonaka and Konno, 1998), it's possible to categorize the new proposed tools for knowledge transfer activities (see Figure 5). It is also important to understand, that these working tools are additional instruments, which could be used by innovative companies. It is not the replacement of the existing methodologies and tools. The dialogue communication techniques and serious play exchange sessions could be used in different company contexts, with different outcome results. This integrative approach could be used for better knowledge absorption results and more efficient knowledge circulation inside organization.

6. Conclusions

Theoretical analysis of open innovation paradigm strongly focuses on knowledge flow directions (inward, outward) (Enkel et al., 2009). Still there is lack of effective knowledge management tools to implement openness in practical business environments. Knowledge management research strongly dominates by tacit and explicit knowledge typology and exchange procedures. Tacit knowledge is described as very important source of ideas for innovative company (Liu, Ciu., 2012). Spiral knowledge model (SECI) (Nonnaka and Konno, 1998) represents

ways of interaction between knowledge types and localization. This rather traditional model was revised and new media communication tools were added. The knowledge management encompasses much more than technologies for facilitating knowledge sharing. In fact, practitioners are beginning to realize that people and the culture of the workplace are the driving factors that ultimately determine the success or failure of knowledge management initiatives (Rubenstein-Montano et al., 2001). Research on social media tools concludes that these tools create a dynamic, complex information infrastructure that enables easier, faster, and more widespread sharing of information inside company (Hemsley, 2013).

Growing trend of new research topics related to gamification (Dominguez, 2013) and serious play (Connolly et al., 2012; Mayer, 2012) raises question about possibilities to use them in knowledge transfer and learning environments.

The proposed framework adopts traditional view on knowledge exchange and the new interdisciplinary communication tools.

The knowledge sources of the Lithuanian companies represent similar knowledge level. Interdisciplinary knowledge sources, e.g. scientific research, consultants, are not important for the companies. The diversity of the knowledge sources influences companies' innovation output (Kafouros and Forsans, 2012). Main sources for innovative solutions of the Lithuanian companies are business subjects from the same enterprise group, suppliers of equipment, materials, components and also clients and customers. Collaboration with the research institutions provides a high quality and information rich knowledge context, which enhance open innovation performance (Sisodiya et al., 2013).

Application of interactive communication tools for knowledge exchange and sharing activities inside R&D departments creates new possible research directions and issues. It is important to stress that there is no empirical evidence from using those tools. The possible research directions could be focused on knowledge transfer efficiency measurement, based on application of the new tools and evaluation of the knowledge absorption level.

Although tacit knowledge measurement is difficult, but criteria based on new product variety and innovativeness, rapid exchange of radical ideas, fast initial idea generation time could be introduced. High tech sector usually described and understood as very formative and focused on technological development. The proposed communication tools with creative background could enhance possibilities to get new radical, multidisciplinary innovations and involve company employees in the knowledge sharing activities for innovation performance.

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