LAPPEENRANTA UNIVERSITY OF TECHNOLOGY

School of Business and Management

Master's Degree (Eng.) in Global Management of Innovation and Technology

LEAN INNOVATION IN LARGE COMPANIES: A CASE OF IMPLEMENTATION IN R&D

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Lappeenranta, April 13, 2015

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ABSTRACT

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Title: Lean Innovation in Large Companies: A Case of Implementation in R&D

Department: Industrial Management

Year: 2015 **Place:** Lappeenranta

Master's Thesis, Lappeenranta University of Technology

104 pages, 27 figures, 9 tables

Examiners: professor Tuomo Kässi, assoc. professor Ville Ojanen

Keywords: lean innovation, R&D management, creativity management, new product development in international company, innovation in product development

The main objective of this study is to evaluate the impact of Lean thinking management philosophy on the creativity potential of the large multinational enterprise. A theory of Lean Innovation indicates that the modern company in any industry can successfully combine both waste-decreasing approach and innovative potential promotion through creativity cultivation or, at least, its preservation.

The theoretical part of the work covers the main factors, pros and cons of the Lean thinking and Innovation management separately, along with generalized new product development overview.

While the modern international market becomes more accessible for entrepreneurial initiatives, small enterprises and start-ups, large multinational corporations are more subject to adopt the Lean Innovation approach in both operational and product development sectors due to extended resources and capabilities. Moreover, a multinational enterprise is a highly probable pioneer in Lean Innovation implementation.

The empirical part of the thesis refers to a case of a large European enterprise, operating in many markets around the globe, that currently undergoes innovation management adjustments and implementations in product development while already have related themselves with operational processes optimization process through Lean thinking. A goal of the work is to understand what kind of difficulties and consequences a large international firm faces when dealing with Lean Innovation to improve own performance, if they can be scaled for generalized approach.

ACKNOWLEDGEMENTS

It is my strong belief that any academic work of any level requires dedication, passion and stubbornness.

I would like to express my deepest appreciation to my supervising professor Tuomo Kässi, a mastermind, inspirator and a person with fantastic philosophical attitude.

The professionals of the company that nourished my quest for practical data and knowledge with moments of intuitions' discoveries and valuable revelations,

My chosen heart, a woman of colossal inner strength, who kept me afloat in times of doubt.

My grand regards also goes to the LUT, with all of its friendly and helpful teachers and personnel, and the administration of my faculty, especially in person of Riitta Salminen and Suvi Tiainen. Their warm attitude was inspiring and their concern is hard to underestimate.

Finally, my mother, my closest friend and dearest ally, whose concern and care gave me strength to go on.

Moscow, April 2015

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LIST OF ABBREVIATIONS

R&D – Research and Development

MDE – Multidivisional Enterprise

MNE – Multinational Enterprise

LI – Lean Innovation

NPD – New Product Development

SBU – Strategic Business Unit

TTM – Time-to-market

LPD – Lean Product Development

B2C – Business-to-Customer

B2B – Business-to-Business

HQ – Headquarters

VSM – Value stream mapping

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1. INTRODUCTION

From all sides of the issue, it is hard to disagree that a modern market, partially driven by the technological advancement of both companies, scientific collaboration networks and other participants, dictates strict rules of operation, allowing little space for careless business initiative and faulty strategic decisions. Tushman & Nadler (in Urbancová 2013) state that "organizations can gain competitive advantage only by managing effectively for today while simultaneously creating innovation for tomorrow". The tight market conditions emerge as the need for the competitive advantage for market players as core, most essential aspects of business. In turn, the effective management is based on a number of initial business capabilities that shape the market position of the modern firm, several of which are process management and innovation generating. According to Rumelt, Schendel and Teece (in Powell 2001), the sustained superior performance arises from sustained competitive advantage.

While the competitive advantage of the company, based on effective management, is considerably formed with innovations and process management, it should be noted that both exist as vast and complex disciplines. While process management is responsible for the overall business operations and even, to some extent, organizational integrity, the innovation management in considered of a more R&D- and product development-related term. Still, a potential user of innovation can exist both inside the company and outside. Klein and Knight (2005) state that an innovation is a new product and practice that the developers of it and/or potential users may be unfamiliar with. In both cases, innovations carry considerable potential when it comes to value generation.

As the companies intensify the search for ways to discover paths to dominant market positions, so the new forms of management solutions arise as an answer to the demand. One of the more trendy solutions known nowadays is called the Lean Innovation, a vision of innovation management as a process that can be managed with the use of widely known Lean thinking philosophy in order to control efficiency of it and reduce the waste. According to Krumm and Schittny (2013), the companies, that managed to achieve success in an attempt to optimize the performance of innovation generation and implementation process, can be seen as Lean champions, because of the ability to create sustainable innovations while the R&D resources are limited, even scarce. This thesis aims to provide the ground for new research "spin-offs" in order to stimulate the scientific progress of Lean Innovation topic discovery and description.

1.1. Background of the study

The idea of the thesis emerged as the result of the literature study on the topic. It may be speculated that the idea to combine Lean thinking and Innovation management was in place the moment the book "Lean Thinking" by Womack and Jones was released in 1996. Following the success of Lean thinking business management philosophy adoption by first the global corporate leaders followed by domestic business of smaller scale, it can be concluded that Lean thinking is seen as a way to optimize each and every aspect of business, including product development. "More recently, development organizations have started applying Lean. Lean migrated from operations into development environments." (Sonnenberg & Sehested).

A tendency to adopt the Lean thinking philosophy to development process, especially R&D and product development is especially important, because innovations, as mentioned, are the key to competitive advantage, thus, rely on market and customer behavior. This may be seen as one of major reasoning behind the attempts to simplify, optimize and reduce the cost of product development process.

Despite the fact that literature studies showed separate cases of Lean Innovation have already been addressed, there are still a number of research gaps in place: one accounts for the industry diversity which renders the Lean Innovation implementation process partially unpredictable, the other tends to address the lack of diverse company size-related approach as an attempt to identify possible bottlenecks. Kovac (2013) states that "…some aspects of Lean management may negatively affect the company's capability to be successful with certain types of innovations".

With the help of corporate experts, it became possible to point out the potential weak spots that limit the potential of Lean Innovation implementation in MNE's, although partially bound to a particular industry.

1.2. Research objectives, problem and questions

The main objective of the study is to evaluate the organizational, financial, cognitive and other issues that accompany the Lean Innovation implementation or take place as a result of it.

For several reasons, the subjected phenomenon is observed in MNE environment:

1. The visibility and observability of implementation. It is important to be able to receive the necessary empirical data in order to conclude credible outcomes on the topic. Larger enterprise is easier to reach and communicate with, due to a well-built communication channels and better internal diversity that allows communicating with several narrow-direction specialists to form a full picture.

2. Intensive R&D operations. A large enterprise on the verge of global competition cultivates intensive NPD operations in a more change-promoting manner, meaning that the potential readiness of the company management to change/improve/optimize the development process any time leaves the Lean Innovation implementation both highly probable and less subjected to initial obstacles:

    - The lack of motivational and organizational drivers to ensure the process;
    - The incorrect/insufficient resource allocation to support the change;
    - The lack of optimal workload distribution to ensure the changing process;

    In their book "Lean Innovation – a Fast Path from Knowledge to Value" Sehested & Sonnenberg (2011) agree that "each member of the management team needs to have personal interest in self-improvement, otherwise you will quickly discover there is a limit to how far you can come with Lean". According to Weeks et al. (2004), in conditions of competitive intensity that takes form of "frequent introduction of new products, and shorter product lifecycles", the organizations are required to implement the change initiatives. According to this statement, it can be concluded that the interest in the upcoming changes of the company management is a critical condition not only for Lean implementation, but for any change at all, including R&D and, eventually, NPD.

3. Challenging conditions: a multinational enterprise, especially operating in manufacturing, has to manage its innovative potential more intensively in order to sustain and improve the competitive potential. In such situations the R&D unit structure and the NPD process complexity can carry individual properties other enterprises may not be familiar with. E.g. the company may have centralized or diverse R&D operations, spread among a number of countries. In this case, the

Lean Innovation implementation will have to be properly "adjusted" based on this condition.

Because the MNE, as a considerable part of the research scope, can demonstrate certain variations distancing it from other global companies, the research problem can be seen as a 2-part construct:

The "A" part stands for the necessity to point out the universal aspects of company operation, organization and structure, that will affect the process of Lean Innovation implementation in all or, at least, the dominating number of companies, when applied to R&D.
The "B" part discusses the lack of empirical knowledge about the difficulties the companies face when implementing. It is necessary to identify the universal challenges that the firms will face.

The main research questions of the thesis are:

1. Does the implementation of Lean Innovation negatively affects the creative potential of the firm (innovativeness)?
2. What are the main difficulties the company faces when implementing Lean Innovation?
3. What solutions can be proposed to overcome the difficulties during or after the implementation, if possible?

To allow the reader better understand the issue behind the research, the company, Chen and Taylor (2009) formulated a characteristic phrase: "Characterized by early routinization and uncertainty reduction, Lean management represents a typical technical process. Being rigid, standardized, and constrained to productivity, it places goals and guidelines, leaving less room for creative thinking and innovation."

1.3. Limitations

There is a number of limitations applied to this work. The first one is that the timeline of the study takes a form of a "snapshot" with partial retrospective insight. It means that the study doesn't involve a period of observations during the process, but rather relies on what had been done, what are the outcomes and the retrospective milestones in process.

Another limitation consists of collaboration, financial aspect and sampling. Due to the reason that the issues related to R&D and process management are strongly related to competitive balances, a number of firms are very strict about the availability of such information "outside the company gates". Thus, in order to receive the needed empirical data, it was necessary to directly access the company, in terms of dialog with different persons inside to cover different aspects of work. Still, certain types of data disclosures were restricted.

The financial aspect refers to the lack of general research budget, which critically limited the opportunity to involve several companies for broader scale of research. It may be argued that the modern communications and transportation turn the kilometers and volumes of information in favor of user for a price quite reasonable. Still, it is important to take the limitation above into account, meaning that it is a normal situation when a company agrees to discuss or even more importantly share information on instances as delicate as product development, the dialog is only possible through actual presence in the corporate office. The diversity of company R&D and product development divisions among the globe, combined with certain filtering applied to them in terms of the work, would require a certain financial basis to broaden the research, again, dramatically resource-demanding.

Finally, the sampling aspect means that, while there is still not much information available about the Lean Innovation case studies, and the relevant subject directories are yet to appear, the conditions apply to the sampling diversity, in terms of which, it is often impossible to come up with a reliable list of possible companies, that may be willing to take part in the research, hence, develop the means to sort the results by any variables.

A research scale limitation refers to the situation, when an attempt to cover the Lean Innovation process implementation in the scale of a full enterprise, even if the implementation projects were done in different time periods and are reviewed briefly, would have led to the consumption of financial and time resources unavailable in terms of the thesis work scale, not to mention the fact that every activity of the MNE in terms of Lean Innovation is bound by own rules, dependencies and limitations. In order to "equalize" the initial bounds of research of different companies in that field, it would require a whole additional project of framework development and massive data processing.

One of the critical limitations, is the ethical and confidentiality aspect of the work. The Lean Innovation is a very sensitive topic, especially for the pioneering companies in their industry. For this reason, the insight, presented in this paper, was considered carrying reputational and, eventually, financial risks. For this reason, neither the name of the company, nor the names of the experts can be disclosed, so that the results of the work are not mistreated. Also, cases when the company can be recognized by the non-direct information shown in the research paper, tend to occur in the academic world (Saunders et al. 2009). Such high level or precaution generally affects the structure of the thesis, shifting the focus from the "balanced" theoretical background plus empirical findings approach, to a more empirical-centered one in terms of the outcomes rather than raw data findings. On the other hand, this limitation can subjectively point towards the importance of the topic for the companies, familiar with the topic.

The final limitation is the availability of the theoretical material. It can be stated that so far the amount of relevant material allows to state that the theoretical framework of the study is of a rather trial nature and, to some extent, requires further proofing through research and academic work.

1.4. Research method

This research is of the deductive nature. The research process is based on coming up with the hypothesis based on existing theory and find the objective reasoning that either supports or denies the hypothesis. The resulting findings, if supported by further observations, may point toward the correct hypothesis. This way, the deductive approach or the research preliminarily indicates the fat land for further discoveries.

The thesis can be seen as a combination of 2 parts, each representing own research value: the theoretical part with the goal of forming a theoretical framework based in prior relevant research.

The second part of the thesis is the practical part, that has taken a form of a collective progress through 2 interviews, both semi-structured, with representatives of the enterprise and a limited number of internal materials, such as working notes, reports and presentations. In whole, these sources shaped the work, helped to evaluate the challenge of it and highlighted the connection between the scarce theoretical material availability and first line practical data.

The analysis of the results is done in an interpretative manner. Due to the fact that the dominating majority of the collected material has a form of interview replies, the processing was conducted manually, with no use of assisting software.

1.5. Structure of the study

The study is structured in a way that the reader can follow the logic of both theoretical and practical part along with the writer. This idea is considered a cornerstone, because, in terms of the work credibility, it allows to minimize or even exclude the chance of weak spots, either not supported enough by theoretical sources, or being flawed because of "logic leaps and false assumptions" (Saunders et al. 2009)

The first part of the work is structured in a funnel-like way, starting with the description and evaluation of general influences on the topic, followed by a more focus applied to the Lean Innovation and the aspects of its implementation to answer the research questions.

Chapters 2 contains the paragraphs related to overview of corporate creativity phenomenon directly linked to innovations, it's origin as corporate knowledge management, innovative potential and management in the firm, the globalization, as one of the reasons for modern variety of R&D structure and the market issues that, in the first place, dictate the evolution of management tools. It also addresses the Innovation as the modern phenomenon, it's place in company operations, it's importance and how it poses core value in product development of the enterprise.

Chapter 3 covers the Lean thinking concept and NDP and, in fine, the Lean NDP. This is the first milestone of the theoretical part of the work, because it explains the additional limitations and conditions of the type of company operations that serves as the object of change in terms of Lean Innovation implementation.

Chapter 4 refers to Lean Innovation as the concept of effective innovation management, powered by the beneficial aspects of Lean thinking application.

Chapter 5 contains empirical study, with both the interview results and the study of corporate internal materials, which demonstrate the flow of Lean Innovation implementation process. This chapter also holds the recommendations on possible solutions to the Lean Innovation implementation bottlenecks.

Chapter 6 concludes the theoretical and practical findings of the research and provides discussion of the findings.

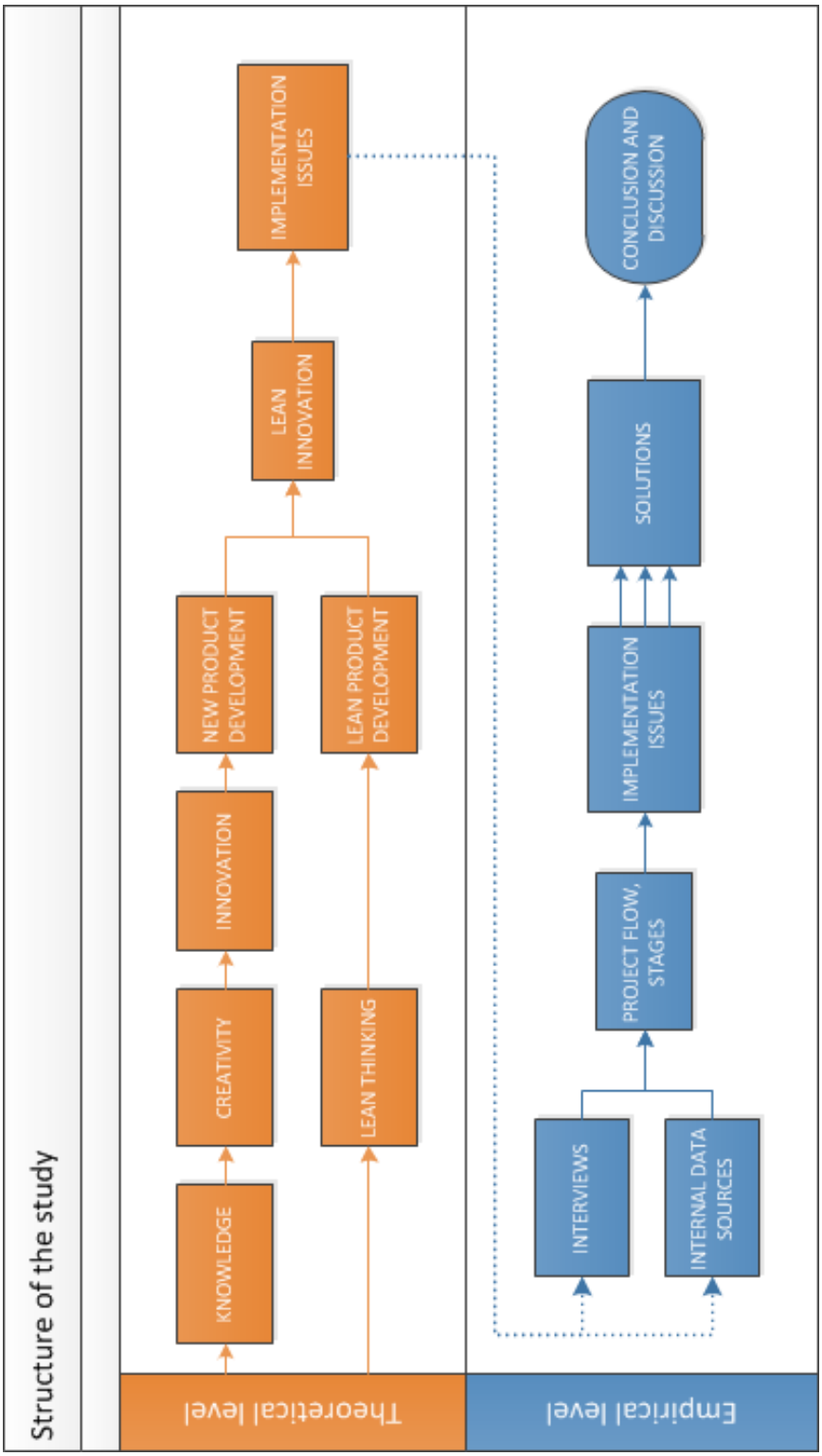

Figure 1. Directional structure of the study

2. INNOVATION PHENOMENON, ITS PREREQUISITES AND DRIVERS

2.1. Company R&D as the main competitive advantage

The competitive advantage depicts the goals of the company that promote growth, improvement and efficient strategic operation. Briefly, a strong corporate R&D initiative, powered by extended decentralized structure, demonstrates the ability of the company to generate innovations and, thus, new products in a fast and efficient manner.

This idea is supported by Sehested and Sonnenberg (2011) who claim that "innovation processes play a key role in realizing a company's strategic ambitions. The strategic need for agility and value creation forces companies to develop their innovation processes. For companies in global competition, the innovation machine needs to be well-oiled in order to produce good results quickly and with great predictability". R&D plays a role of a massive innovation generator inside the company and, as a result, greatly affects the competitive potential of the company.

In Arundel et al. (2008), it has been stated that according to the OECD's Frascati Manual (2002), R&D is the systematic creative work that increases the knowledge of man and can result in new applications. Optionally, it can be confirmed that research and development, although when reviewed critically may not eventually be the most effective innovation-generating mechanism, can be seen as structural core of the modern corporate innovative potential. A systematic process means that the generation of new knowledge and, eventually, innovations is not related to unexpected discoveries, thus, according to Frascati Manual, taking form of 2 general approaches: the basic and applied. The basic knowledge-generating approach states that the company uses the R&D to generate knowledge before there is application ready for it. The applied research states that R&D works to solve a certain problem, develop a certain technology or simply directs the research focus of corporate R&D. The situation, when the knowledge is being built up and stored for further application, can be observed in a number of industries. According to Hoyer (2007), the automotive industry, especially in case of hybrid vehicles, may serve as an adequate example. Hoyer (2007) notes that the development of HEV's was conducted in conjunction with the development of fully-electrical cars. It may be concluded, that, although the HEV's a century ago were of little difference compared to the modern ones, the market proved little interest, rendering the effort of government- and public level initiatives useless. Or course, apart from the market, one of the crucial setbacks lay in the field of batteries development, that was unable to

provide the automotive industry the batteries cheap and efficient enough, to demonstrate clear market benefits of HEV's compared to conventional diesel and gasoline engines. The development of HEV's received a second chance in the 70's of the 20th century, when, followed by the public-private initiatives, the automotive giants (primarily of Japanese origin) powered the HEV development process once again. Eventually, the HEV initiative restarted successfully when the market was ready for it.

Arundel et al. (2008) argue that the R&D, along with the basic and applied division, can also be viewed according to the purpose of the R&D. The in-house R&D means that the company will eventually use the results of own R&D without selling or conveying them to another market player. The collaborative approach explains the mechanism, when firms/organizations naturally unite to collaborate in projects and initiatives. Naturally, such tendency means that when the project is complete, the results are shared among the participants. It may be noted that the format of collaboration may vary and is often discussed individually.

Conclusionarily, Rao and Soumya (2007) refer to clusters, as sources of competitive advantage: "*Clusters* are industrial development block or competence block or industrial agglomeration of producers, customers and competitors that promotes efficiency, increases specialization and is a source of competitive advantage". Cluster can be formed by various corporate intentions, including focus on economy, management, marketing and knowledge. Alternatively, cluster is a form of R&D collaboration that provides the spreading of technology around the market.

Along with benefits of clusters, Rao and Soumya (2007) state that "technology" and "innovation" are also important competitive advantages of the company. "Technology" stands for the prerequisite for new products that lowers the cost, improves efficiency, boosts sales, etc. "Innovation" is the ability to generate unique individually-tailored solutions when problem-solving, eradicating bottlenecks and improving performance. The success of new product development is also closely related to the innovativeness of the firm. It may be discussed that technology, innovation and, eventually, competitive advantage all start from collaborative of in-house R&D. However, the R&D as the main source of innovation has a certain setback. Because the knowledge is being built systematically and the inspiration and creative potential is constantly challenged by routine, the R&D is a better way to come up with incremental innovations rather than radical. Still, the statistics may dramatically vary from company to

company and from agglomeration to agglomeration, depending on the industry, strategy, structure, focus, etc.

2.2. The prerequisite of prosperity – the organized knowledge

Each and every aspect of the modern firm operation relies on knowledge. Knowledge is the ability to collect, store, transfer and increase the information which leads to the ability to progress and operate it. Urbancova (2013) when referring to the number of researchers, including Bartes (2009), Senge (2007) and others claims that "the 21st century is based on knowledge, information and innovative economy". Organization's success depends on the employees' knowledge. At the same time, Rumelt (1984), Barney (1984) and others in Nickerson and Zenger (2004) point out that the knowledge operated by the company may be referred to as "capacity". It is the ultimate goal of the corporate stakeholders and key operators to protect and increase this capacity to guarantee a possible perspective of growth and development for the company. As stated by Arrow and Hahn (1971), Debreu (1959) and others in Nickerson and Zenger (2004) "Such knowledge or capability defines a firm's capacity to efficiently convert its inputs into valuable outputs". In practice, it may be speculated that the knowledge is not a mere resource for the corporate gears and not even the basis of it. It is essential that knowledge lies in the fundament of any initiative. Mclean (2009), citing the words of Martins and Treblanche (2003) declares that "…21st Century organizations are knowledge-based".

Apart from knowledge being a core part of any business initiative, it is clear that knowledge is also a resource that requires adequate management. According to Auernhammer and Hall (2014) the number of modern business sustaining and improvement systems, that take into account or even distinct knowledge management as separate stream of action is vast:

Models	Concepts
Communities of practices, social networks and online communities	Communities of practice and the creation of knowledge, creativity and innovation
Creative and innovative systems	Disciplines, practices, structures and organization of creativity and innovation
Distributed knowledge systems	Knowledge-based view of the organization, disciplines, practices and structure of knowledge creation
Information-based system	Organizational construction of knowledge and meaning
Knowledge conversion (SECI model and Ba)	Tacit knowledge as source of creativity and innovation; spatial knowledge and shared context creation within the organization; organizational knowledge creation
Knowledge-centric systems	Learning about learning in organizations
Learning systems (single- and double-loop learning)	Reflective learning about action and governance to continuously improve (first- and second-order cybernetics)
Open and co-creating systems	Open innovation, user groups and co-creation to generate customer and user innovation
Self-producing systems (autopoietic systems)	Autopoietic systems of knowledge creation and innovation
Sense making and organizing	Sense making and organizing from process
Spatial constructed systems (autopoietic systems)	Spatial construction of organization
Systems of shared meaning	Influence of culture (structure) on process and outcome
System-thinking system	Organizational capabilities and disciplines of learning
Viable systems (self-referential systems)	Recursive interaction with environment to adoption of changing environment

Table 1. Models that incorporate concepts of knowledge, creativity and innovation. (Auernhammer and Hall, 2014)

While the variety of knowledge management directions is considerable, it must be noted that in terms of the research the knowledge and knowledge management is one of the building blocks of R&D – one of furnaces of corporate Innovation. It must be kept in mind that the concepts above are of speculator nature and are based on common sense rather than popular concepts. Auernhammer and Hall (2014) disclose this idea in own vision: "It should still be recognized…that the explanations

of creativity and innovation offered by these models are very complex. They take into account a large number of personal, social and contextual influences, to explain how individual, group and organizational processes are supported and constrained". This claim should help the reader

improve his own understanding of the following theories being nothing but the spin-offs of greater knowledge that is easier to be explored when split into smaller pieces. Thus, it is absolutely true to note that, to some extent, all of the demonstrated models are simple parts of the common whole.

1. **Communities of practice, social networks and online communities**. A creational background of business that takes aim on problem solving rather than clear knowledge generation. Before the knowledge is created, an application must be disclosed. A clear theoretical knowledge is the prerogative of specialized scientific groups, which conduct "professional", applied research that lies in the basis of a number of applicational perspectives. Normally, a theoretical basis is a result of financed initiative. For the same reason, social networks and online communities can be seen as a matter of conturfeit, the sources that act as the front line of "theoretical adoption", which aim to check is the theoretical results are "false-proof" enough.

2. **Creative and innovative systems**. A methodological part of knowledge management. May be observed as larger-scale communities of practice. However, on the other hand, innovative systems often hold a important empirical context, because originally bear the knowledge-development intention from ready-made theoretical scales.

3. **Distribution knowledge systems**. A type of knowledge-management that can be seen as as smaller part of creative and innovative systems. The focus of knowledge distribution systems is, as expected, the methodological background of controlled knowledge distribution. More than that, in global vision, knowledge distribution is an obligatory aspect of any knowledge management system for the boundaries of knowledge and it's accessibility are often required to be places so that the knowledge holds actual value. There is little price for something that is available to everybody, as a competitive advantage.

4. **Information-based system.** A type of knowledge management with clear closed or internal architecture. For instance, modern information-based systems are intranets often accessible only within the organization. Such systems cannot be seen as powerful tools of generation management, or at least they are not as powerful, as the systems especially designed for the following means, but still demonstrate an important level of knowledge

management. Whenever the knowledge is accessible within the company, it has a clear structure, purpose, sphere and perspective.

5. **Knowledge conversion**. An extremely important part of both corporate and global knowledge management. The details of the concept are to be explained further. A mainstream of modern knowledge management that addresses the issues and mechanisms of converting the tacit knowledge into operational.

6. **Knowledge-centric systems**. Just when it was mentioned that there are massive scientific foundations that aim to provide the world a next-generation vision of next-generation vision, the knowledge-centric system just turns out to be one of them. It is a matter of discoveries from the science about science perspective. To conclude this, systems, that aim to promote knowledge growth through discovering the new ways of dealing with it basically serve as conduits between the yet unknown beacons of progress and effective practical applications.

All the other systems fit into the started classification enough so that it is not necessary to provide further explanations of them. In whole, the knowledge systems occupy 2 controversial visions: internal and external. To some extent, each system is internal and internal at the same time. It is clear that even the most advanced R&D division of the company is still linked to the progress, discoveries and research rates of the "outer world". At the same time, even the most diverse creative system is just a combination of individual contributions which further rely on small-scale and individual research, rarely disclosed for the open discussion. It is important to understand the division of models by mentioned attribute to correctly review the knowledge management from corporate and especially MNE perspective.

It has been mentioned that the knowledge conversion models hold the position of mainstream of applied knowledge management systems. Currently, when addressing the issues related to knowledge-management, it is common to define 2 types of knowledge: tacit and explicit. While there are numerous visions of deeper and more complex definitions, the background is clear:

EXPLICIT KNOWLEDGE	TACIT KNOWLEDGE
Articulated knowledge, expressed and recorded as words, numbers, codes, mathematical and scientific formulae, and musical notations. Explicit knowledge is easy to communicate, store and distribute. Can be found in books, on the web, and through other means of data recording.	Highly personal, hard to formalize, difficult to communicate to others. May be very hard to capture. The challenge behind tacit knowledge is to identify the knowledge transferrable to explicit form and the knowledge impossible to capture. The grand idea is to tune the communication between the knowledge carriers with the knowledge seekers.

Table 2. Explicit knowledge vs. tacit knowledge (Higher Education Commission of Pakistan, 2012)

One of the most important aspects of knowledge division into tacit and explicit is tow convert one to another. The purpose of such conversion, as it may be clearly seen, is to make the knowledge usable. While the knowledge remains tacit, it is only available to either the holder of it or a group of holders. What is even more important, the tacit knowledge is often applied "all by itself" without the holder highlighting it as actual knowledge. It may be argued that if a group of people have managed to receive the same or similar tacit knowledge, there is a way to teach the others by making them go through the same conditions/situations/life periods. But it must be understood that it may take extended time and effort to promote tacit knowledge, at the same time posing high risks of failure due to differences of personalities. Objectively, the explicit knowledge is both optimal and controlled type of knowledge that can be purposely *learned*. The risk of explicit knowledge being unavailable to the person is present but not high apart from the tacit knowledge, because the explicit knowledge is already disclosed, public to some extent and adapted to the social and cognitive capabilities of learners.

The knowledge conversion model is about the means of transforming the tacit (hidden) knowledge into explicit (known). Also known as the SECI model, it has been first introduced by Nonaka. Gourlay et al. (2003) refers to it as the model of new knowledge creation that is based on "…social interaction" between tacit and explicit knowledge whereby knowledge is converted from one type to another, and new knowledge created". The model states that the process of transformation of tacit knowledge to explicit goes in parallel by 2 lines. First, the tacit knowledge is generated individually, as a result of combined aspects of personality, social conditions and available explicit knowledge. Combining them in unique ways makes it possible

for new tacit knowledge to emerge, thus making it possible to turn in into explicit. The second line is the interaction-based knowledge creation that emerges when the individual knowledge it filtered, formed and crystallized within social interaction. Also, it may go on several organizational levels at once.

The combination of social and personal as the source of new knowledge was demonstrated as the concept of "Ba". It was originally created by Nonaka and Konno in 1998 (Auernhammer and Hall, 2014). "Ba' should be seen as the core of the SECI model, an attempt to explain why the tacit knowledge can be transformed into explicit. Auernhammer and Hall (2014) provide a brief explanation of the main parts of the "Ba" concept:

1. Originating "Ba" – a momentum of socialization. A "dimension" where people share feelings, emotions and experiences.

2. Interacting "Ba" – a space where people learn mental models of each other and "provide" their own for collective analysis.

3. Cyber "Ba" – a space for interaction in the real-time environment.

4. Excercising "Ba" – a space where explicit knowledge becomes tacit.

It must be noted that "Ba" cannot be referred to as the primitive concept of space in physical, temporal, metaphysical or other entities. To certain extent, it can be stated that "Ba" is the matter of fact, a contingency that, while complicated, lies in the SECI model of knowledge transformation, creation and exchange.

Nonaka saw the SECI a figure of "Ba" having strict dependencies, while at the same time being able to penetrate temporal and material boundaries.

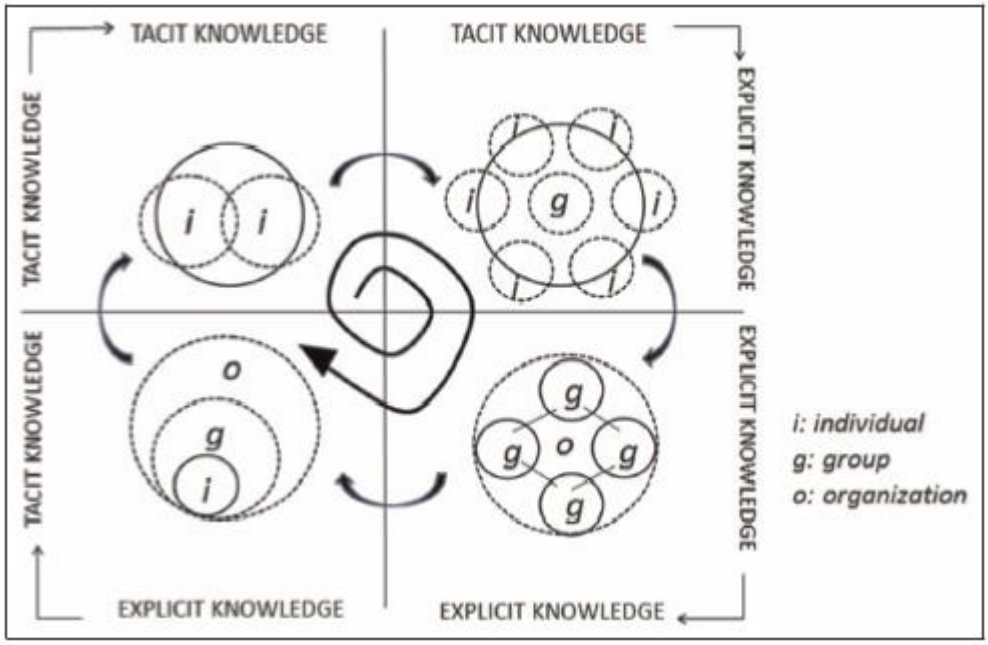

Figure 2. Spiral evolution of knowledge conversion and self-transcending process (Auernhammer and Hall 2014, adopted from Nonaka and Konno 1998)

The Figure 5 aims to demonstrate the "Ba" concept live, showing that are 4 "phases" of spiral transformation, that the transition of explicit knowledge to tacit and vice versa:

Phase one – Socialization (upper left): tacit knowledge is being acquired from individual levels
Phase two - Externalization (upper right): tacit knowledge, upon being processed on group level, start to emerge as the explicit knowledge
Phase three – Combination (lower right): explicit knowledge of group level takes form of structured explicit knowledge of organized level
Phase four – Internalization (lower left): explicit knowledge gradually merges with personality as a part of the tacit knowledge – developed and adopted.
Afterwards, the cycle repeats.

This model provides understanding behind one of the main knowledge management concepts used to build effective information and knowledge exchange and creation systems. At the same time, it must be clearly stated that the provided model is a mere reflection of the knowledge-based theory of the firm.

Nickerson and Zenger (2004) argue that "the manager's fundamental knowledge-based objective is to sustain above-normal profits by continually discovering new knowledge or new solutions

that form from unique combinations of existing knowledge". Again, according to Nickerson and Zenger (2004), Nelson and Winder define the corporate knowledge as "input-output combinations achievable with all possible mixes and levels of activities known to the firm". In other words, everything the company does internally and externally brings knowledge.

However, it must be noted that the process of creating this knowledge, based on the fact that cognitive interactions are in the center of the creation process, has certain restrictions, that, although avoidable, are of critical importance:

1. Nickerson and Zenger (2004), while referring to Arrow, state that there is a paradox in knowledge exchange that has a high risk of sabotaging the whole corporate "network". The idea of paradox is that in order for the knowledge to be shared among individuals for cognitive processing successfully, each individual must be aware of its value. However, the value can only be measured when the knowledge is disclosed. At the same time, if the knowledge is disclosed, it may be resold with the zero marginal cost. Clearly, it is a destructive intent because the knowledge is already possessed and was obtained for free. It is hard understand the importance of it when no personal input was made for its generation.

2. The search of knowledge has a room for selfishness. In practice, the search for new knowledge, no matter in terms of problem-solving or theoretical quest, is always based on the existing knowledge of the contributors. The amount of knowledge present may be prove to be just a highlight to future discoveries or a major basis. Either way, this "basis" knowledge is significant to the practitioner of the search. The more knowledge contributed – the more pride taken in case of achievement. To a certain extent, the social influence makes the practitioners search the optimal path, especially when a certain task is set that requires sets the boundaries of future solution. But when the personal contribution reaches a certain level of "selfishness", the practitioner starts to seek the satisfaction from personal contribution more than the common truth of the right solution. (Nickerson and Zenger, 2004) This is when a high risk of taking the wrong road emerges. In order to maintain the objective direction in search for knowledge, each practitioner at any time must be aware that the result achieved as a result of cognitive teamwork is always more important than the personal contribution, no matter how significant it may be.

To conclude the importance of knowledge and its form in the lifecycle of the company, it is important to note that the possession of knowledge is never more important than the way of organizing and using it. For this purpose, a large number of knowledge organization models can be applied, some of which have been demonstrated in Table 5. The presence of corporate internal knowledge management system is crucial for it ensures the solid fundament of company development. Obviously, a strong R&D initiative is directly dependent on the skill of the company decision-makers and their expertise in dealing with promising knowledge.

2.3. Creativity as an inception of corporate R&D

It has already been noted that the R&D of the modern company still plays a key role in competition race and provides a major part of the market improvements that shift the position of competitors. R&D only exists when there is a place for knowledge generation, management, a well-thought through structure of company and a unique culture that makes the transition of tacit knowledge into explicit possible. McLean (2009) supports there logical outcomes by stating that "Most firms today recognize that in order to get ahead and stay ahead of their competitors, they must innovate and commit products and services to market better and faster than their rivals…this process is heavily dependent on organizational and individual creativity…".

At first glance, the creativity is easy to understand and define as the initial power of a person to generate breakthrough ideas. However, the definitions vary. Most agree that creativity promotes innovations of products and services which boost the added value of the company. Amabile (1996) and Oldham and Cummings (1996) in McLean (2009) claim that creativity stands for "the production of novel and useful ideas by an individual or small group of individuals working together". Pesut (2013), quoting his own words back from 1985, adds to the definition, by saying that creative thinking is "a metacognitive process of generating novel and useful associations, attributes, elements, images, abstract relations or sets of operations that better solves a problem, produces a plan or results in an outcome, pattern, structure or product not clearly present before". Amabile (1996) downgrades the complexity of creativity to "creativity is the production of novel and useful ideas in any domain". Finally, Lubart (2003) in Saulais and Ermine (2012) describes the process of applying creativity as a creative action that "… is supposed to request an intentional and arduous work, the realization of which must include numerous difficulties", meaning that, to put it simple, creativity is based on the ability to think outside of the box.

As expected, creativity is highly related to the knowledge generation and progressive management concepts, widely driven across companies and mentalities, resulting in curious,

altered forms. As Saulais and Ermine (2012) view it, the modern company has 2 basic aims to reach: “The first one focuses on tangible products, leading to the development activity from “the idea to the product”. The second one focuses on intellectual activity within the company in term of “creativity” or “knowledge creation” or “inventive activity”.

The integrity of creativity and knowledge is further underlined by Runco (2004) who argues about his own statement back from 1994 that “In addition to what may be its most obvious function, namely as part of the problem solving process creative ideation allows the individual to remain flexible”. This thought is supported by the previous overview of the competitive advantage of the modern enterprise and the impact of flexibility also known as the ability to adapt fast, on it.

As intuitive as the creativity process may seem, there is a vision that behind the definition of creativity lies a structure that actually provides explanation to the phenomenon. At the same time, a number of limitations applies to it.

First, according to Amabile (1998), creativity is a result of fusion of three components:

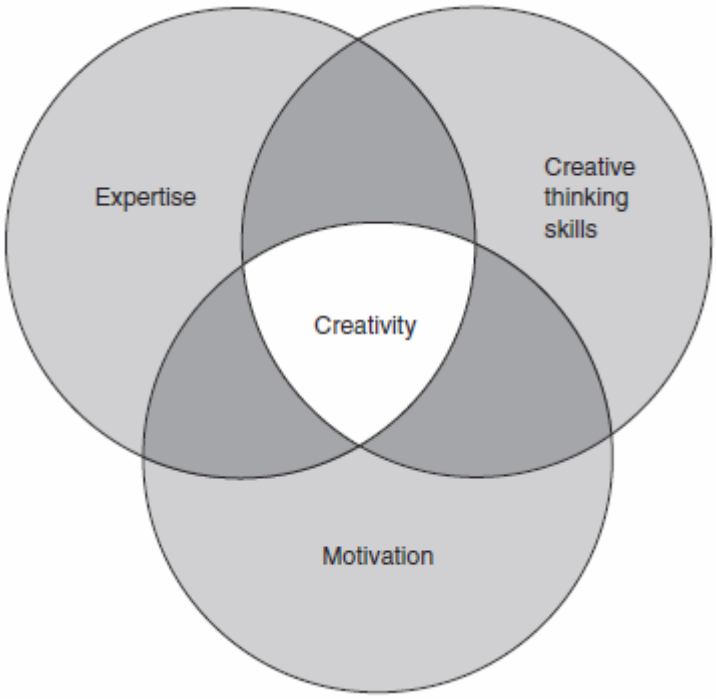

Figure 3. The three components of creativity (Amabile, 1998)

Observe, as a number of more general forces of sometimes indirect relevance, when composed, turn into one of the most tremendous powers driving modern market, progress and evolution.

What is even more inspirational, this force has been this driver before. Still, abstracting from the overall importance of the entity, each of the components "plays it's own role":

A. Expertise. A variation of collected knowledge, either by the individual, a group or an organization. Includes technical, intellectual and other relevant detail.

B. Motivation. It allows for the inner driver of the individual , especially in the situation, when the number of external motives is already considerable. It is important to understand that the quality of the solution to the problem may only surpass the potential benefit from finding it only when the motivation of the individual is greater than of other means like appreciation, monetary compensation, etc. Runco (2004) agrees to the importance of motivation, saying that "personality research frequently includes intrinsic motivation as a core characteristic of creative persons".

C. Creative-thinking skills. An ability to apply problem-solving approach, adapt it to the task, including speed and efficiency. Still, it must be noted that creative-thinking often cannot be measured and evaluated in any other means than a result, "divided" by the difficulty of the task. In a way, creative-thinking skills may be seen as a combination of motivation and expertise. As a matter of application, before a solution to the issue is found, the individual/group/organization possess the motivation to overcome the cause and the expertise to operate the knowledge of the field. Otherwise, the scheme is incomplete.

Alternatively, creativity is demanding is resources. Amabile & Gryskiewicz (1989) state that along with time and money, there is a number of other resources critical for creativity: "freedom, autonomy, good role models and resources (including time), encouragement specifically for originality, freedom from criticism, and norms in which innovation is prized and failure not fatal.

In short, the resources other than time and money are freedom, organizational support and workgroup diversity. It is relatively easy to understand the importance of time and money, since the work is a paid matter and finding solutions, as well as creating knowledge takes time. However, freedom is a somewhat more complex entity. The creativity is based on the line of free will, the ability of a person to express the idea freely for further analysis. But otherwise the freedom is limited by organizational support and workgroup diversity. Basically, both issues result in positive limits to creational freedom when applied strategically. The diversity of the group is the key to the synergetic effect of the collected expertise. To a certain extent, the more

dramatic the gap between the individual fields of expertise, the more space for creativity there is. At the same time, creativity is the guided process. This is where organizational support comes in. Of course, bureaucracy and internal competition harm the creative potential of the company, but when the corporate leaders provide a clear direction of development, the whole power of creativity is directed towards a concrete number of tasks, which greatly empowers the process of knowledge creation.

A concept of transformation of the organizational influence on all parts of creativity was demonstrated is the concept by Amabile, back in 1996. It is clear that the figure shows the direct connection between the creativity and innovation. Although the case of innovation in disclosed further, the concept allows arguing that the R&D may be seen as a logical form of organizationally inspired creativity moving towards innovation.

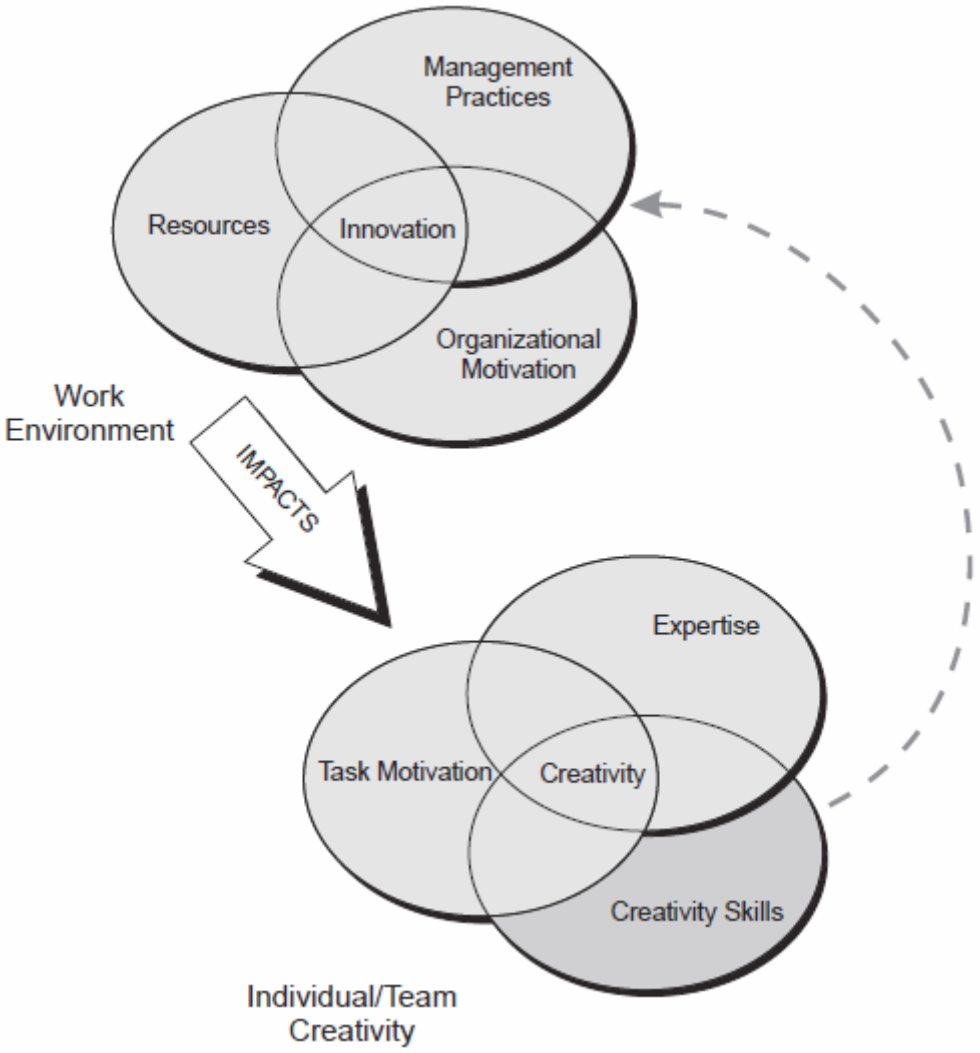

Figure 4. Impact of the organizational environment on creativity (Amabile, 1996)

Observe. Amabile claims that organizational motivation, as a component of creativity and innovation, is a way to structure creativity and "the orientation toward innovation must come, primarily, from the highest levels of management, but lower levels can also be important in communicating and interpreting that vision". It is known that R&D, depending on the structure of the MNE, is usually a separate business unit, either centralized or diversely located throughout the land. Still, it is a part of the company that aims to create new knowledge. If proposed that R&D by default is the division of most loyal and inspirational attitude of company leaders to creativity, not to mention the structural benefits, not to mention the considerable scale of modern international MNE, is one of the few ways of receiving the controlled and directed creative process.

Salais and Ermine (2012) provide indirect agreement to the discussed concept above by referring to the definition of intellectual corpus: "the intellectual corpus is a collection of intellectual abstractions recognized as a creation (and materialized on supports included in the information system)…" What is even more important is that, according to their logics, a creative system in any company is bound to developing into a structured form that, in one way or another, implies the creation of intellectual corpus: "…creative system will lead to the creation of intellectual property works which will be accumulated in the intellectual corpus and which will generate value within the intellectual capital". By observing the provided figure, it can be further verified that R&D is both a form of the intellectual corpus of the company and a diverse, independent part of it:

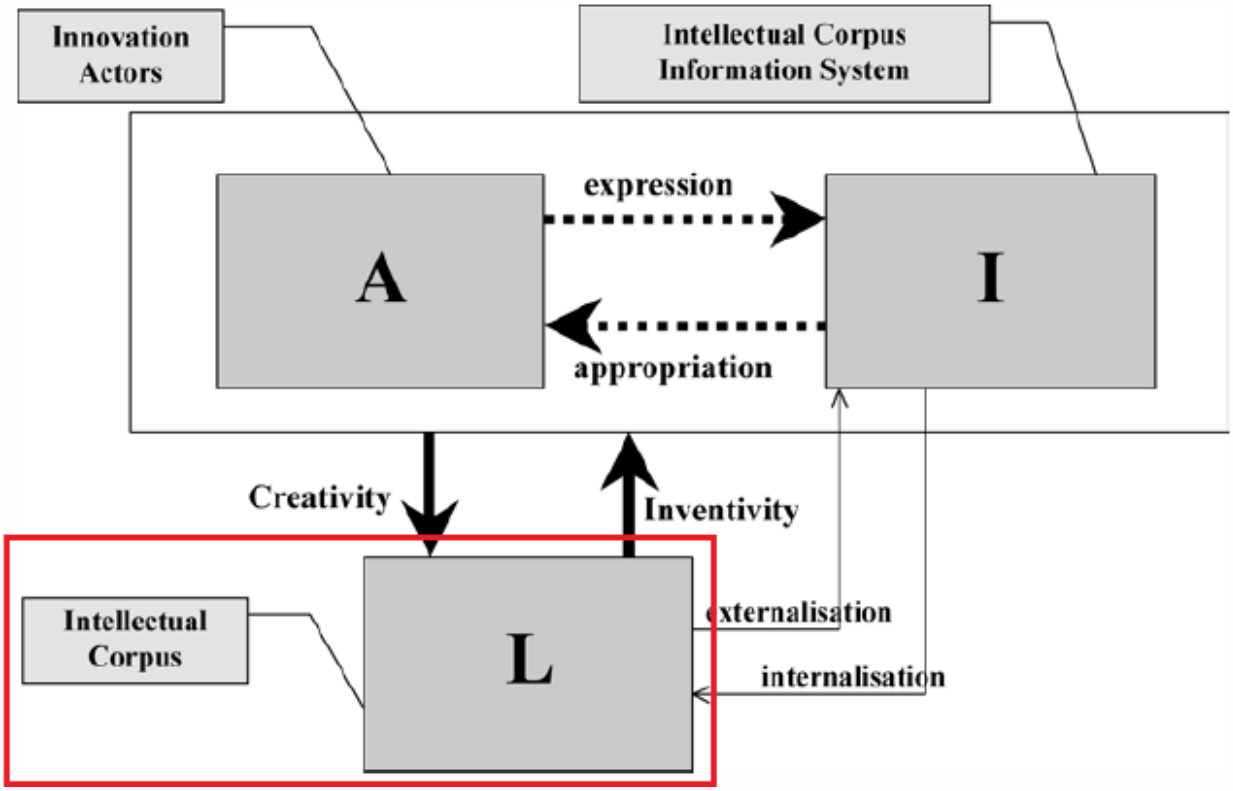

Figure 5. The AIL systemic model of Intellectual Corpus (Salais and Ermine, 2012)

While creativity, in form of expertise, motivation and creative skills is being gradually transferred to R&D capacity of the company, an issue of transformation of creativity to innovation must be addressed from the perspective of inventivity. To a certain extent, inventivity is an intermediary between creativity and innovation. Salais and Ermine state that "inventivity consists of the ability to create and to transform reality, to materialize a new idea carrying change and liable to find an innovation traceable in the Information System".

To generalize the outcome of the overview, it is important to understand that although the full concept is yet to be disclosed, creativity is the inceptional driver that both makes the progress and the development of new concepts possible. Needless to say that Lean Innovation is a mere variation, although considerable, of such concept.

2.4. Connection between creativity and innovation

In 2007 David Tanner argued: "All definitions of innovation have a vital element in common. They require creative thinking!" As clear as it may seem, there is a large conceptual gap, which

must be filled before referring to concepts more concrete, such as Lean Product Development and Lean Innovation.

Innovation is a vast term, to start with. The more knowledge-oriented modern companies become, the more "innovative" they tend to be, thus, more capable and willing to generate and utilize new knowledge. Still, there are certain boundaries to Innovation definition. In 2005 Tidd and Bessant formulated that "innovation driven by the ability to see connections, to spot opportunities and to take advantage of them'. Only based on this statement, it may be proposed that innovation is a somewhat concrete, crystallized form of the creative effort, a birth of new knowledge or a solution to problem that in a form of method, product, organizational aspect, etc.

Further, Tidd and Bessant claim that "innovation is more than simply coming up with good ideas: it is the process of growing them into practical use. Definitions of innovation…all stress the need to complete the development and exploitation aspects of new knowledge…" Citing the words of Porter (1990), Tidd and Bessant outline that "Companies achieve competitive advantage through acts of innovation".

In an attempt to cover the primary connection between the creativity and innovation, Amabile (1996) provides semi-subjective definitions for both. Creativity aims to create novel ideas in any field, while innovation demands positive answer to the question about the successful implementation of the novel idea for the good of the organization. The implementation may hold different goals: to improve the product or process, for internal purposes or to be sold outside, etc. Plsek (1997) in Pesut (2013) verifies: creativity is about connecting and rearranging the knowledge, while innovation is about not just the idea gone "live", but as a "…first, practical, complete implementation of an idea".

At this moment it can be stated that the process inside the organization that leads to innovation undergoes several steps that allow speaking of a contingency:

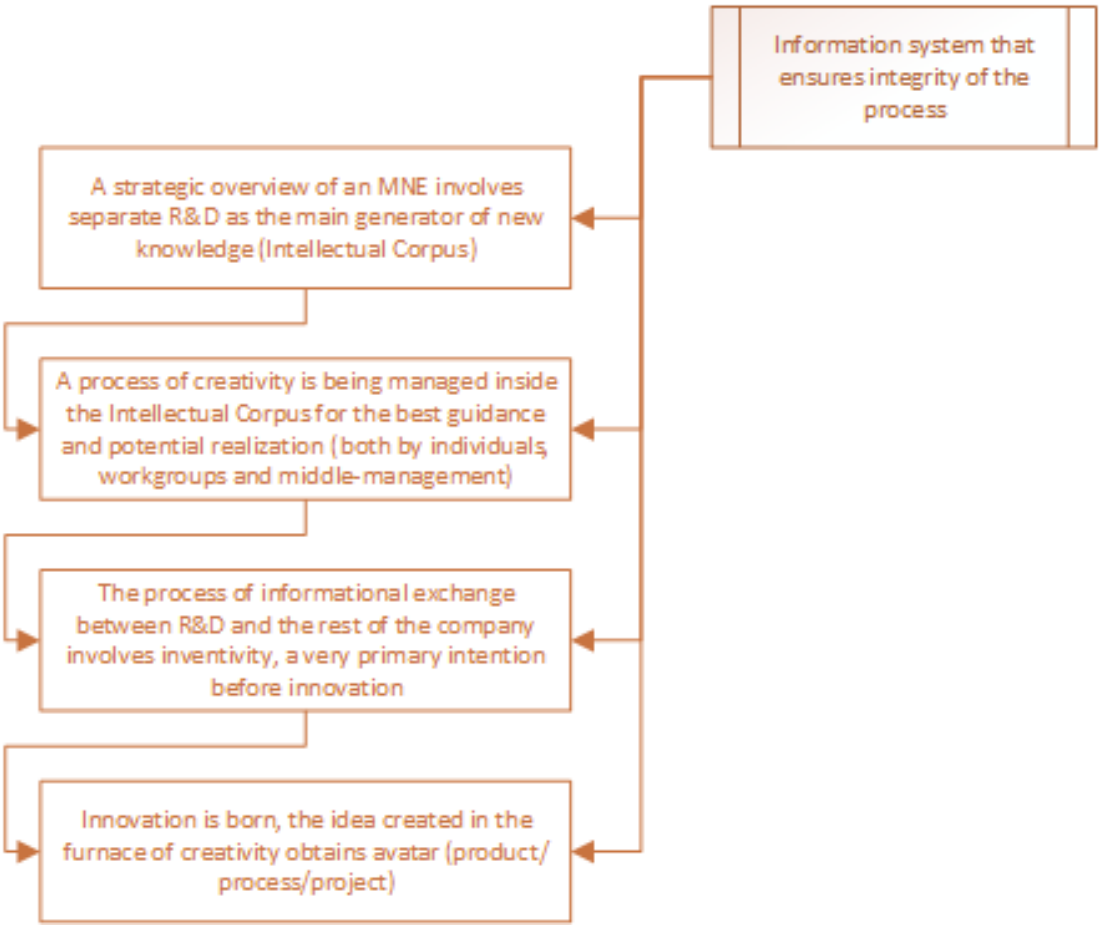

Figure 6. From creativity to innovation

Can innovation exist without creativity? Definitely, the existence of one without another is ultimately improbable, for it is crucial that before the project is complete and the idea has taken form, it is by all means clear that the existence of idea cannot be doubted.

However, it is possible that the gap between two innovations in a form of creativity is absent. This is possible when the radical innovation, i.e. the one that involves a considerable change in the product/process or overall approach to either holds a vast potential for incremental innovation, that involves smaller steps of innovation, that don't bring radical change but rather "linear" improvements.

Based on this, during further referrals to innovation, it is by default taken into account that before innovation an action of creativity was taken.

2.5. Overview of the innovation phenomenon

The innovation, as an independent phenomenon, is impossible to encounter. In it's pure, undirected form and sense the innovation would be the emergence of a solution that is, literally, useless. That is because every innovation requires a goal, an issue it must solve or a direction that would allow to evaluate it if the innovation is breakthrough. For this reason, in many cases innovation is the product of organization, of management and problem-solving.

While a path the innovation takes to "realize itself" comes through a number of corporate obstacles and guidance, it is clear that the structure of the company plays a certain role in the process of innovation generation. Although it is clear that innovation may be limited to R&D as its main source, it is still diverse in mechanisms and achievements. It is important to understand the inner variations of innovation and the ways of it becoming real in the walls of an MNE.

In 2005 in his book "Innovation Management: Strategy and Implementation Using the Pentathlon Framework", Goffin, it was stated that "Managing innovation is complex and so there are no 'quick fixes'. The challenges with managing innovation are also compounded by the fact that many ideas that are effective in one organization cannot be easily transferred". It may be speculated that, due to high differences in approach, the scale of any research that cover innovation as a part of the modern world, may be strictly limited to the case studies of the concrete MNE or even SME. Still, some things don't change from company to company.

First of all, the initial need for innovations promotes better knowledge management, cultivation of creativity, never ending search for better organizational and strategic model, etc. The main prerequisites for innovative business are:

- **Technological advances**. Modern rate of knowledge collection and utilization is fantastic. Technological integrations, multiplied by the increasing rate of smart electronics and information systems, dramatically increases the chance of a new technology changing the market. The examples are numerous: Facebook, Google, Tesla, etc. Technological advancement forces the companies both to follow the infrastructure and capture the initiative to drive it. In order to follow the infrastructure, the company must possess enough knowledge to understand how to integrate its market activity into the changed market rules and tendencies. E.g. after the development of social networks, as the companies realized that people are spending more and more time there, the value of context advertisement inside the social network increased. Currently, a considerable part of

PR and advertisements is concentrated in the social network activity. E,g, according to the eMarketer advertisement revenue dynamics in social networking, the U.S. divisions of social networks managed to attract 55.6% more revenues in 2011 than in 2010.The company may capture the initiative by developing trend inside a trend, literally capturing the benefit of the technological advancement for its good.

- **Changing business environment**. Companies have always been focused on maximum profit. However, with a number of complex tendencies in place like globalization that leads to changing in organizational models, relaxation of regulations that increases the attention of the investing companies to the particular region, and others, the companies have gained additional capabilities for effective cost-cutting. Currently, it is possible to cut the costs by improving the effectiveness of core business processes at the same time. Although innovation alone is not always capable of providing the necessary results, it is still a powerful asset to the cause. Albrecht and Sack (2000) confirm that the modern business environment has several outlines that support the interest in innovation and business process cost reduction:

    A. Outsourcing of non-value-added, but necessary services
    B. Elimination of or reduction in rewards for services replaced by technology
    C. Shorter product lifecycles and shorter competitive advantages
    D. Increased rewards for services that help leverage technology and globalization and that assist in making better strategic decisions

- **Intensified competition.** One of core tendencies of increased competition is the emergence of new and bordering fields of operation. The company may expect a challenge from a competitor that, when observed several years ago, wasn't even introduced in the given sector. That is because the pace of the change and the impact of technologies is high.

- **Changing customers and needs.** Again, there are global tendencies that emphasize the upcoming market changes, such as the changes in age groups balance. According to the world population ageing report 1950-2050 by United Nations Department of Economic and Social Affairs Population Division, taken in the period from 1950 to 2014, the share of 60 and older age group has increased from average of 10% to 12% and after the 2000 the "incline" is only increasing. By 2050, the older generation will take up a 1/5 of a global

age group structure. The same counts for the major active group (age 15-59) that, along with 60+, is constantly increasing the share. Generally, the tendency shows the decrease in the number of children born annually. This allows to state that the companies tend to review their product portfolios and marketing approaches to readjust targeting for better investment returns. It is clear that every age group has it's own distinctions in demand, capabilities and values. Following these changes makes the companies think faster which makes them turn to innovations for the answer.

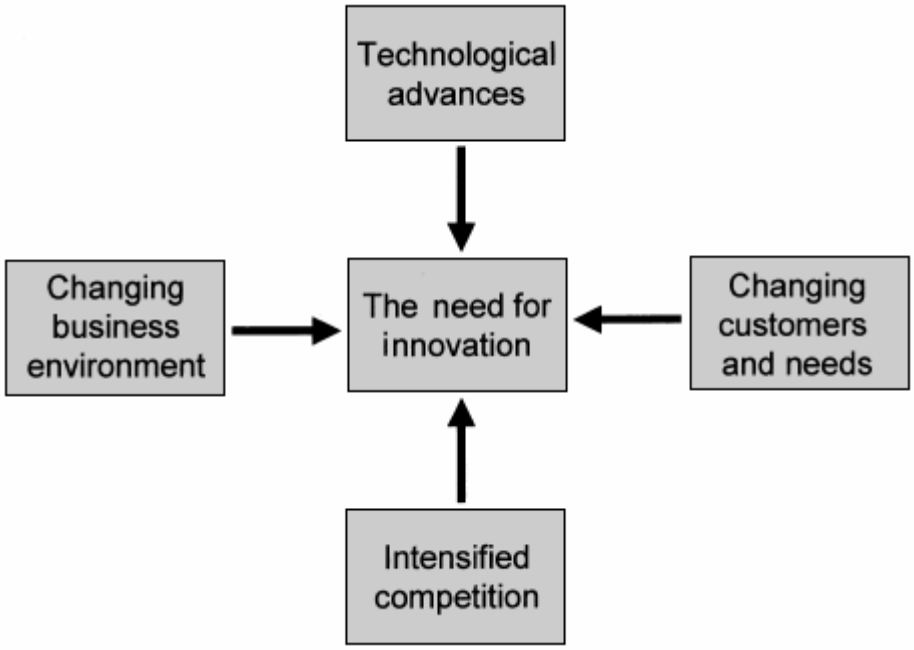

Figure 7. Drivers of the need for innovation (Goffin 2005, adopted from Sheth and Ram 1987)

According to Booz & Company, in 2013 the amount of investment in R&D reached it's peak. While not showing the top annual dynamics, this fact subjectively indicated that R&D is still important and may be seen as the center of corporate innovation generation.

The Booz & Company research further shows that the investment structure shifts towards IT in a form of "computer and internet investments" that supports the previous statement about the technological advances as a motivational factor for innovation development. 8 out of 10 companies that top the R&D investment rating in 2013 come from IT sector or at least one of their divisions is situated in this sector. These companies can be referred to as the most innovative, meaning they carry the most innovation capacity.

While the motivational aspects of innovation are clear, it is expected that the phenomenon as complex may hold uncertainties in structure and variation. Evaluation of these grounding factors of innovation is important for understanding of organizational applications.

In 2005 Tidd and Bessant formulated the "four dimensions of innovation space":

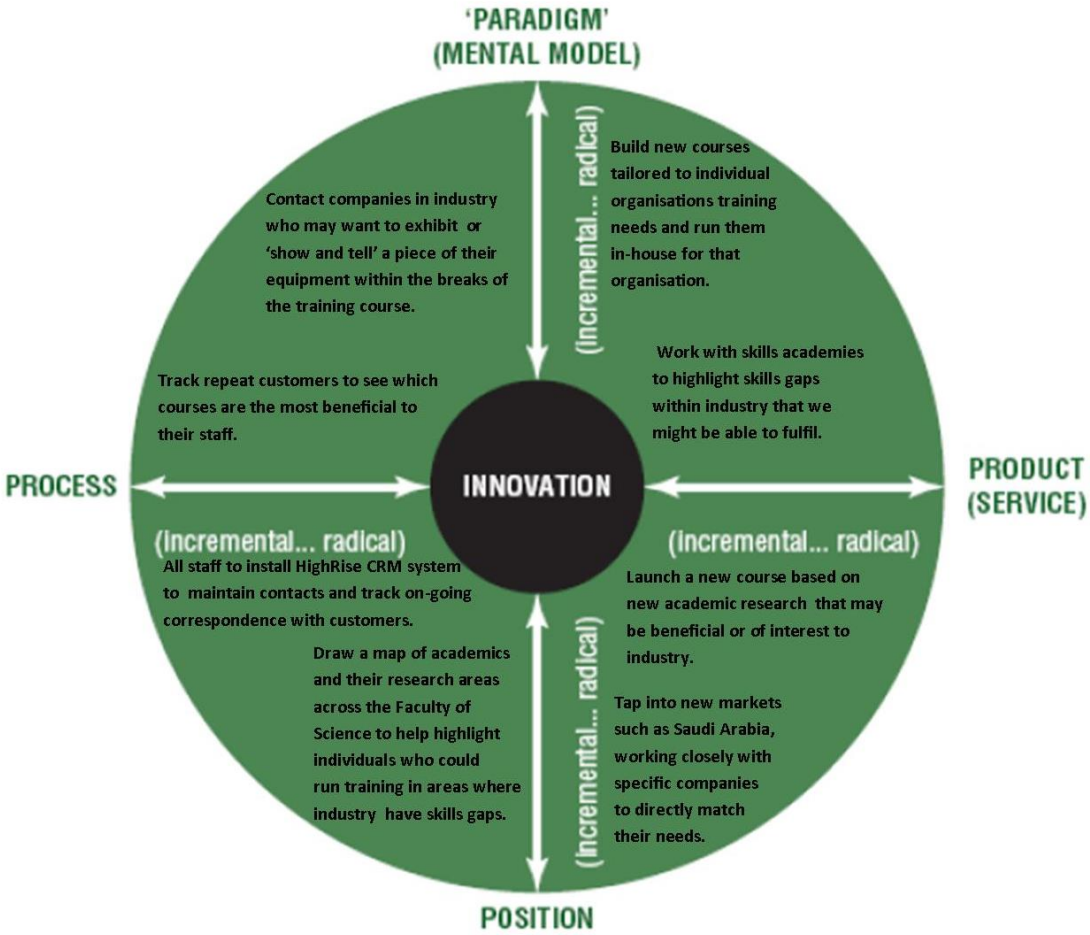

Figure 8. The 4P's of innovation space (Tidd and Bessant, 2005)

Product innovations – changes to products and services in the corporate portfolio

Process innovations – changes to the processes of product and service creation and delivery

Position innovations – changes in the ways of product and service introduction to the market (E.g. the extended usage of corporate pages in social networks as a new way in marketing and PR)

Paradigm innovations – changes to the overview of the activities of the company

This concept was further speculated by different researchers. One of the key figures of the Deloitte financial audition companies – Larry Keeley, in his book "Ten Types of Innovation:

further developed 4 into 10, by uniting smaller subtypes into logical groups: configuration, offering and experience. Configuration group covers profit model innovations, network, structure and process, which generally may be referred to as mostly paradigm innovations. Offering group is about product performance and product system, also seen as product and process innovations. Finally, Experience group refers to service, channel, brand and customer engagement, which, otherwise, are covered by position innovations.

Geoffrey Moore, when addressing the type variation of innovation in "Dealing with Darwin: How Great Companies Innovate at Every Phase of Their Evolution" argues that there are 12 types and taking into account the fact that each process in organization has the form of a cycle, these 12 types match the general concept of "Renewal Innovation". The concept claims that each type of innovation is bound to occur in the specific time frame of the renewal.

At the same time, Goffin (2005) refers to the types of innovation mostly as dimensions that lead to the logical output in a form of commercial innovation: new products, new services, manufacturing and business processes. Based on his saying, it may be speculated that all of the dimensions are equally important from the competitive advantage perspective: "…innovating in a number of dimensions can enable sustainable competitive advantage".

The concepts of innovation may vary, however, despite the point of view, the 2 logical types will remain, although possibly altered by the vision of the researcher: product and process innovations. It is hard to argue that product portfolio is the flagship, the largest caliber in the corporate artillery in the battle for customer and profit. At the same time, process is the logistics, manufacturing and supply of the army – the very foundations of market wars.

Milling and Stumpfe (2000) are particularly interested in product and process innovations. In addition to the fact that they accept the concept of product and process innovations being 2 separate, equally important types, they demonstrate that there is a much stronger connection between them. First of all they agree that "For industrial companies innovations of the product system and particularly innovations of the related processes are essential". It must be noted that products and processes are strongly connected to each other in any company. However, this connection is especially strong in manufacturing companies.

Milling and Stumpfe (2000) (refer to the theory that was announced by Utterback and Abernathy back in 1975, that explains that the rate of product and process innovations is directly dependent on the stage of the lifecycle of the product. To a certain extent, this theory is related to Moore,

except for the scale of the renewal. At the same time, this theory explains the 3 steps of innovation process:

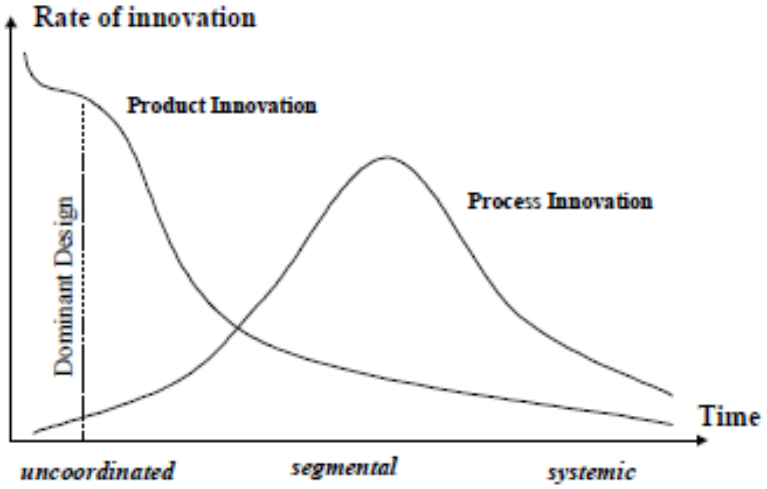

Figure 9. Model of industrial product and process innovation (Milling and Stumpfe, 2000, from Utterback and Abernathy, 1975)

The uncoordinated stage of product innovation is referred to as a period with particularly low productivity of the related process and frequent changes in product design that lead to less optimal processes which, in turn, lead to higher production cost. Because the dominant product design is yet to be reached, the potential for product innovations is also low.

The segmental stage is announced by the emergence of the dominant design. It is noticeable that along with the increasing rate of the process innovations, especially with close relevance to production, the rate of product innovations diminishes and the radical innovations are rarer to occur. This stage indicates the decrease in production costs which leads to increased manufacturing volumes.

Finally, the systemic stage, as the product is further standardized and the need for process improvement is greater, both product and process sections are closer than ever. The tendency of standardization dramatically sabotages the need and chance of radical (breakthrough) innovations.

To sum it up, products and processes are very close, but the tendency of innovation and it's rate can be set both from the product or process perspective.

At the same time, Greenhalgh and Rogers (2010), provide an explanation to the very mechanism of innovation itself.

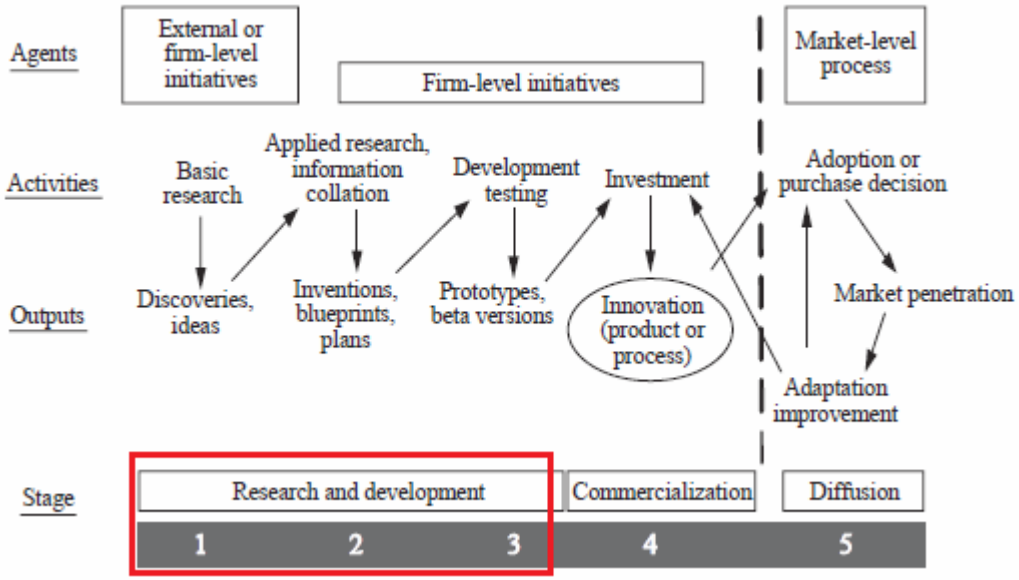

Figure 10. The stages of the innovation process (Greenhalgh and Rogers, 2010)

At current stage, it is particularly important to see the stages of innovation during research and development. First, it must be kept in mind that the R&D of the MNE, only the firm internal initiatives are taken into account, as the ones produced by the internal R&D as an answer to the uprising issues or research topics of trend. The figure indicates that the innovation takes root from the very basic research, which leads to the discovery of conceptual ideas. However, the basic research must be addressed as initial rather than fundamental, contributing to the fact that the companies tend to conduct the research for future use, now always guided by strict boundaries of application. Afterwards, the promising material from the primary research is decomposed into subtopics which allow better research project management and optimal time and effort evaluation. It is clear that applied research leaves a clear concept as a result that, from this moment, indicates the ending of the ideation stage and reveals the direct route to the "form search" of the idea. In order to come up with the prototype, the innovation process involves the development testing, a process of going through the various subconcepts after the applied research to achieve understanding of the fundamental boundaries and limitations of further "idea going live" development process. Whenever a compromising solution is found, starts the commercialization process.

2.6. Organizational aspects of innovation in MNE

How innovations are addressed from the organizational perspective today has become a question of doing business. Where the companies have turned to gathering, refining and putting perspective ideas to good use, emerges the understanding that the R&D has, to a major extent, become a mechanism of innovation management, rather than conventional scientific engine. The idea behind this assumption is that while the R&D majorly answers the question "how", it involve the process of conveying the idea from the moment of its birth to the moment where it takes form, certainly a new product, service or process. It is very important to note that the Innovation Management as a phenomenon stretches far beyond the boundaries of the conventional R&D. It can be stated that R&D consists of Innovation Management, but at the same time R&D is but a part of Innovation Management itself. At the same time, how innovations are managed, how the research and development process is constructed within the corporate temple of science and progress is a truly unique case for every situation, enterprise, case. There is regional, structural, and other context to distinct separate cases. Still, there is a number of organizational aspects, that serve to answer 2 questions: "how is innovation managed" and "what must be taken into account for the firm to manage innovations effectively and efficiently".

First of all, the Innovation Management as a phenomenon is related to the number of challenges that the enterprise faces, including those that affect the R&D structure. Sharma (1999) indicates that there are 5 dilemmas:

1. The larger the enterprise, the more creativity it possesses, generating more perspective ideas. Clearly, it is pointless to chase all of them. Still, the lack of constructive "proofing and filtering" system may lead to the situation when decision-makers will intentionally halt and drown all the ideas without paying any attention.

2. Effective Innovation Management is a balance between the initiative and experience. While the breakthrough idea has the potential to alter a whole section of corporate operations or create a new one, it has a relatively low implementation potential. At the same time, the collected knowledge and experience allows the company to use well-known tools for creating new processes, but there may be a lack of revolution. Combining new idea with implementation and management experience results a synergetic experience turning an idea into lifelike project.

3. Choosing between hiring from outside the company for R&D and linear progressions inside the company is also a challenge. Hiring outside is more expensive, but the personnel may have the needed knowledge and ideas to boost the research on a particular issues. At the same time, internal staff transition is cheaper, it may hold less radical ideas but it bears the experience of the company operations from a different field, which may prove to be a rich basis for fruitful, "issue-tailored" research projects in future.

4. Tuning a collaboration network between separate R&D (SBU) divisions may bring tough luck compared to building individual division capabilities. The issues is that sharing the resources between the divisions is consuming, requires time and expense. The reward will be an alternative R&D network that may potentially replace the corporate one. OM the other hand, when each R&D develops its own capabilities, the company gets inspired think tanks keen and extremely proficient in addressing particular R&D directions. Balancing the two processes may be the necessary compromise to sustain the corporate R&D linkage but not intentionally reduce the potential of individual laboratories.

5. Launch dilemma. Launching small test product quantities reduces the risk of market failure, but increases the manufacturing price of each unit with smaller chance of the project expenses paying-off. At the same time, releasing a large quantity my boost the sales, reputation and cover the spent funds on product development, but the consequences of failure may be catastrophic.

The firm internal R&D can be divisional or corporate. While the importance is considerable, the approach to positioning of the R&D laboratories, that comes out of the chosen innovation strategy states the difference further affecting the firm innovation performance. Tidd and Bessant (2005) state that "…Contrast R&D activities of interest to different parts of the firm" and further underline the main contradictions between them:

Corporate level:

- Long time horizons
- Slow learning feedback loops
- Weak internal linkage
- Relatively cheap projects

Business unit level:

- Short time horizons
- Fast learning feedback loops
- Strong internal linkages (with production and marketing)
- Expensive projects

Choosing between the corporate level (united R&D laboratory) and business unit level R&D structure addresses 2 issues described below: centralized structure vs. non-centralized, home or international R&D. Before continuing, it must be noted that the company may have the opportunity to choose a non-centralized, but home-based structure. Again, it is further directed that this solution is not of a mainstream trend, since establishing several laboratories in one country may help attract and utilize the highly-creative staff (e.g. university partner programs), but reduces the rate of company internationalization and the opportunity to tap into the benefits of foreign markets, mentalities, etc.

Their further highlights allow preliminary conclusions that the effective innovation management is based on the type of R&D and, eventually, the choice of corporate or divisional positioning:

- **R&D supporting existing businesses** (products, processes, divisions) should be located in established divisions
- **R&D supporting new businesses** (products, processes, divisions) should initially be located in central laboratories, then transferred to divisions (established or newly created) for exploitation.
- **R&D supporting foreign production** should be located close to that foreign production, and concerned mainly with adapting products and processes to local conditions.

Clearly, the direction of research dictates particular interest to the second type of R&D "Supporting existing businesses". Understandably, the emerging and existing company businesses both need new products and processes. However, it must be kept in mind at all times, that the further focus on Lean Innovation indicates logical movement towards optimization of the existing structures, systems and processes. Thus, R&D that helps sustain the rotating flywheels of business already in place is of ultimate priority. Narula and Zanfei (2003) provide indirect support of such logics by stating that "Overall, MNEs have increasingly internationalized their innovative activities... The importance of R&D activities of foreign affiliates has been generally growing in most host economies over the 1990's, although with significant diversities across

countries: it is especially high in the case of some countries (UK, Ireland, Spain, Hungary and Canada), and lowest in Japan, with other countries (including the US, France and Sweden) in intermediate position". They also state that "…firms internationalize their R&D because of the need to improve the way in which existing assets are utilized". It can be further proposed that the type of R&D supporting the new business initiatives will hold higher requirements since it is less resource-consuming to start the new division including all the optimization experience and implemented solutions, "tips and tricks" that already helped alter the existing structures. Otherwise, the corporate management has a chance of facing the situation when it has to go through the same process of optimizing and implementing the Lean Innovation for all the business units separately. Koen (2007) supports the division between R&D for existing and new businesses demonstrated by Tidd and Bessant by claiming that "The SBU product development structure supports ongoing businesses and while efficient, has difficulty creating entirely new businesses with high returns". Retrospectively, in his own research, Koen (2007) refers to the SBU as a part of the company, that may be referred to as a laboratory, responsible for the conduction of the majority of product development.

Apart from the initial structure of R&D in terms of centralized or non-centralized approach selection, that is, in turn, affected by the number of its own variable, the R&D and, thus, the Innovation management is affected by the overall innovation vision that involves 5 forces (as seen by Koen, 2007):

1. **Overall strategic business unit strategy.**
   Defines the mission, value chain and market channels of the strategic business units.
2. **Core competences and capabilities** that depict unique set of skills that provide significant competitive advantage to the company. Koen (2007) refers to the experience of Prahalad and Hamel (1990) that provide an example of Honda having a core competence in development of technologically advanced car engines.
3. **Market trends** an intensive insight in current market trends and forecasting of the upcoming ones.
4. **Competitive forces.** Although the aspects of competition have already been addressed earlier, the actual barriers that may sabotage the company complex innovation vision may arise when a competitor manages to seize the intellectual property that may result in developed technological solutions impossible to be used in new products due patenting.

5. **Financial or economic goals.** Innovation vision must answer the basic struggle of any company – increasing the revenue growth. It is important to evaluate if the innovation vision matches the company financial goals.

Koen (2007) also indicates, that the overall project development process with an incline towards innovation management is being ruled by the following constituencies:

1. **Senior management.** Both responsible for innovation vision, platform and product strategy, as well as portfolio utilization and strategic management.
2. **Actual R&D management.** As stated, the heart of the company cutting-edge technology roadmapping and development.
3. **Process owner.** A universal coordinator managing a separate product development project.
4. **Portfolio manager.** Unlike the senior management, a responsible person for :on-ground" tactical portfolio management, that coordinates the simultaneous conduction of separate product development initiatives.
5. **Product line planning team.** An optional group that is tasked to evaluate a complex of corporate parameters in order to sketch the future product platforms.

As it has been underlined that the corporate R&D has a clear trend in moving towards the internationalization and decentralization of operations, Gassmann and von Zedtwitz (1999) have uncovered the actual trends that directly affect the evolution of international R&D organizations:

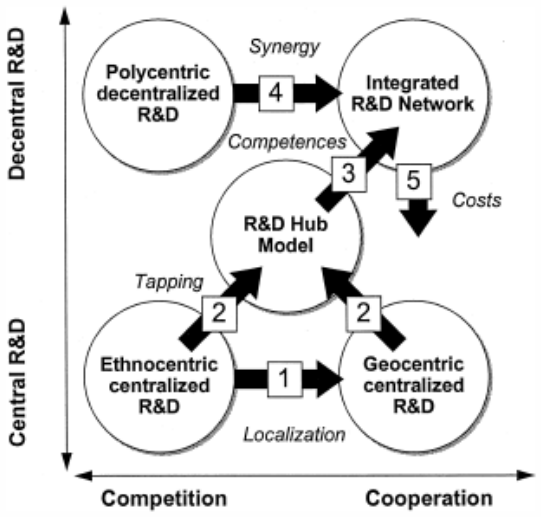

Figure 11. Five major trends drive the evolution of international R&D organizations (from Gassmann and vor Zedtwitz, 1999)

Trend 1. The companies restructure their R&D in favor of internationalization and decentralization to keep up with the adequate level of market sensivity, a parameter that generally indicates how fast and accurate are the changes in company product portfolio, marketing strategy, R&D, etc. that help provide tailor-made approach to the particular market.

Trend 2. As a part of international R&D structure, the companies not always establish technological centers and laboratories. When the rate of progress in another country in selected industry increases, a listening post is established. It may not carry scientific, production or research power, but it allows to gather and process the information in a way that will further allow the company to tap into the know-hows arriving from the concrete region/market/country.

Trend 3. Corporations that have previously offered a strict guidance to their R&D operations now provide them with more freedom in decision-making, operations planning, etc, thus, cultivating creativity.

Trend 4. If a company develops the R&D network by mergers and acquisitions, in order to improve the performance, the centers of excellence are established, that allow to link the autonomous R&D's and reduce the possibility of double projects, cases when, due to lack of information exchange, separate R&D units conduct the research in the same field with the same perspective.

Trend 5. The amount of R&D centers is being reduced, but the level of internationalization is sustained. This allow the companies to issue better control over the R&D with less strict policies, as the sensitivity aspect is taken into account not only for the market reactions but for the internal purposes, further reduce the duplication of operations and reduce the costs.

3. NEW PRODUCT DEVELOPMENT

3.3. Conventional new product development from R&D perspective

While the previous section addresses the overall organizational issues of the innovation management in the perspective of new product development, which, in turn, is a relative direction of R&D, in order to understand the rigid parts of the corporate R&D addressing NPD, it is important to provide the overview of the general corporate NPD. While it can be argued that the logical flow of the theoretical part is being broken, the reader is encouraged to keep in mind

that the creativity and innovation phenomenon cannot be parted, leading to the following substructure of the current sections:

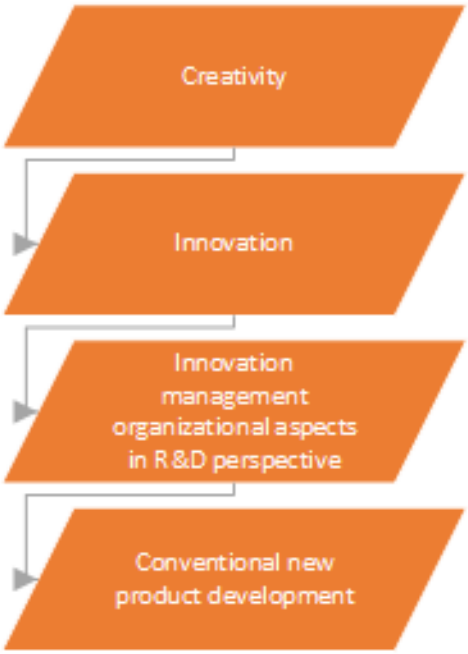

Figure 12. Intermediate logics

Understanding how new product development process works allows to better understand the role of R&D in it, it's importance, as well as the basis for the changes that take place when Lean thinking and innovation management are introduced to it.

First of all, Almeida and Miguel, based on the work of Ulrich, distinct the process of NPD as "the transformation of a market opportunity into a product available for sale, through a set of activities executed in a logical way, sequentially or concurrently". The NPD process is also accompanied by a high level of uncertainty and risks directly related to the success of the new product on the market. At the same time, it has been noted that the R&D process aims to provide the technologies and solutions that make the new product possible. McGrath (2004), when discussing the new formations and evolution of NPD, especially underlines the importance of R&D in the modern NPD. According to his vision, the evolutionary timeline of the NPD is the following:

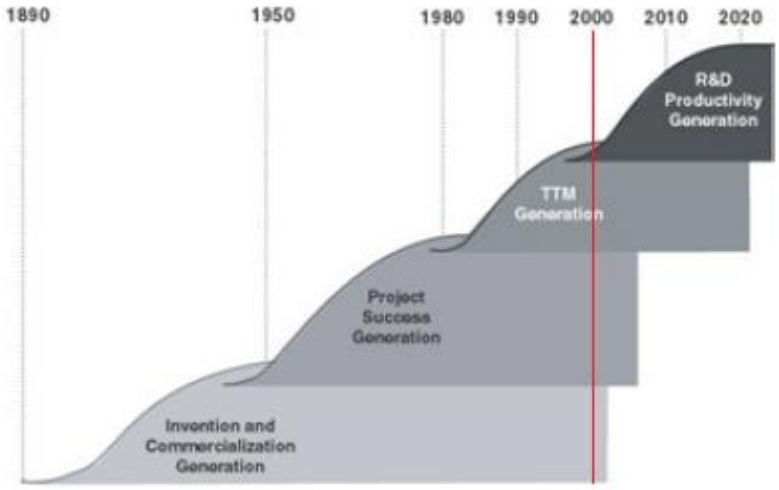

Figure 13. Four generations of product development management (McGrath, 2004)

The author underlines the curve of the modern evolution by saying: "Today's practices are relatively new…they are already being replaced by the practices of the next generation, which I call the R&D Productivity Generation because of it's emphasis on the creative productivity of the entire development enterprise". Based on his words, it can be speculated that he directly addresses the importance of creativity and, thus, innovation management as a basis of R&D.
The evolution of the NPD management practices was strongly stimulated by the increasing rate in market changes and lifecycle reduction in the beginning of 2000's, that was, in turn, provoked by the increasing competitive fight and a boom of corporate internationalization. As a result, the companies has a critical need to create new successful products and do it fast. The modern NPD techniques take deep roots in the TTM approach that originated at the same time. According to the philosophy of TTM NPD the most critical success factor of new product development was time-to-market – a complex variable that displayed the time it took to form the preliminary idea or technology into a ready-for-market product. This variable was strongly based on spent resources but as obvious as it may be, it allowed the company to see the real-life dynamics between the R&D investments and the time it too to release the new product to the market.

Assuming that the R&D Productivity Generation is a relatively young model, it the time of his research, McGrath (2004) claimed to expect a double increase in R&D efficiency compared to pure TTM approach. Continuing, one of the base evaluation factors of the R&D is it's capacity: "The objective of the R&D capacity management is to get more new product output from a relatively fixed level of input, and the benefits of succeeding can be very substantial". According to his expectations, the new generation of R&D-centered NPD will hold the potential of 40% increase in R&D capacity. To put it simple, it may seen that the companies will have the

opportunity to receive the same market-responsive new products in the same timelines but for the 60% of the price. Fain et al. (2011) support the importance of R&D in terms of NPS in their own research, although from the perspective of R&D and marketing integration into the NPD process. In turn, Jugend and da Silva (2014) underline 2 important issues regarding the role of R&D in NPS:

1. The importance of R&D is not constant. It is related to the fact that the product development projects may be of 2 types:

    - Involving technological innovations
    - Where technological innovations are absent

    While the division of products and their types, especially from the perspective of NPD, is complex and often subjective, it can be proposed that the product that does not require the technological innovation is of radically incremental nature, thus requires minimum improvements for market success. On the contrary, the technological innovations are strongly associated with radical and incremental innovations that promote emergence of entire classes and types of new products introduced to the market, or lead to dramatic improvements of the existing products.

2. It is also important that the integration of R&D into NPD requires powerful tools and processes in motion, such as: presence of cross-functional teams, matrix organizations, support and activities of product managers. Still, while the particular idea of viewing the R&D as an integrated part of NPD is logical and expected by evolution of NPD, in its more common form, the R&D does not have a direct connection to the NPD process, except for the borderline between the technological innovation and the idea of the product. It is important to underline the possible lack of complex integration for it does not make the R&D absent from the entire NPD process.

As McGrath (2004) proposes, the R&D capacity increase is a resulting variable of the R&D utilization. Basically, the more successful the new products are on the market taking into account the contribution of R&D, the more utilized the R&D is considered. In order to demonstrate the model of the perspective evaluation, McGrath (2004) refers to the experience of the imaginary company “Commercial Robotics Inc.” (CRI) that aims to improve its R&D utilization rate:

	Current	Improved	
R&D Investment (000)	$100,000	$100,000	
Number of Developers	600	600	
Cost/Developer (000)	$167	$167	
Utilization	60%	80%	+33%
Number of Applied Developers	360	480	+33%
Cost/Applied Developer (000)	$278	$208	−25%

Table 3. Benefits of increased Utilization at CRI (McGrath, 2004)

In dry numbers, based on the calculations above, the CRI can increase the utilization of R&D in 2 ways:

- Increase the number of applied developers at the cost of their expenses. As seen above, it is the strategy the company management chose by recalculating the number of applied developers from 360 to 480 at the cost of the individual expense reduction from 278$ to 208*
- Alternatively, the management could have reduced the number of applied developers, cut their price and reinvest the money. This also could have increased the percent of utilization.

It must be noted that the applied developer is the developer that is currently in use by the R&D as a part of the project. The application rate of developers directly relies on the number of projects currently conducted by the company. Although originally speculated, McGrath's (2004) insights indicate that the increasing number of applied researches has nothing to do with an increase of R&D annual financing. By taking into account a diverse number of factors such as integration of project based into the unified corporate information system, introduction of powerful employee training initiative, resource planning, etc., the company tends to optimize the cost of NPD and technological projects, utilizing the financial contributions more effectively.

3.4. Lean Product Development

Before further referring to Lean a part and the driver of product development, first there is a need to explain the basics of Lean thinking. The word "Lean" in modern operational and business

environment is a catalyst of speculation and optimization stir resulting in extremely diverse and often incorrect understanding of Lean, Lean thinking, Lean management, etc., from bold cost-cutting to optimizing techniques that have nothing to do with Lean. To eliminate the confusion, Radeka and Sutton (2007) in their Lean thinking overview refer to the historical background of the term and its emergence. The "Lean Production" term was first used by John Krafcik, who introduced the results of the MIT International Motor Vehicle Program (IMVP) in a book called "The Machine that Changed the World: The Story of Lean Production". According to the book, "Lean Production" meant a multidirectional reduction of manufacturing waste: space, tooling, raw materials. inventory, etc. It is important to note that the IMVP program was the result of the penetration of american car market by Japanese manufacturers, primarily – Toyota. The issues behind the start of the program was that the Japanese car manufacturers managed to provide the customers a high level of quality with significantly more favorable pricing policy. Clearly, discovering the secrets behind effective and efficient Japanese car manufacturing was the main objective of the IMVP program. As a result, the alternative to mass-production was found in a form of Lean, specific, tailored approach to manufacturing. Radeka and Sutton (2007) continue to highlight the key historical occurrences of the emergence of Lean by stating that in 1996 Jim Womack, a known modern founder and supporter of Lean Thinking, presented the book "Lean Thinking: Banish Waste and Create Wealth in your Corporation". Five key principles of Lean organization were introduced: value, identifying the value stream, flow, pull and perfection.

A core asset of Lean in any form is the "value", an ability to deliver the customer something for the right price in the right time he will be willing to pay for. In its primitive form, value is the evaluation of the product in the eyes of the customer that allows him/her to convince himself/herself in the necessity of purchase. It can be both a unique attribute of a concrete product and a whole market-level attribute that defines the basic possibility of product purchase. For example, when purchasing a car, the customer receives a number of essential parts of it pre-assembled that he/she considers valuable: doors, windshield, steering wheel, motor, wheels, suspension, etc. Each of these parts is valuable for the customer because absence of any of these parts means complications in product usage. In other words, the customer will still have to purchase and install the missing part before starting to use the car or the user experience will be negative (e.g. in theory, it is possible to drive a car without a windshield). Moreover, the tendency indicates increasing value for customer for car equipment originally not directly related to usage: navigation, display, cruise control, seat heating, etc. This example shows that the value in particular industry or even for particular product is a flexible term, subject to influence, that can be controlled, directed and eventually…managed.

The Lean thinking has a fortune of success stories around the globe, verifying the reason behind demand and efficiency: Google, Volvo, Lockheed Martin and Boeing. The list can keep on forever.

In 2011 Marc formulated, that "Applying Lean concepts to the product development process ensures that the pace of knowledge capture and decision making supports the creative process of product development. This enables better decisions to be made throughout the produce development process – leading to reduced costs and lead times while improving quality". It may be speculated that the Lean Product Development is one of the corporate activities that was changed as a result of the 5 Lean principles applied. Needless to say that the company activities require strong alignment, firm strategic vision and considerable flexibility to be able to sustain and improve the advantages of Lean. Mohammadi (2010) further indicates that LPD can be of 2 variations: process-oriented and outcome-oriented. Mohammadi (2010) refers to Liker and Mogan (2006) that view the process-oriented approach as an activity that tends to bridge the LPD and Lean Manufacturing and eventually the one to be observed further. The outcome-oriented approach as seen by Cooper and Edget (2008) in Mohammadi (2010) is an observation of the techniques the companies, dealing with Lean, used to achieve known results. It may be argued that the outcome-oriented approach is, to certain extent, an inversed, retrospective variation of process-based approach. It must be noted that the process-based approach was chosen for further research since it directly complies with Lean philosophy that implies constant improvement, meaning that improvement is a process, rather than one-time project. Karlsson and Ahlstrom (1996) in their research address the hindering factors of LPD that come from the high requirements to readiness of corporate environment:

1. **Difficulties of creating a cross-functional focus in the organization**

Their research shows that the members of the team other than from R&D had the tendency of devoting less time to the activities of the group than to their direct responsibilities. There is also a risk that an important corporate department will not be included in the group due to the blurry vision of the higher management having less understanding of the resulting outcomes and the expected team performance. The departments not only had trouble allocating resources to the team on behalf of itself, but also had complications choosing the right person to "represent" the department in the group. In summary, the issue behind creation of cross-functional group is not just about group assembly, but the course to unity based on understanding of the team goal and role of each participating department.

2. **Simultaneous engineering is an inherent paradox**

Practical observations show that cross-functional groups tend to make technical and organizational mistakes in setting the right focus and the sequence of LPD stages. A struggle to cut the lead times in LPD process stimulates the starting of simultaneous activities dedicated to different stages of LPD. As a result, the team has a higher probability of moving towards the wrong direction, improving one part of the process and dramatically decreasing the performance of the other at the same time.

3. **Difficulties concerning the coordination of the projects**

In practice, the team attempted to conduct coordination through regular meetings. While the number of meetings increased in time, the level of coordination wasn't. Extended size of the team and direct contacts between the team members additionally decreased the effectiveness of meetings.

4. **Managing the project through visions is an intricate manner**

The direction of team activity is a delicate sphere. Before conducting the project, the team is expected to formulate the specifications of stages and activities. To come up with specifications, the team members first share their vision of the project aspects and must reach the compromising or at least objectively valid consensus. In practice, multiple visions of group members lead to the usage of specifications changing "on the go" during the project.

5. **Strains in the relationship with suppliers involved in the development process**

The R&D department demanded that the suppliers must be involved in the development process as soon as the project begins. While the team has no clear vision of the result, the supplier is in even more frail position, actually required to estimate the costs when the project is, again, altered "on the go". This extends the project timeline and attracts the risk of more "dead-ends" in discussion, as well as complications in team internal environment and team-supplier communication.

Continuing the theme, Radeka and Sutton (2007) underline that there is a need for established structure behind LPD. One of the pioneers and leaders of Lean approach, the Toyota Company utilizes the following LPD structure:

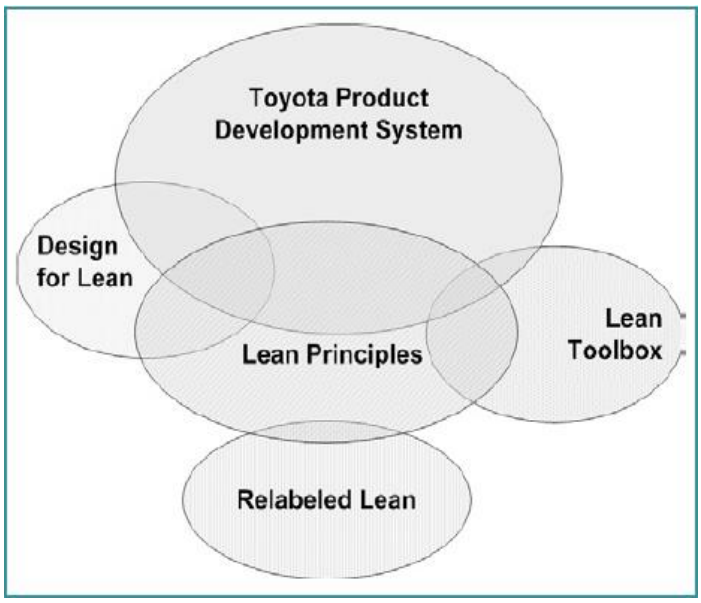

Figure 14. The Landscape of Lean Development (Radeka and Sutton, 2007)

The Lean Principles are utilized directly, by demonstrating a value-centered approach. Additionally, in practice, LPD relies on Lean Toolbox, an assortment of techniques and methods to identify, analyze, sustain and improve the product development processes. One of the essential of Lean Toolbox is the value-stream mapping. Design for Lean is a complex approach to tailor product designs for better Lean approach applied utilization. The authors state: "This approach consists of a set of tools for reducing the downstream costs of the product in manufacturing, service and support". A Relabeled Lean may be seen as the philosophical framework, a constant reminder to the Lean practitioners that Lean obligatory objective is waste elimination and value increase.

The Landscape represented by Toyota for Lean initiatives can be seen as a variation of the more general LeanPPD model researched by Sorli et al (. In their research, the LeanPPD model, while sharing the common Lean principles, uncovers a more "stable" combination of LPD essentials:

Figure 15. LeanPPD model and tools (in Sorli et al., adopted from LeanPPD Project)

Observing the model, there are both commons and differences compared to Toyota approach. The Lean Self-Assessment & Transformation as well as Product Development Value Mapping tools are both a part of the Toyota Lean Toolbox. At the same time, Set based Lean Design Tools has a lot of intersections with Design for Lean. It can be speculated that the Relabeled Lean is a default element of the model, a basis expressed as the separate element of the concept to distinguish the importance of anchoring the initial Lean principles. Finally, Knowledge-Based Engineering Environment is distinguished as a separate important aspect of LPD that requires the LPD project phases, decisions and activities to be conducted only based on actual, objective and proven knowledge. This comparison is to indicate the common background behind the individual, tailor-made Lean Management systems. Further, this assumption will assist in evaluating the Lean Innovation initiatives of a firm.

While the R&D remains one of the central parts of the LPD process, it is also distinguished by separate influences of Lean. Reintertsen and Shaeffer claim that product development was the second actovity to test the effectiveness of Lean in global tendency after Lean Manufacturing, while R&D was the first section of a complex NPD process to get familiar with Lean principles. When comparing Lean Manufacturing and Lean R&D, Reinertsen and Shaeffer (2005) draw special attention to the differences between them:

”Manufacturing is a repetitive, sequential, bounded activity that produces physical objects. In manufacturing, risk-taking is not a major mechanism for adding value. A manufacturing process can do exactly the same thing a million times and still add value every time.

R&D, in contrast, is non-repetitive, non-sequential, unbounded activity that produces information. Rational risk-taking is central to adding value in research and development. Unlike manufacturing, an R&D process adds no value when it does exactly the same thing twice.”

These differences transform into a very different understanding to how the Lean principles should be applied to R&D:

1. Non-repetitive processes are highly variable due to their unstandardized nature. At the same time Lean aims to decrease the variability. The issue is that variability in R&D is the source of value. Eventually, applying Lean will require a deeper understanding of "good" and "bad" processes to carefully evaluate and remove unnecessary processes that promote variability but do not add value.

2. Manufacturing works with physical object that can only be in one place at a time. R&D works with information that can be simultaneously used it many places. This allows to establish an incomparable process or collection and processing of feedback that poses a role of one of key drivers of Lean change.

3. In addition to variability, the fundamental understanding of "good" and "bad" for R&D is also blurry. Not necessarily regarding the value generation, but even in terms of evaluation of improvements.

4. R&D is based on uncertainty and risk. Developing and releasing a new technology can become the beacon or the curse for the company. However, without taking it, competitive advancement through R&D, Innovation, Creativity and LPD is highly unprobable.

Reintertsen and Shaeffer underline that, as a counterfeit to the difficulties of applying Lean to R&D, there is a vision of systematical measures that would allow leveling the implementation risks. For clarity, the measures are viewed in the perspective of Lean manufacturing – Lean R&D comparison, to underline the differences in approach:

1. Reduction of batch sizes.

For manufacturing batch is the volume of production. For R&D – batch equals volume of information. The results of any research project, especially when advancing in an unknown field, the reception of new data it's quality are equally important. Smaller information batches allow to receive faster feedback in development. Eventually, faster feedback reduces the risk of time and money loss for non-rewarding research steps and actions, not to mention entire projects.

2. **R&D processes must be variable**

While excessive variability is harmful for most processes, the R&D activities are initially diverse, which makes the limited, controlled variability a necessary asset of R&D operations. In terms of variability control, the most critical resource is capacity that safeguards the process from the harmful influence of excess variability. Moreover, the higher the utilization indicator of project, the more capacity is required to prevent unnecessary variability. Capacity shortage might result is a large chunk of project "flying" because the critical line of the process could not include the probability of accident. The understanding of such situations emerging leads to the development of various methods of control that can either improve the variability analysis of R&D, or simply contribute additional resources in critical project when the variability starts to threaten the flow of it. Finally, Reinstertsen and Shaeffer point out that R&D promotes narrow specialization. It means that cross-functional activities are complicated by bottlenecks which, in turn, are created by narrow specialists encountering difficulties in cooperating between each other.

3. **Controlling the flow vs. perfect planning**

The Lean manufacturing operates a term of "flow", a generalized interpretation of the project/process progress. Any project dictates that the flow is not obstructed by any negative encounters or setbacks. It may be stated that the flow of the project is ensured by 2 activities: planning and dynamic interference. Planning is used to predict the results of actions. It is critical to note, that the analysis of R&D is highly ineffective or even dangerous. Dynamic interference is about applying the adjustments on the go, during the flow of the project. In R&D activities, it is often so that only the nearest steps can be evaluated, so balancing the resources between the activities is another good way to prevent the drawbacks in projects.

4. **Adequate failure rates**

Real-time control, timely feedback and careful analysis of variability result in the opportunity to control the failure rates. In turn, failure rates may indirectly underline the problems with capacity and utilization. Lean manufacturing is about reducing the failure rates to 0. It can be mentioned that another powerful optimization approach based on statistics known as "Six sigma", it it's higher form of implementation allows to reach a failure rate lower than 1 failure per 1.000.000 manufacturing operations. On the contrary, there is no R&D without failures as well as variability. The task of the implementation team to

5. **Pull vs. push**

Lean manufacturing is about the "push" approach. The market capacity is evaluated, the factors fit into formulas leading to demand planning. Demand dictates production plans. Production plans point towards resource allocation, etc. Again, when the process is known ad controlled, "push" works out just fine. But not with R&D that should rely on "pull" approach. It means modifying goals to evade the unreachable and to act according to the current situation. Generally, "pulling" is acting demand-based rather than prediction-based.

6. **The right approach to waste**

Finally and most importantly, the R&D has a different approach to waste. E.g. the Lean manufacturing operates the cycle times in days and weeks, while R&D does so in months and years. At the same time, the figure below shows that expenses are incomparable:

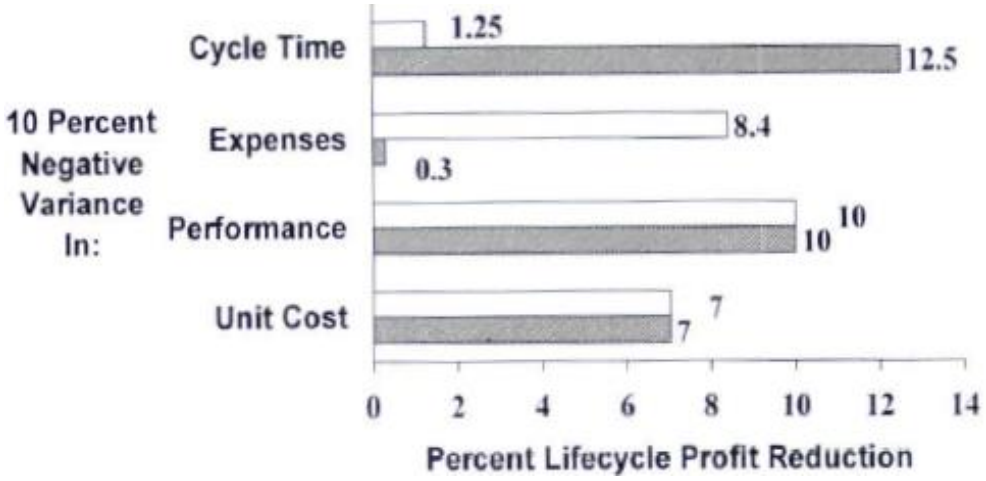

Figure 16. R&D vs. Manufacturing Leverage Points (in Reinstertsen and Shaeffer, 2005)

This figure shows that the waste in cycle times in R&D can be dramatically more impactful than in manufacturing. Generally, this means that the main sources and measures of approach are different for R&D and manufacturing. This also leads to an alternative understanding of optimal process. Before Lean, the performance was mostly measured with efficiency, the high utilization levels of specialized equipment, large production batches and specialized workers. This Lean to high level of inventory waste. Choosing the same approach in R&D would lead to the high levels of utilization, which, combined with high level of variability, would result in service delays. Concentrating on one particular parameter is just not an option for R&D, to succeed in thoughtful Lean implementation each team should identify the individual set of critical parameters that would balance efficiency and waste generation.

4. LEAN INNOVATION

There is no known way to trace the exact moment of first emergence of Lean Innovation. 2 factors took effect to ensure that: 1. Lean is complex and integral, but evolutionary. There are still arguments about the valid classification of some early hybrid TQM-Lean systems being actually Lean or not. Besides, many companies, while tailoring Leab to their own needs, changed the name of the applied concept or even changed the priority or a "set" of fundamental Lean principles. This tendency aggravates the case further. However, even if the setpoint was chosen (e.g. the release of IMVP first public paper), the second aspect takes effect. 2. Trace of Innovation and creativity. The issue is that certain corporate activities that meant innovation were in place even before Innovation was even called Innovation. It may be accurately speculated that internal R&D-related activities for solution-finding and emergence of new ideas for breakthrough products, at various times, had different approaches to structure, evaluation of results and management, but were always powered for generating innovations. Additionally, the diverse corporate experience leaves no chance of covering the whole layer of Lean and Innovation applications if the scale of at least on industry.

When Terence Bernhart started to work on the implementation of Lean in R&D division of Pfizer, when evaluating the results he noted that "Innovation is supported, not merely within the project, but also within the wider organization, as researchers begin to innovate on their own against the how's and why's of business problems." At the same time, he noted that "After initial success and cultural endorsement, nearly all Agile R&D projects are initiated by request through positive word of mouth". Before actually referring to Lean Innovation, these two statements allow to speculate that Lean, when taking specific conditions, has a high potential of not just not-interfering with, but supporting the innovations within the company. The experience of Pfizer should be seen as an additional, signal line of skeptical vision, when digging deep into the topic.

4.3. The concept, uncertainty and difficulties behind Lean Innovation

We have reviewed the separate entities of Innovation and Lean. Within given research limitations, Innovations are generated by internal R&D as an answer to business bottlenecks, issues and the core of new product development, the most innovation-demanding part of the company. Nobel and Birkinshaw (1998), after conducting a massive research on the connection between Innovations and internal corporate R&D, resumed, that Lean eliminates waste, reduces

variability and demands real-time process control and resource redistribution. When combined, they from a unique new approach to various corporate activities – the Lean Innovation.

In 2011, Sehested and Sonnenberg provided their vision of Lean, Innovation and Lean Innovation: "Working with lean means working systematically to eliminate all non-value-adding processes in order to achieve your goals with least possible effort…Innovation is about creating value by solving problem. Furthermore, they see innovation mot just as the complex process of finding the solution to the issue, that starts with ideation, but the step that follows creativity, demanding fast utilization of available knowledge. What is noticeable, it is commented that "In this book, we use the term innovation broadly to include research, R&D, product and service development and other types of development work in both the private and public sectors". Finally, Sehested and Sonnenberg underline that "Lean Innovation is about working efficiently with knowledge…Cut to the bone, Lean Innovation helps a company do three fundamental things. First to 'do the right thing', then to 'do it right' and finally to 'do it better' all the time." Considering previous findings on issues regarding Lean implementation to R&D, it may be proposed that Lean Innovation includes dealing with excessive variability and identifying the critical processes, that help to keep the innovation process controlled and managed.
Radeka (2012) also claims that "The ability to innovate is only worth something if those innovations generate value." leading towards the understanding that Lean is actually a necessary and even integral part of innovations generated within the company. Browning and Sanders generally agree, but challenge the concept by stating that "environments, characterized by a need for innovation, is it even possible to be "Lean"? The answer is yes, but the path towards this goal is more challenging in a context of novelty and complexity." Srinivasan (2010), after tapping into the experience of combining Lean and Innovation at Rockwell-Collins resumes that "By taking an enterprise perspective, we see that lean transformation and innovation are complementary strategies that when implemented right are mutually reinforcing." Unwinding the various directions of thought regarding the Lean Innovation makes it possible to underline 2 generalized statements:

1. Lean Innovation is a beneficial, compatible approach to managing some of key corporate competitive resources
2. Lean Innovation indeed carries the obstacles in implementation. However, there difficulties may be projected by individual corporate mode of business.

Speaking of implementation difficulties, Browning and Sanders provide their vision of formulated roughness:

1. In order to achieve value in innovation, it may be necessary to add the process rather than remove it. While Lean is bound to identify the processes that do not add value and must be eliminated, understanding what process, while non-existent, might improve the value creation, may be a challenging goal.

2. While Lean aims to see the process as a contingency of individual activities, the objective understanding on real value and waste generation of the process should base on understanding of the collaborative effect of process activities.

3. While Lean Innovation sounds grand, it must be remembered at all times that Lean itself is not easy task. Flaws in preparing the corporation to implementation may result either in failure of Lean implementation, or Lean performing poorly, even generating more waste due to incompetent operation.

4. While managing company business is a complex task, Browning and Sanders remind that novelty and complexity may be better managed separately, one after another.

A concept, also presented by Browning and Sanders, addresses the issue of internal balance between Lean and Innovation. While Innovation is represented by novelty and creativity, Lean is for complexity. The resulting picture may state that novelty is reduced for the sake of low complexity. Browning and Sanders call this phenomenon “Traditional Lean Thrives”.

Chen and Taylor (2009) also speak of difficulties expecting inexperienced and careless Lean Innovation project managers. According to their construct, the contradictions were viewed from several perspectives:

Reduction of slack: The lean concepts promote the reduction of any slack, or underutilized design resources, within the environment to eliminate waste.	Extra time and design resources are needed to facilitate innovation [32].
Reduction of risk: The lean concepts promote the reduction of any risks or potential failures that can result in necessary corrections [9].	Identifying any forms of risk as a negative can prevent innovation from being achieved [29, 31].
Reduction of variability: The lean concepts promote the reduction of variability to achieve product quality at relatively low costs [5, 6, 30] .	Variability is necessary to account for uncertainty in the system. Uncertainty is a major source of creativity. Preserving variability fosters innovation [3, 29, 33].

Table 4. Lean culture vs. Innovation culture (from Chen and Taylor, 2009)

Standardization: Use standard process, standard materials, and standard parts in designing new products. Match new designs with existing components and manufacturing methods [12, 13]. *Design for manufacturability (DFM):* Simplify the product design, minimize the parts count, and standardize parts and processes. Designs need to be compatible with existing manufacturing procedures and processes [13].	*Radical innovation:* Requires different approaches from the existing ones [15, 33]. Causes increased uncertainty in the work setting; design may not depend on existing technologies [29] *Revolutionary innovation:* Requires dramatically different design, new machinery, and new skills to render existing technologies obsolete [19]. *Architectural innovation:* Requires changes to the interactions and linkages between the core concepts and components. Using existing architectural knowledge may hinder this form of innovation [22].
Value Analysis: Current customers' requirements are exclusively followed to assess value in product design [8, 13]. Non-value adding activities are eliminated.	*Radical innovation:* May be initially worse in some areas than the existing technology (when a new s-curve starts) [32]. *Disruptive innovation:* Blindly following the requirement of existing customers will lead a company to stumble over disruptive innovations [23].

Table 5. Lean design vs. Innovation capability (from Chen and Taylor, 2009)

Lean supply chain management: minimizes buffers in the system and limit number of vendors to eliminate waste [35].	*Radical innovation:* Flexibility is required in the supply chain to respond quickly to unknown-unknown occurrences and/or necessary corrections [29]. *Revolutionary innovation:* Same as radical innovation.

Table 6. Lean supply chain management vs. Innovation capability (from Chen and Taylor, 2009)

The lean job setting leads to increased stress, reduced job autonomy and skill utilization [36], and less informal communications. The multi-functionality and high productivity requirements on employees leads to the loss of specialized expertise [11, 12].	Expertise and motivation are two key contributors to an individual's creativity [4] . Too much stress will decrease employees' motivation. Low level of job autonomy leads to low level of motivation [24]. Informal communication may inspire creative thinking [31].

Table 7. Lean human resource management vs. Employee creativity (from Chen and Taylor, 2009)

It is clear that Chen and Taylor (2009) took the approach of evaluating complex Lean vs. Innovation phenomenon. At the same time, scaling the statements they provided it may be argued that they apply to all parts of corporate operations equally due to their diverse influence.

To conclude the diverse understanding of risks that accompany Lean Innovation implementation, Kovac (2013) argues that "Characterized by early optimization and uncertainty reduction, lean management represents a typical technical process [3]. Being rigid standardized, and constrained to productivity, it places goals and guidelines, leaving less room for creative thinking and innovation."

4.4. The importance of value

In order to deliver a framework of understanding unique Lean Innovation case in clear manner, it critical not just to understand the drawbacks of the process, but to apply the structure or at least a manner of classification that will serve as an anchor to further statements and conclusions. Despite the variation in industry, scale, business model and the country of origin, while it is clear

that each company faces unique challenges when dealing with Lean Innovation, it is especially important to note 2 essential aspects: 1. Approach to value. 2. Approach to waste. A somewhat conclusion of the previous chapter allows to speculate that a major part of contradictions between Lean and Innovation are based exactly on the "attitude" to value and waste. Furthermore, some speculations propose that Lean treats Innovation as a process and operates the boundaries of understanding value and especially waste, making Innovations fall behind.

Summarizing the positive reply of researchers who discovered beneficial combination of Lean and Innovation, one of more constructive approaches tends to see Lean as the methodology that manages processes including Innovation generation and management, meaning that the understanding of toolbox to eliminating waste is central. At the same time, Innovation generates value, but that doesn't contradict with Lean proposing individual approach to various types of business processes. Clearly, the boundaries of effectiveness and efficiency may dramatically vary.

Schuh et al. (2008) state: "The early structuring of value, product and process is a key factor for development projects. The customer value represents the fundamental element in Lean Thinking. In R&D, the effective match of customer needs and product functionalities is one of the most important challenges." Based on their considerable research, they further identify the cases of overengineered products that provide the customer considerably more functionality than actually needed. This is one scenario of incorrect identification of customer values. Doing so results in raising a substantial barrier for successful R&D. It was already noticed that R&D has generally longer project times. However, following the reasonable deadlines, thus, eliminating time waste is one of the issues on inappropriate R&D operation. Further breakdown of the importance of focusing on value creation in Lean Innovation reveals the following: "The Value System structures requirements transparent and tailored to suit the specific needs in form of a target hierarchy. Product benefits and targets are prioritized and visible for every stakeholder at any time."

The following figure shows the "funnel" of value, a systematic approach that aims to identify the needs of the customer. This process allows to potentially boost the performance of R&D. thus, improving the level of Innovations and innovation management within the company. The main setbacks are overengineering and under engineering. If overengineering means providing the customer with too much unnecessary functionality, the under engineering means the opposite – demonstrating the product that will not satisfy the customer due to limited abilities and performance. It may be underlined that the proposed approach is a specified scenario of using one of the key principles of Lean – Value stream mapping.

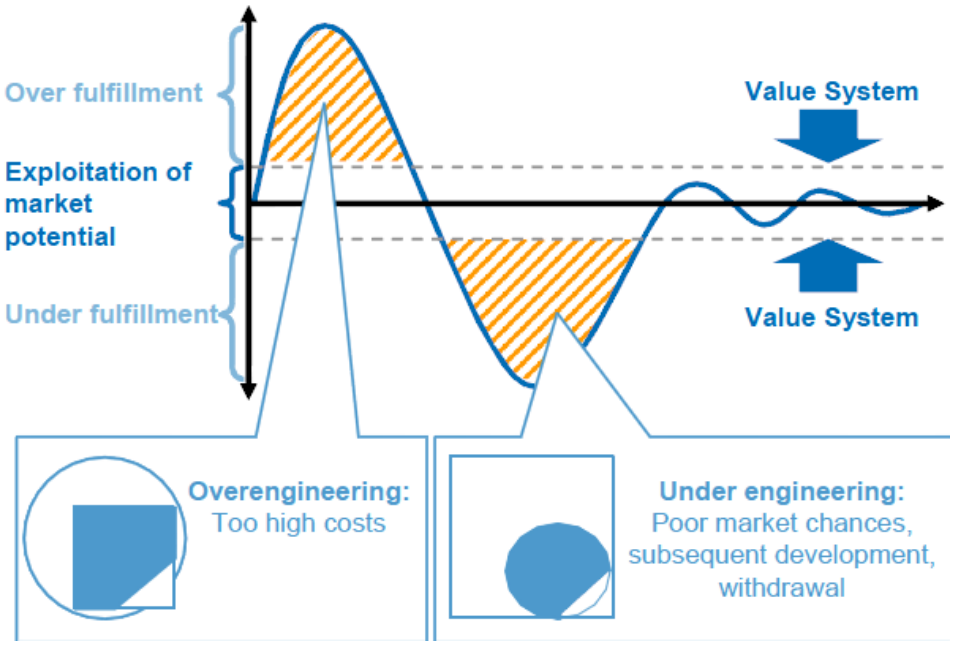

Figure 17. Focus on value by transparency through a Target Hierarchy (from Schuh et al., 2008)

The Target Hierarchy is one of the tools of value stream mapping that helps set up the targets of project while it goes in the style of a balanced scorecard. It's goal it to identify the interests and objectives of internal customers before the beginning of every project. By doing so, it is possible to weight the targets, prioritize them and, what is especially valuable, safeguard the project from the risks of faulty decision-making while identifying the interests of the external customers. In summary, the communication between the customer and the company starts long before the actual collaboration.

Professor Kovac (2013), in his work called "The integration of Lean management and innovation" does not provide a similar deep insight into value identification, but formulates the 4 Lean principles in the perspective of value:

1. Specify value from the standpoint of the end customer by product family.

2. Identify all the steps in the value stream for each product family, eliminating whenever possible those steps that do not create value. Make the value-creating steps occur in tight sequence so the product will flow smoothly toward the customer.

3. As flow is introduced, let customers pull value from the next upstream activity.

4. As value is specified, value streams are identified, wasted steps are removed, and flow and pull are introduced, repeat this process again and continue it until a state of perfection is reached in which perfect value is created with no waste.

Noticeably, Kovac (2013) refers to the term "value pull". It involves participation of the customer in the process of NPD. It may be speculated that it is also possible to identify the concepts that would allow the customer to take part in the project during the R&D stage. It has been previously mentioned that in order to achieve beneficial results when applying Lean to R&D, it is important to receive fast feedback on the progress. It may be argued that it involves 2 factors at work: 1. The "size" of project stages to increase the feedback stage. 2. The feedback mechanism that may involve corporate management, multiple scientific testing and verifications, own evaluation by project team or involvement of customers.

Radeka (2012) supports the framework of value identification in NPS by also presenting the guidelines to finding the value-creating activities:

• The activities that build knowledge about our customers: their needs, their behaviors, and their environments.

• The activities that build knowledge about our product technology: fundamental science, design alternatives, supplier and manufacturing capabilities.

• The activities that integrate customer and technical knowledge into products that we can produce and our customers want to buy.

Following the idea of value stream mapping in NPD and innovating process, Radeka (2012) proposes the decomposition of the value stream of the NPS process into 4 sub-processes that depict the differences in value for the participants of the project:

Figure 18. The four value streams of product development (from Radeka, 2012)

4.5. The structure of waste

Waste is the grudge of all business abs processes. Waste slows the progress, violates efficiency, breaks the deadlines and makes the company miss the competitive advantage. When referring to Lean Innovation, waste is especially harmful due to the importance of NPD and especially the R&D within it. While Innovation generates value for the customer, Lean identifies waste. Simply selecting and removing the wasteful sub-processes and routines is not an answer because Innovation demands variability and, as a result, the paradox may arise: sustaining certain amount of generated waste to improve the overall efficiency of operations.

When reviewing Innovations separately, waste my only be identified by the specific effort of the project team or regular means of managing and restraining the business processes of the company. Lean, on the contrary, sets waste elimination as one of the major goals and while it is critical to involve all parts of the company of the process, R&D requires exclusive approach. It must be noted, however, that in certain context the waste generation not be directly related to R&D but rather to borderlines between the responsibilities of various divisions. For instance, R&D provides solutions but the project portfolio manager identifies the opportunities to group the products. This initiative, further discussed in conjunction with the company engineers often results in the emergence of modular platforms, common parts and other means to make the NPD agile and less expensive. For instance, a process that requires formatting the assembled data on the side of R&D for further transition to product department for evaluation and project

supervision, may be flawed with less than required attention to the connection between the departments and additional time required from the product department to understand all the nuances of the upcoming innovation, including needless communications with the R&D. At a glance, the generated waste in not critical and does not add much to the general project time, but the issue here is not about the size of the waste but about the responsibility of the departments: the flawed process doesn't affect the work of R&D and until the departments are evaluated at the same time, the team discussing waste elimination of product department will also have no understanding of where this waste came from.

Radeka (2012) simply states that activities that do not match the limitations in the previous chapter, are considered waste. In short:

1. Activities that do not provide or support the process of gathering new information about the customers in most general understanding.

2. Activities that do not match the initial purpose of R&D: building knowledge on any set challenges.

3. Activities that do not promote communication between the company and customers to provide valuable products and evade over- and under engineering.

The effort of professor Kovac (2013) resulted in the figure demonstrating the key wastes in Lean Product Innovation, not necessarily applied to R&D and NPD processes, but rather of general importance:

Figure 19. The Waste in Lean Product Innovation (from Kovac, 2013)

It has been previously underlined that while the result of manufacturing is the product, the result of R&D is information. Considering the fact that information is gathered and processed by personnel directly or with the help of the enterprise information systems, the waste is referred to 2 main active forces of R&D:

1. People (administrative operations, delays in activities)
2. Information (carrying mistakes, cycles of correction, excessive information, miscommunication, etc.)

Browning and Sanders, when researching the experience of Lean Innovation in Lockheed Martin working on the F-22 project, revealed that the complexity of business process interrelations leads to the situation, when "The large number of interrelationships in a complex process leads to the possibility of a seemingly small change in one area leveraging a much larger, emergent change in the whole". This allows concluding that the nature of waste is double-layered: the first layer is referred to the structure of the process and the variables that affect it (e.g. people and negative effects on interconnections with other processes), the second layer addresses the outcome of the process (e.g. generated information).

What is even more important, working with the first layer increases the strength of influence of a "healthy" process on the faulty ones. In practice, this means that the capabilities for improvement obey the principle of getting more for less, when a smaller contribution to waste reduction has a greater positive effect if represented in comparable variables.

Schittny and Lenders (2010) add to the importance of a weighted, tactical approach to waste by highlighting not just a tool, but a systematic approach to waste management in terms or Lean known as "Muda Walk: Short and focused tour of the workplace, to experience / show where potential for improvement or waste in process and structure exist when examined right. This includes a skilled approach with corresponding questions that avoids finger-pointing or scolding." This allows speculating that identifying waste is not a target or a stage of the process, but rather an independent continuous activity, conducted regularly and with adjustable evaluation frames. Schittny and Lenders also mention that the end task of Lean Innovation is a generation of positive information (research results) without waste. This verifies that struggle to waste elimination is being waged on both layers.

Despite the solid statement identifying the information as a result of R&D, Radeka (2012), when referring to the Lean Innovation experience of world-known brands, argues that the results of NPD in general, depending on the industry of performance, dramatically vary:

- **Facebook** generates products in form of improvements to user internet connection content, providing easier and more convenient access to social networking, including user-to-user communication, media content pictures, videos) and infrastructural aspects (interconnection with other social networks)
- **Amazon** literally has one giant product for constant improvement and development – the unique platform for e-commerce. For instance, introduction of "one-click" approach to ordering, allowed to eliminate waste in online shopper value stream.
- **Starbucks** operates in food and beverages industry, mostly concentrating on coffee. One of the core waste elimination directions is the improvement of methods of delivery of end-products, that uncovers additional value for the customer (e.g. the introduction of a high-grade instant coffee)

This allows to speculate that even the R&D orientation influences the results and approach to waste. Thus, flexibility and adaptiveness of the applied techniques must be in place to ensure the effectiveness of waste elimination.

4.6. Lean Innovation prerequisites and post-implementation setbacks

Based on known Lean Innovation implementation experience of available MNE's, the implementation sequence is relatively constant: Lean follows Innovations. This phenomenon is explained by the priority of the implementation steps: if an MNE is oriented on generating innovations via internal R&D, it is most likely that the division will be integrated into the corporate structure before the development of the systematic value promotion and waste reduction approach. While Lean is suitable for managing a starting project/process, in scale of a whole R&D, it is first required to develop a framework. For this, the R&D must be present. Radeka (2012) uses the term Lean Product Development as a variation of Lean Innovation for product development. The insight into provided case studies of companies that have implemented the methodology allows to state that each participant had a well-developed R&D structure before Lean was introduced to it. Notable is the fact that Lean may have already been scaled to, for example, manufacturing and the company comes to the logical conclusion of scaling the positive effect to other sides of operation.

Sehested and Sonnenberg (2011), referring to the research that was conducted in 2008 by Boston Consulting Group, used the responses from the top-management of world companies to formulate the main obstacles of generating value through innovation investments:

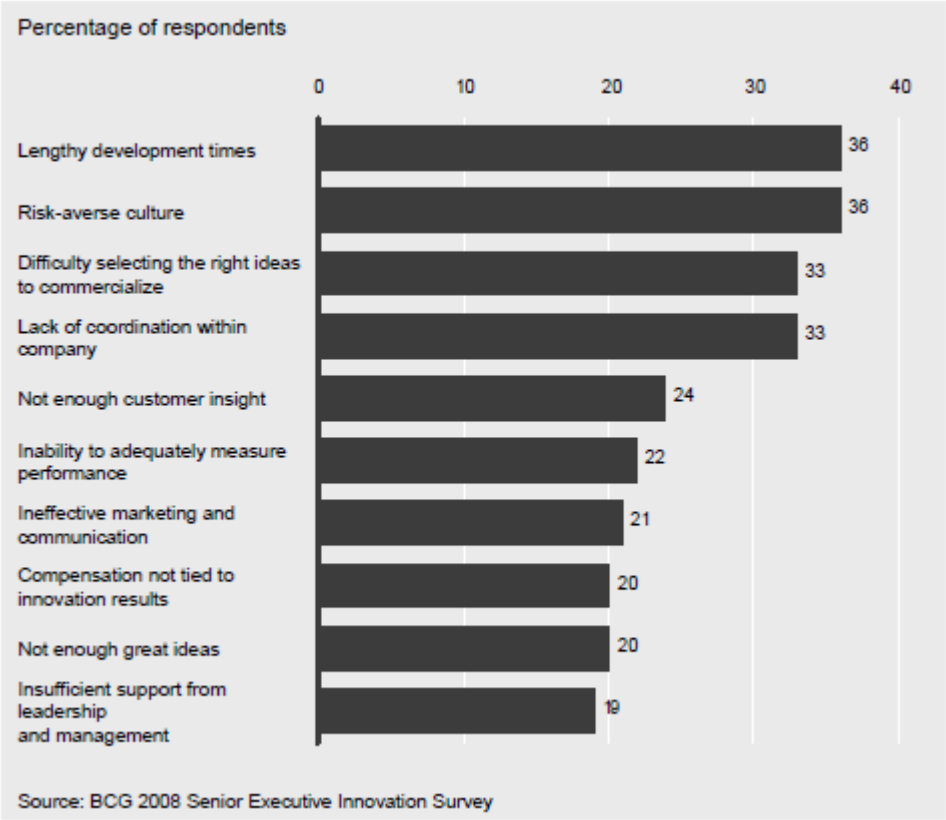

Figure 20. The Biggest Obstacles to Creating Value from Investments in Innovation, According to Global Senior Executives (from Sehested and Sonnenberg, 2011)

Eventually, the companies often encounter a situation when innovating alone is not enough to innovate efficiently. Sehested and Sonnenberg refer to 2 major challenges the companies face when addressing the issues related to low value generation of R&D:

- Difficulty knowing what has the highest effect
- Difficulty making and maintaining improvements

Importantly, increasing the NPD speed and innovation does not mean the company has implemented Lean Innovation. Having no complex understanding of workload and processes interconnection results in team overload and, as a result, dramatic increase in generated waste called “the vicious circle” of waste:

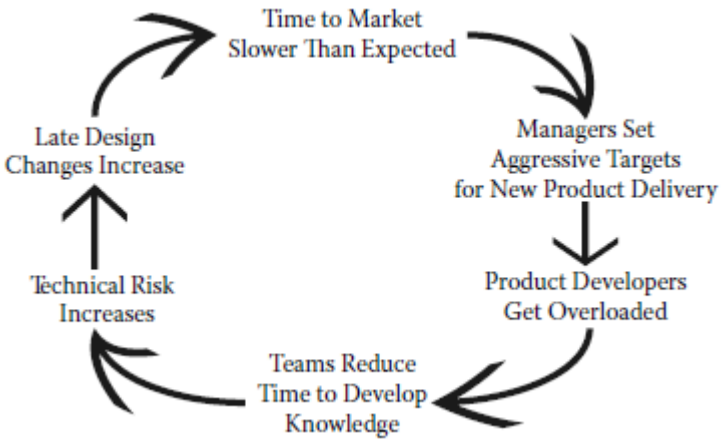

Figure 21. The vicious cycle of waste in product development (Radeka, 2012)

It is not essential which part of the circle is the beginning. What must be considered is that the waste will keep increasing until the processes have been reharmonized. Otherwise, the teams responsible for various processes and steps will eventually seek shortcuts to relieve the workload which will decrease the output and efficiency of the processes.

Therefore, the first prerequisite of Lean Innovation implementation is the systematic problem-solving system. Radeka (2012) distinct 2 of them:

1. The "classic" scientific-based approach, demonstrating the following contingency: hypothesis -> experiment design -> experiment conduction -> hypothesis adjustment

2. Plan-Do-Check-Act (PDCA). This approach has its own impressive history. Edward Deming was popularizing it in Japan in the 50's and then in USA in 80's of the 20th century. Later, Jim Womack "included" it into Lean thinking. In early 2000 Dr. Allen Ward demonstrated an evolution of the approach called LAMDA: Look-Ask-Model-Discuss-Act). It is noted that LAMDA is one of the most popular choices of companies practicing systematic problem-solving for Lean Innovation.

The second aspect to be noted proposed cultural. The researchers distinct the situation when the company is unsuccessful in Lean Innovation for the reason that the personnel is unaware of its importance. Sehested and Sonnenberg quote: "Many well-meaning, but top-down implemented, streamlining initiatives have failed because the people who were responsible for the changes did not understand the essence of the innovation work." Neubaur and Lenderz (2010) support:

“Another main success factor is the right awareness of the development team about their contribution to the company success.”

The third and the final one is understanding the changing nature of innovation. Previous chapter explains that creativity is unstable and projects greatly vary in performance, targets and goals. Being motivated to understand the flexibility of innovation boundaries is essential.

Additionally, it may be stated that the enterprise must be in the position of readiness from the perspective of available systems and tools. For example, before switching to Lean, the companies were using a TQM (Total Quality Management) approach for evaluating the quality of the processes and overall company activities. Previously mentioned, the TQM is a relatively blunt approach speculating the parameter of efficiency as a primary for evaluation. Although the benefits of Lean may be visible, it is important to note that the tools TQM offers must be already considered non-scalable or even outdated before the implementation project. Considering this is important since it will further affect 2 important aspects of the project:

1. The risk of the delayed project. It means the company may realize the project only partially, resulting in a “hybrid” or “transitional” state when it actually attempt to combine the new and old approach. This may sabotage the positive outcomes of the project and promote organizational confusion.

2. Being not fully ready for reasoned expenses in time, finances and effort, it is probable that the company attempts to shortcut the project, with the goal of reducing the expenses. Again, a matter of confusion may arise when the company management makes wrong decisions by replacing the tools to be newly implemented by the ineffective, but already present. The outcome is similar: a company will receive a poorly-structured system, with faulty evaluation approach and obstructed communication between corporate divisions.

Browning and Sanders (2012) mention that the implementation of Lean over innovation requires taking into account the phenomenon of complexity and novelty. Novelty can be referred to the uncertainty, an aspect previously mentioned to explain the variability required for waste reduction depending on the project. Novelty can also be viewed as a lack of familiarity with the process. Any fresh project will introduce new challenged in process interconnections and novelty anew. Complexity is somewhat familiar to novelty: “…a characteristic of an entity that contains

a large number of varied parts that interact in varied ways. Complexity increases uncertainty and instability by making it less clear how one activity might affect other activities". The researchers express the importance of taking into account novelty and complexity by stating that high levels of it may hamper the implementation of Lean. Considering the beginning of the chapter, this will dramatically obstruct the implementation of Lean Innovation. The developed figure states the following:

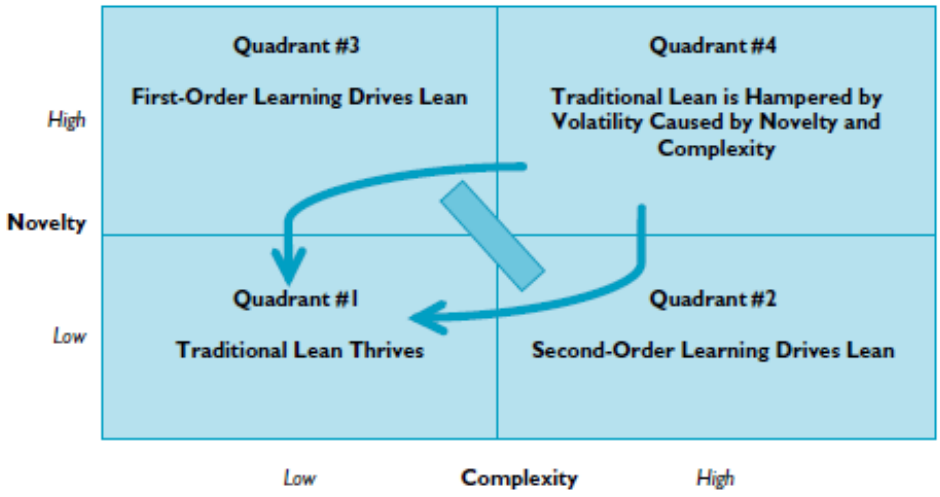

Figure 22. Repositioning Your Organization for Lean (from Browning and Sanders, 2012)

The idea behind the figure is that complexity and novelty must be overcome by learning. This coincides with the importance of knowledge management in the company. Observed is the dependency of levels of novelty and complexity ranging from low to high, as the learning helps to overcome the mentioned setbacks. Learning as a complex feature of the corporate internal value may be divided into first- and second-order learning. **The first-order learning** is mostly shaped by the learning curves that affect cost reduction depending on the volumes. In short, the larger is the period or repetitive activities, the faster is the learning curve. In practice, first-order learning reduces the novelty by revealing the knowledge on processes previously unknown. PTC whitepaper supports the logics by stating: "Solving problems at their root enables you to add to your stock of knowledge. This reduces the number of problems to address, and allows you to use knowledge from past learning in future work, to improve products and processes." **The second-order learning** may be considered as an inevitable addition to the first-order learning. It is the cause of the downtimes occurring when personnel is "switching weapons". Getting familiar with new tools and techniques to use takes times. At the same time first-order learning remains idle due to low volumes and slow knowledge accumulation. Eventually, R&D environment can take form of any of the displayed quadrants from company to company. The

ultimate goal of the company is to reach the condition displayed in quadrant 1. Important is the fact that low novelty and complexity do not equal to low creativity and innovative potential. The summary behind the issue cannot be referred to the aspects of concern before the implementation but rather calls for readiness for novelty increase while Lean is being implemented.

Chen and Taylor (2009) based on findings of Lewis claim that the hypothesis stating the outcome of Lean implementation being an obstacle to innovations, is verified. It has been previously stated that this proposition is one of the cores of the thesis. However, from the perspective of implementation difficulties, it is explained not from the massive process standardization, but rather the orientation towards the incremental innovations instead of radical. The simple fact behind this tendency is the high level of uncertainty and risks related to launch of radical ideas to market. This concluded the additional layer of decision-making in Len Innovation implementation that defines the success of the process. Simply put, if a company sees radical innovations as a good way to reach dramatic competitive achievement, the influence of Lean must be carefully balanced. Focus on incremental innovations will pose a much greater effect with fewer contradictions present.

Chen and Taylor (2009), while discussing the product development in general, still underline the high importance of qualified personnel and especially the project leaders. The trick behind powerful team guides is a stronger negotiation position that allows them to sustain positive communication between project participants, motivate the team, safeguard project deadlines, direct project goals and targets. It may speculated that a project rich in potential, with a very high-graded approach to preparations, while being, in fact, a series of continuous processes, has a high risk of failure is not guided properly. The guidance is a set of control functions to sustain the level of performance and project/team leader is the person bound to demonstrate the required qualities, competences, etc.

After the risks and setbacks have been taken into account, the enterprise is further loaded with a number of requirements that decide the future performance of Lean Innovation. The complexity of corporate structure poses a higher risk of additional side-projects bringing corrections to the implementations (with probability of inadequate implementation and the emergence of the situation when the company comes up with a “hybrid” system, rather than full-scale implementation). Still, the principles are rigid and must be changed only with strict accordance with business specifics.

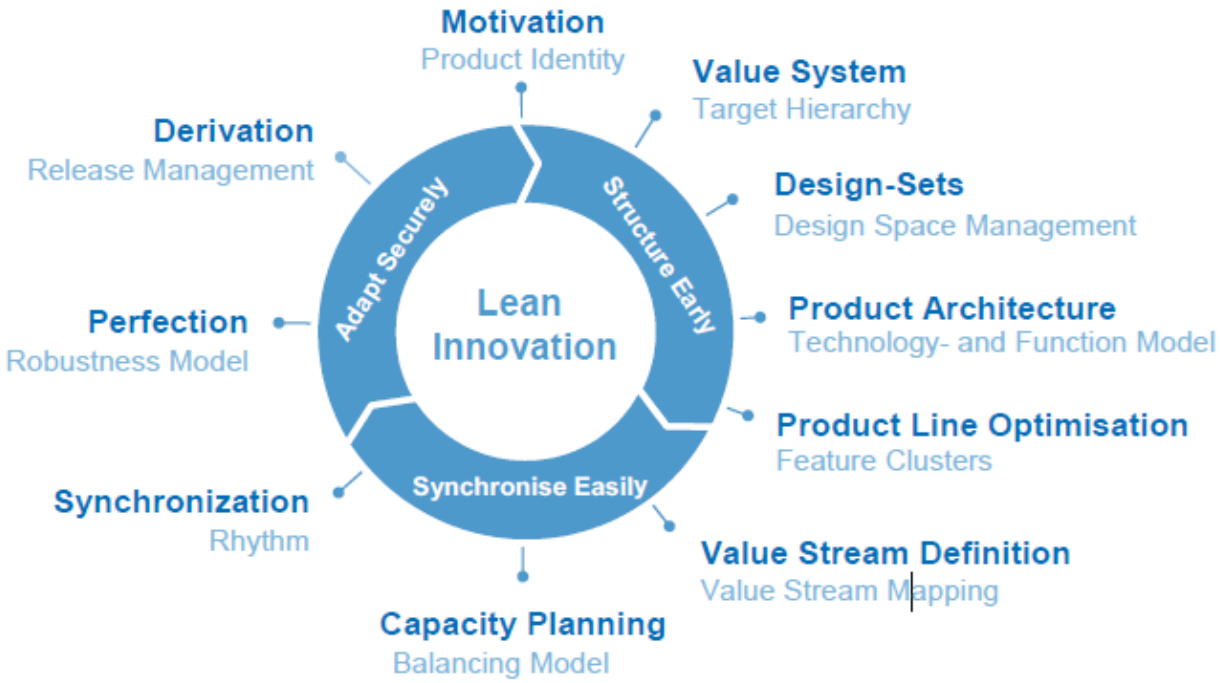

Figure 23. The Lean Innovation Principles (from Chen and Taylor, 2009)

The key steps with corresponding principles go as follows (listed clockwise):

1. **Structure early**

   Aims to highlight the importance of the preparatory measures:

   - Motivation of the team
   - Transparent structure of targets and clear identification of value and value-adding activities
   - Design-set aims to describe all relevant technical solutions so a whole variety of options is reviewed and the optimal is selected
   - Product architecture defines 3 parameters: margin-gain potential vs. expense costs, production suitability (if the production is ready) and the possibility of newer releases during lifecycle. Must be presented early.
   - Product lines are adjusted to new products. It is one of the ways the R&D is connected to future production. Depending on the readiness of the product lines, the re-equipment of product lines may be needed. The expenses are added to the balance of margin/cost of the product.

2. **Synchronize easily**

Impersonates the necessity of vision between the active project parties and project interconnections:

- For creative and repetitive processes value must be measured separately. Creative processes have more freedom and allow a greater degree of inevitable waste. Repetitive processes are rigid and most subject to Lean activities. Neubaur and Lenderz (2010) speculate that an important part of the value identification process must be conducted in parallel with the process of researching the customer behavior. While the customer feedback has a direct influence rather on NPD process in whole than on R&D in particular, the uncovered bottlenecks that require technological solutions may come from the clients, affecting the complexity and novelty and ,thus, affecting the value-mapping process. The described approach is being referred to as "Design-for-process". The figure below demonstrates the surface logics of the process:

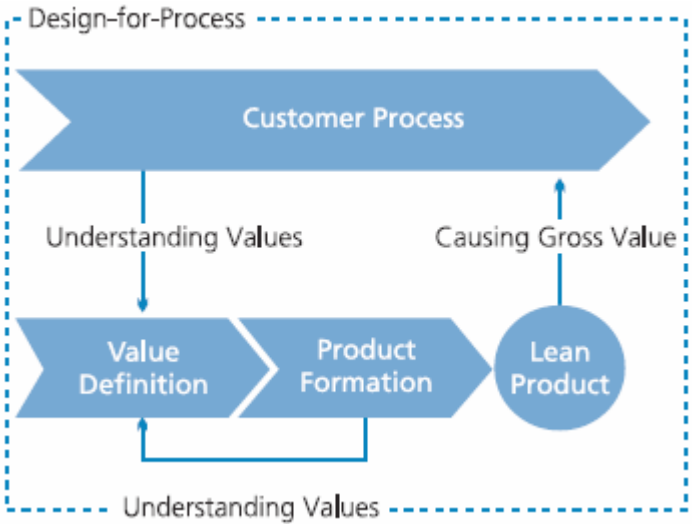

Figure 24. Design for process as Core Element of Lean Innovation (from Neubaur and Lenderz, 2010)

By underlining the importance of listening to customers in NPD, Neubaur and Lenderz resume the following: "A success factor for the value stream analysis of development processes is the constant synchronization between development competences and capacities and the innovation demanded by the market."

- Capacity is essential. It regulates shortages, waiting times and further product quality issues. Before implementation, capacity must be balanced.
- Different operations in project take different time. To make a continuous flow of process, the work-intensity of operations is balances. Balance of the resource planning follows accordingly.

3. **Adapt securely**

   Robust products may be adjusted to changing market environments during the lifecycle, extending the market presence time and affecting margins:

   - The product robustness evaluation must be transparent. The criteria must be unified. Directly affects the security of adaptation to production.
   - Release management is a part of a larger portfolio management. It answers the question **when** to release a product, depending on a number of factors including the complexity of the product

It may be true to say that the model is very case-sensitive in the sense that the model of NPD and the functions of R&D may be scaled differently within the process. Accordingly, some of the principles, based on the specific case, may be inapplicable to R&D alone. The further overview of the empirical experience may pose a need to restructure the mentioned model.

When the company reaches success in Lean Innovation implementation, it may be evaluated by the 5-step maturity model, proposed by Neubaur and Lenderz (2010). The specific value of the model is the separate overview of changes specific to R&D regarding the waste, value and other major chunks of adoption:

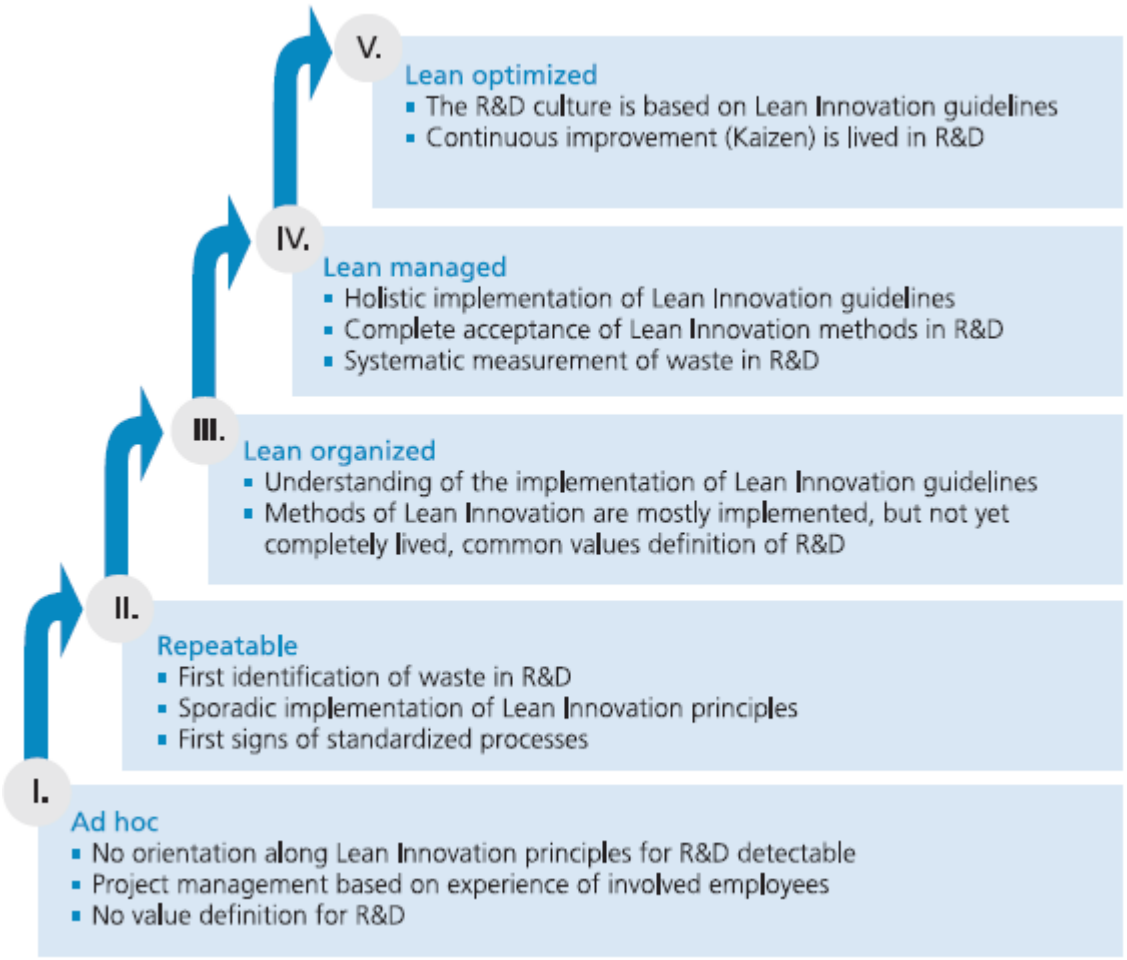

Figure 25. Plan the Implementation According to the Step model (from Neubaur and Lenderz, 2010)

5. PRACTICAL FINDINGS OF LEAN INNOVATION IN EUROPEAN MNE

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The following section of the work aims to present the experience of Lean Innovation implementation project is one of the larger international companies of Europe. The limitations of the research have been provided before the theoretical part. Also, the inputs will be demonstrated in the separate part of the section. To conclude the first word, the reader should consider that some of the materials will be demonstrated in direct comparison to theoretical findings, other will be shown in an interpretative manner, proposed to be of unique experience to this MNE.

Below you will find the general structure of the section:

1. The overview of the company.
2. Data sources, collection and processing

3. Company Innovations and R&D
4. Lean Innovation experience
5. S solutions

5.3. The overview of the company

The explored enterprise is one of the major market players of the world food industry that originates in Europe. The specific niche of the company is dairy products orientation. The company is system supplier for other food manufacturers, rather than a food manufacturer itself. This puts the firm in a tricky position: on one hand, the B2B market is rather different from B2C in a variety of ways. However, the mechanisms of Innovation adoption, product development and market research remain rather intact. On the other hand, to certain extent, the products this firm offers their customers must take into account the direct market changes in B2C market. Observe:

Figure 26. The mechanism of indirect B2C market exchange

The following figure aims to show that the case company has as peculiar distinction compared to other B2B companies: its own R&D influences the strength of brand of both the company and B2B partners and also takes into account both the B2B and the end customers. Considering the communication with the B2C market, it must be explained that the operator of the dairy industry, that works to be a system supplier, must have specific ways of application for this mechanism to work. Simply put, this particular enterprise provides hardware and the packaging materials. Clearly, the hardware is indeed an important, value-adding asset (to be explained further), but the packaging material is the face of the company; when developing the shape and the form pf the new pack, the company has to take into account the material consumption, ease of adoption, expenses of hardware modification and other attributes to attract the interest of the partner, and also consider the shape, the printing technology possibilities, eco-friendliness, etc. that match the interests of the end customer. To finalize the idea, depending of the product orientation, it may be proposed that a certain part of the company is more R&D-B2B-specific, the other one is R&D-B2C-specific. The final aspect to be argues is that, as stated previously, all the company processes are strongly connected and as a result, the developed hardware solutions must be compatible with the packaging solutions which form an additional complex B2B-B2C Innovation bridge to be argued.

Anticipating the further disclosures of the chapter, due to nuances in data availability and the theoretical findings more related to B2C, more attention was given to the B2C-oriented R&D and Innovation mechanisms of the firm.

The current scale of operations is the following:

- The total employee number exceeds 20000 workers
- Net sales account more than 10 billion € yearly
- The manufactured equipment is sold and installed in more than 100 countries worldwide
- The manufactured packaging materials are demonstrated in more than 150 countries worldwide

The company is also known for strong internal R&D originating from several key innovations that provided the company powerful competitive advantage at the stage of origination that managed to sustain the position of the top industry performers by progressing in positive innovating.

Also, being a system supplier allows the company to better understand it's customers on all levels and also tap into the vast pool of knowledge of regional, country-wise, national and other specifics of local operations. As a result, the company has a powerful potential to tailor its product portfolio both in offered material and service products to meet the needs of potentially any business of any scale. This accounts for the diverse manufacturing, delivery, installation and after-installation services, consulting (before and after-purchase), training of customer employees (especially in operating the equipment), assisting in sustaining and improving the critical regulatory standards such as hygienic. Additionally, the company is a part of a much larger complex that can offer the customers the required products and services when this specific enterprise cannot. This allows to see the relationships between the firm, the business- and end-customers as a unique complex environment of knowledge collection and exchange that potentially puts the company in even more beneficial position from the perspective of innovation generation, market insight and feedback collection.

5.4. Data sources, collection and processing

The scale and the specifics of data collection directly originates from the available resources of time and finances. However, to certain extent the difficulties that emerged from the attempt to cover as much material as possible of the firm related to Lean Innovation, were compensated by the opportunity to tap into the knowledge and data not just as a side-researcher, but rather a trainee, a person that has several key benefits compared to outsiders. However, there are additional boundaries resulting from the same opportunities. The balance is shown below:

PROS	CONS
Direct access to company operational data	Data is strictly limited to eliminate the identification of the case company.
Easier access to personnel in higher positions	Data may be gathered only during off hours.
Access to strictly non-public data (meeting notes, project templates, reports, containing data on developed solutions)	Ethical concerns based on the different involvement level of full-time and temporary employee.

RESULTING DATA SOURCES
3 semi-structured interviews with managers directly related to NPD, R&D and LI. Due to geographical diversification, those were done via communication means similar to Skype
Company intranet, intenal analytical tools, project notes and reports
Transcripts of dialogs with employees not directly related to LI which helped to see the bigger picture of the company processes

Table 8. Pros and cons of internal company position for the researcher and data sources available.

The following materials allowed forming an understanding of the company implementation case to answer the questions about the impact of innovativeness of the company, the setbacks during and after the Lean Innovation implementation along with found solutions. Ironically, sometimes found solutions led to other setbacks.

Because the data is diverse and is not represented in a single-line cognitive form (meaning that the data may be seen rather as thoughts on the subject than concrete frameworks), the processing of data was done in a pure interpretative manner with not use of additional software. One of major reasons is that the data allows to speak of certain trends and underlines, but at the same time it is relatively pointless to group the replies in order to sort out the stronger and weaker statements. The whole variety of the available data, since gathered from the internal sources, is by default valid, equally important and is required to form a "spherical" understanding of the company experience.

5.5. Structure, strategy and R&D

This section aims to provide the general information about the Innovation management in the firm along with the structure of the R&D department. While the structure of the R&D is relatively accurate, the Innovation management overview is in a vulnerable position because the current state of Innovation management in the company involves the application of Lean principles, but in order to evaluate the progress of Lean Innovation project, it is also critical to understand the state of Innovation management before the implementation of the project. Unfortunately, the discovered information about the Innovations in the company before the implementation project does not allow to clearly dictate the differences between now and then due to certain structural gaps The issues behind the situation is that although most of the structural aspects are known, the specifics of employee communications, aspects of knowledge transition and efficiency of operation may remain blurry. If recalled, the efficiency after the implementation is supposed to be measured by the value generated by the processes compared to waste (necessary and unnecessary). The evaluation of the efficiency before the operations can only be seen as the proportion of active personnel, number of projects, average rate of completion, percentage of failed/delayed projects and other comparable numbers. Unfortunately, a majority of the stated information remained available only segmentally during the research.

Still, to start with, the case company is an enterprise with considerable Innovation and creativity capabilities. As stated previously, the founding of the company is directly related to the unique innovation that ensured competitive advantage for the company for quite some time before the sustainable business was established. However, even during the earlier stages of business mergence, the company already possessed an important Innovation initiative to boost performance and rate of growth. As a result, today the company reflects the classical model of a company that mostly relies on the creativity within own R&D. It may be speculated that the firm is too strict about the Innovation management policy. Taking into account the experience of the modern all-scale enterprises there are even known cases of the companies exchanging knowledge freely on purpose, aiming rather on the cultivation of the diverse innovation-generating environment rather than gaining competitive advantage. As a result, the company possesses a number of unique technologies and technological solutions that are being upgraded, improved and managed by the lone effort of the internal R&D. As a result the knowledge capacities of the R&D may be much broader that compared to the ones of the companies using other means of knowledge reception and exchange.

The current company development state allows to speak of more than 10 R&D units worldwide. The positioning of R&D facilities was originally dictated by the origins of the company. Further, as the number of manufacturing facilities grew, the company applied an intensive study of the optimal R&D facilities localization for improved performance. A number of factors discussed earlier were taken into account: the nuances of the region economical, mental and financial capabilities, the supply chain and communications aspect, not to mention the knowledge generation potential of the region. Clearly, the more educational facilities and high-technology application the region possesses, the more knowledge can be potentially gathered with the assistance of positive employee flow. At the same time, the manufacturing and feedback from customers is critical. It is important to be in constant contact with manufacturing to receive an invaluable feedback on the progress of the company manufacturing solutions, along with the feedback from the customers on the markets of both scale. As a result, the positioning of the manufacturing facilities is a compromise between the location of key markets for growth, optimal routes for supply chains, essential knowledge-generating facilities with high potential for high positive employee flow and beneficial economic areas.

Additionally, the R&D is united with the service division in one business unit. The idea behind this structural solution is simple: understanding the issues the customers face when operating the purchased equipment along with the problems that emerge when applying packaging materials allows speaking of the front-line feedback for new products, especially carrying new technological solutions. Generally, the resulting structure of company R&D can be referred to as decentralized, with massive communication being conducted between separate R&D centers but one-sided communication between of R&D initiatives and the company HQ. The resulting structure has the following view:

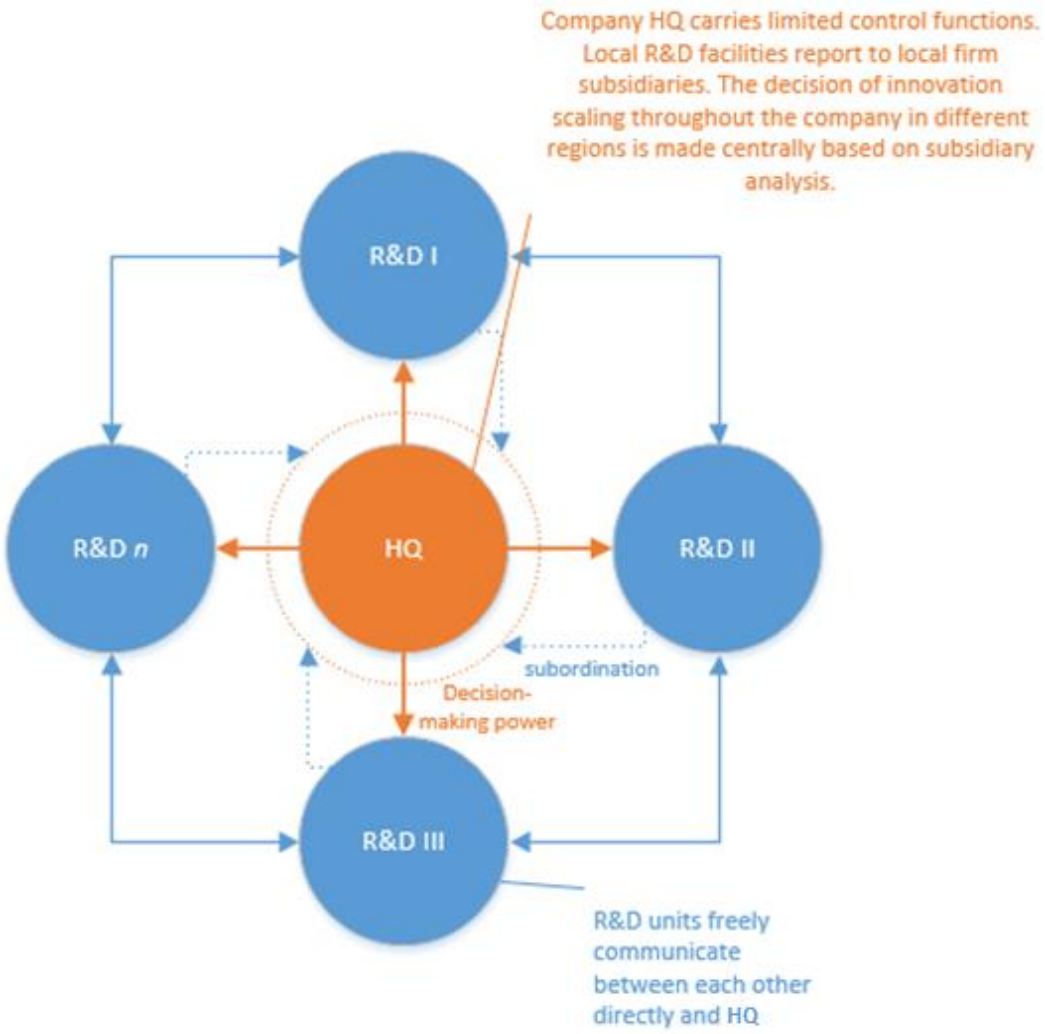

Figure 27. R&D connection between each other and HQ

According to the feedback, the following model has proven itself effective numerous times. The secret of the efficiency is relatively simple: if the company has diverse global operations, the HQ would have to sustain a grand amount of analytical power of all levels (development, service, finances, planning, processes, supply chain, etc.) to either compensate or even duplicate the same functions in local-based subsidiaries. The issue is that the easiest way to react to changes is to gather and process information at the same place. From this perspective, gathering information directly from the market and processing it on-place hold the potential of a more effective decision-making power. If decisions were made within the HQ, it would involve 3 critical setbacks: 1. Time lag between the decision making phase and it's execution on-place 2. When the decision making phase is extended, the data affecting the decision may change resulting in inaccurate decisions. 3. Higher staff count in HQ, duplicating the functions of local subsidiaries,

including product performance monitoring, user experience feedback collection, sales analysis, etc.

Sustaining the higher level of freedom in decision-making for subsidiaries results in agile, effective and efficient management, able to perform timely reaction to change. At this rate, the HQ performs observatory and strategic functions, providing general guidance and issuing key structural decisions. For example, the decisions on positioning of key figures in local upper management are made with the participation of HQ.

Of course, if the local operations would be fully independent in making decisions, there would be an opposite risk of hampered communication between the subsidiaries and the potential flaw in information delivery to HQ. For that reason, the local operations including R&D are formed into geographically oriented clusters that serve 2 functions: diversification of operations to a concrete number of countries and provision of intermediate management guidance between local and global level initiatives.

Combining the operations on product-, function- and location-level scale would decrease the benefits of the structure by binding the local businesses of the enterprise by unnecessary frames. Concluded is the fact that the products, R&D initiatives are eventually available worldwide with the financial, analytical and other functions realized on-place. At the same time, apart from the matrix structure, the company structure fits the theoretical bounds of international divisions and, even more, corresponds with dispersion-coordination framework from Guillen. Verifying the level of coordination and geographical dispersion allows claiming that the case company adopts the multidomestic strategy (country-based organization). The cluster-level communications are also in place but do not demonstrate a certain middle-control structure but rather a model of managed cluster collaboration. This means that whenever the decision affecting the global operations must be made, it can be localized by a certain cluster. Within the cluster, the information is requested by the HQ and the decision is made both by the HQ and by the subsidiaries forming the cluster. It means that the decision will be objective, considering the interests of the company leading team and local higher management and transferred directly to the affected businesses.

Considering the described structure allows to state that the company R&D operates on both local and international level, providing support to manufacturing and responding to cluster-scale customer needs, at the same time providing the opportunity to scale the solutions to all company business if perspective and addressing the emerging issues on global scale. From this perspective, the R&D still leans toward the divisional level rather than corporate. According to

the received replies, the theoretical findings of Tidd and Bessant (2005) for divisional R&D may be verified:

1. Short time horizons. The actual time horizons may vary depending on the complexity and scale of the project. At the same time, it is known that the modern environment forces the companies to be agile. As a result, the average R&D project may take 2 to 3 years.

2. Fast learning feedback loops. Thanks to strong collaboration between R&D and fast feedback-from-market rates, the feedback loop allows greatly benefits the mechanism of collecting the first-order knowledge, as well as leads to better understanding of the market.

3. Strong internal linkages. The collaboration environment between the research groups is the powerful tool to share and multiply the specialist competences. It may be verified that the open-minded corporate culture promotes the establishment of powerful interdepartmental connections. As previously explained, this measure aims not only to improve the overall efficiency of the processes, but reduce the time lag emerging due to additional iterations between departments during the NPD projects.

4. The last statement is related to the higher project prices when done in divisional scale. In terms of the case company, the R&D projects are being evaluated in required resources before launch meaning the financial aspects are mostly HQ-sided to decide. Considering this fact, the R&D costs have the tendency to be equalized among various R&D units due to centralized decision-making regarding finances.

Further, it can be stated that the company R&D units are mostly oriented on applied research, mostly relying on the information about the issues delivered from the customers and oriented to provide appropriate solutions. The relative freedom of separate R&D facilities is supported and strengthened by the considerably liberal company position regarding the training of personnel. It means that in order to equalize the performance of various R&D units, the company aims to organize frequent trainings and knowledge exchange initiatives to increase the knowledge basis and overall project awareness between the R&Ds. This attitude additionally improves the horizontal bonds between the R&Ds.

Before the launch of Lean Innovation project, the Innovation performance of R&D departments was evaluated strictly by means of capacity, leading to the number of specialists involved in the

project and the time it takes to complete it. This approach carries to essential prerequisites to Lean Innovation implementation:

1. Building up the problem-solving power by gathering the first-order knowledge, gradually increasing the speed of conducting typical stages in typical research projects. The average rate of issue-solving rate equals 60% of customer satisfaction.

2. The absence of value-waste approach, resulting in the situation when the certain parts of the project take considerably longer in scale of the whole project as well as additional, unnecessary communications between the R&D and Product Development. This type of faulty communication resulted in contradiction between the growing efficiency of R&D and lower general project performance. The paradox of better segmented but worse general performance.

3. A technological misbalance between different R&D in terms of projects due to the fact that not all knowledge can be easily transferred between R&D departments. This may be explained by the phenomenon of tacit knowledge utilization that is problematic to be explained and applied by a different team due to understanding and sharing barriers.

As a result, the time-to-market timelines suffered setbacks as well as the evaluation of the technological projects demonstrating lower output than potentially possible.

For the current decade, the company is oriented on ecological innovations that improve the performance of manufactured machines at the rate of lower consumption of electricity and the need for lower amount of service materials (lubricants, peroxide, etc.) as well as the increased level of automatization to decrease the operational risks from incorrect operator actions. Needless to say that the same trend in packaging material innovations mostly results in 2 aspects: the increased time of product preservance within the package and a high level of recyclability of used paper material. The amount of consumed material is also considered but to a lesser degree. Previously, it was stated that the companies aiming to improve the existing technologies result in performing well in incremental innovations but dramatically losing the pace at radical. In the situation of the case company, the market itself, along with the Lean Innovation implementation, dramatically altered the Innovation balance within the company. Of course, the culture within the company served as the basis that made it possible combine a high potential for both radical and incremental innovations. Generally speaking, at a certain point, the company, while being a beneficial partner offering system-level solutions, encountered a decrease in market performance

dictated by the emergence of the non-system suppliers. Being mostly of Asian region origin, the non-system suppliers provide less options but at a considerably lower price. As a result, the customers either switched to a more narrow number of services benefiting from lower price, or sustained the minimum requirements that allowed the company access to case company system solutions. With this situation at hand, the case enterprise realized the need to take urgent measures to boost own Innovation performance to recapture the competitive leadership of non-system suppliers. Additionally, speaking of culture, the company leadership attitude literally allows any employee to address his/her own supervisor with an idea that may potentially benefit the whole company. Although the financial side of the process remains undisclosed, it may be stated that the company has previously conducted several incremental projects that emerged outside the R&D and is currently financing the project that may result in technological breakthroughs on the market.

Concluding the Innovation and R&D chapter, the evaluated satisfaction level of customers with case enterprise innovations exceeds 60%. This indicates that the company managed to dramatically benefit from the Lean Innovation implementation and, speculating, the creativity level was not just sustained, but increased at times.

5.6. Lean Innovation experience

First, Lean Innovation is not only feature- but prerequisite-based . Specifically, on the exact period of first Lean application to R&D. Second, by the bearing point of Lean Innovation project initialization. Finally, tapping into the origins of Innovation approach proves to be a great asset in uncovering the actual activities behind Lean Innovation.

To start with, the case company started adopting the Lean philosophy more than 8 years ago, applying it to own manufacturing. The manufacturing facilities are positioned diversely in different regions. It may be sufficient to mention that the manufacturing process is currently online in Italy, Mexico, Sweden and some others with the division on packaging materials and hardware The development plans also include powerful intervention to Asian markets. It has been mentioned that the adoption of Lean is the adoption of generally the principles of approaching the company operations. As a result, the companies may come up with own methodologies that even differ by name. This is the quite the case with the researched company. According to the findings, the Lean approach was introduced to the company manufacturing

starting with the home manufacturing and was further scaled to other facilities. This allows the company to sustain a high level of equality in terms of quality, efficiency and shared company culture. It may be speculated that the Lean integration process went according to the generally accepted adoption rules:

1. The company understands the importance of change

   To certain extent Lean approach is also a matter of fashion. It is a good addition to the image of the company to be considered the cutting-edge adopter, good for reputation too. In the situation of the case company, the following reasons were in place:

   - The adoption was demonstrating clear benefits. Evaluating the effect is difficult, but analysis of expected positive change is critical

   - Assets in sustaining the competitive advantage were needed. Reviewing the values to battle the non-system suppliers was the matter of company survival. The company managed to reorganize the product portfolio for more reasonable costs and as a result better pricing flexibility

   - The annual research devoted to uncovering the various levels of employee satisfaction allowed to speculate that the company needed a new source for internal unification in order to sustain and improve the initially high standards of internal communication and collaborative activities conduction.

   - Diverse R&D operations and extended product portfolio. The company had to answer for the customer needs of the packages of different volumes, sizes and shapes and also strengthen own position in times of emergence of plastic substitutes.

2. The company evaluates the maturity of the approach

   There must be enough information about stories of success and failures and internal information to make an important decision such as this. According to the findings during the analysis of the competitors and other manufacturers not necessarily covering the food market, the case company managed to discover that the TQM approach also allowed the companies to sustain a high level of competitive advantage even without covering the issues related to culture, portfolio complexity and others. But why choose the more

complicated and expensive path? By the time of analysis, it was fully understandable that Lean has greater potential and uncovers more opportunities further.

3. The company seeks the partner to set up the launch base of the project and prepare the management.
   Nornally, a solid consulting enterprise is being chosen as a partner for the project usually through tender-based activities. The current case involved a tender done in several stages, each stage representing its own criteria of evaluation:

   - Evaluation of the financial stability of the consultant
   - Evaluation of the company experience, competences and capabilities
   - Evaluation of cognitive aspects in terms of finding common language.

4. The project team is assembled including the employees from both sides and is supported by the favorable and assisting attitude of the leadership level managers and manufacturing division head managers that carry the role of sustaining the project from inside the company by becoming Lean champions – the practitioners of Lean that would further ensure the non-necessity of external project support.

5. Actual Lean adoption that includes the following steps:

   - Identifying the focus area for implementation and first-order improvement

   - KPI's are reviewed and rewritten as a part of the AS IS value stream mapping. As the project flows, the KPI's of AS IS and TO BE streams are being compared before and after value stream mapping for improvement evaluation

   - The definition of waste is introduced; the TO BE value stream is being constructed. Changing from AS IS to TO BE is called the Value Stream Transformation.

   - Lean toolbox is being introduced as an inception of personnel education

   - The KPI's are being compared to identify the improvements.

- The cycle is repeated for all focus areas in order to start forming the "archive" of first-order knowledge related to Lean project conduction.

- The experience is being documented and formed into the best practice that will be further scaled and shared

The result of the project was the emergence of 5 champions, 4 of which, based on their positions, were directly related to global and major manufacturing initiatives. In progress, their collected experience allowed to launch a supporting project that helped the company to come up with its own squad of blackbelts, being both proficient in "casting" Lean and in company product, manufacturing knowledge, possessing positive reputation and strong vertical and horizontal connections inside the company. As the result of Lean implementation and company transformation, the shift in values emerged as seeing the company success as right combination of processes, people that manage them and the tools that they have available for their needs.

While the Lean adoption project was in place, the R&D innovation-generating initiatives did not undergo any considerable alterations. While the adoption project took roughly half a year, the R&D capabilities only increased extensively by the amount of R&D centers and experienced personnel. Without considering the waste and value of research projects, it may be stated that roughly 35-40% of financed research initiatives covered themselves in terms of financial benefits received from product improvements. Due to the specifics of company R&D, meaning the lack of breakthrough discoveries in the industry, the incremental innovations still allow to speak of powerful discoveries that affected the market and the competitive environment. The general direction of innovations, as mentioned, is still concentrated on the ecological aspects of company manufacturing. This idea is relevant to company success in many aspects: 1. Sustaining the image of the green brand, that aims to conserve natural resources and improve the overall level of living. Strong accent is made on the food market changes due to increasing global population. 2. Decreasing operational expenses by improving manufacturing solutions, control systems, etc. Technological advancement of the manufacturer is often valuable for the customer. 3. Improving the reputation of the customer by adding the positive impact of manufacturer reputation. The end customer knows both the quality of manufacturer and its customer and reflects the positive image of both.

As also mentioned, a majority of the innovation ideas came from the strong all-market customer feedback that provided fruitful ideas for hardware and packaging materials improvements. The

company innovation approach is being done in a pipeline-like manner, involving the following steps:

- Global Product and Service strategy that defines which products and services must be introduced to the market in the selected timeframe. The strategy is defined by the strategy council that is situated in the company HQ.

- The strategy affects the choice of product development needs that, after being prioritized, are evaluated from the perspective of resource allocation. The prioritization is being done based on the number of coefficients displaying the following parameters: relevance of the project to current company strategy, risk of market failure and cost of project. Eventually, each project gets a score that influences the decision regarding the launch/block and the position in queue. The idea of guidance is supported by the involvement of both HQ- and local sided stakeholders: the business process experts, local and global process drivers and local superusers.

- The product development, as commonly seen in other industries, consists of the technological development that is further delegated to product development. Needless to say that the level of horizontal connections between the technological and product divisions is exceptional during the products.

- The product undergoes a series of routine stages such as testing, introduction to customers, sales planning, launch of manufacturing, etc. From this point, the product lifecycle management begins.

Notable is the fact that the following sequence matches the Innovation process stages by Greenhalgh disclosed in previous chapters.

While the Innovation generating activities are being initialized in R&D locally, in order to manage and scale the development to all the company operations, the process is guided by the HQ-based counselling structure that is being responsible for transformation in terms of new product development.

Additionally, the Innovation challenges presented by Sharma (1999) were addressed:

1. As explained the company has the system of project evaluation that allows overcoming the flow of creativity to filter the perspective ideas from non-perspective. Additionally, an expert manager opinion states that the overall creative power of the enterprise gradually increases with every new R&D center, resulting in larger volume of ideas sent for consideration. Thus, it may be verified that the size of the company indeed affects its creative potential.

2. The second statement addresses the balance between the radical and incremental innovations. Due to the current state of the industry and considering the interviewee expertise, there is no answer for the case company. Critical is the fact that a number of research projects in the industry are being financed in external organizations and technology adoption take place as well. Still, the current R&D situation and the level of hardware development allow claiming that, indeed, the incremental innovations volumes far exceed the volumes of radical.

3. In terms of the research, there balance between the externally found R&D specialists and internal promotions and horizontal shifts is not known, as well as the average rotation cycles of the personnel employment in company R&D department.

4. The conflict of developing the internal R&D capabilities of the separate centers and the overall R&D collaboration network was solved with the involvement of 2 measures:

    - The R&D units are categorized based on the product type. Some are strictly oriented on packaging materials. The others work with hardware.

    - The structure of corporate R&D claims that the research projects are done in collaboration between various R&Ds. This ensures powerful knowledge exchange and promotes the development of separate R&Ds.

5. Manufacturing planning dilemma due to market reaction uncertainty. In order to minimize, during the technology and product development, a series with end-customer meetings is conducted, the feedback is accumulated and processed into ready-made decisions. In short, the better the evaluation and forecasting, the smaller the risk of financial losses because of incorrect market demand assumption.

Before addressing the Lean Innovation company experience, it is important to state that, while having a rich experience in both R&D activities and Lean, the issues of Innovation paradox were strongly addressed. The evaluation stage of scaling the adapted version of Lean to R&D operations involved the consideration of the Discipline vs. Creativity contradictions:

Discipline	Creativity
Minimized failure risks	Acceptable risk to success rate
First-time mistake-proof initiatives	Mistakes-to-success initiatives
Efficiency	Effectiveness
Perfection	Intuition
Progressive	Sporadic
Evolution	Revolution

Table 9. Conventional innovation paradox

As a result, the company was aware of the upcoming challenges and managed to develop and effective preparation plan. Still, before referring to the solutions and overcomes, the challenges, difficulties and issues must be demonstrated.

First of all, it may be stated that the first Lean Innovation adoption was done in the sequence of steps similar to Lean Manufacturing implementation in its own time: the need for scaling the Lean for R&D was identified, followed by the evaluation of the project resources, that resulted in the conditions and limitations for the tender-based selection. Notable is the fact that, unlike Lean Manufacturing, the consultancy was required to identify and overcome the challenges of applying Lean to R&D. Again, the partnering company had to undergo a series of insights, a team was formed and the project guidelines and goals were formulated. Again, it was decided that the Lean Innovation must first take place in one of the R&D centers. The most challenging parts to consider were: the value stream mapping, the identification of waste and selection of focus areas. It is also important to note that, while amount of Lean champions increased and the project had strong support from higher- and middle-management, the application of knowledge already obtained by the Lean practitioners in manufacturing department was intentionally unused. Understanding the differences between manufacturing and R&D leads to the informed search for alternative expertise. Eventually, a different “breed” of Lean R&D experts was intended. Despite the difficulties in implementation, the impact of LI brought significant improvements to R&D operations and, as a result, altered the strategic course of the company, specifically regarding innovations.

Below are the key obstacles the company faced before conducting LI implementation:

1. The project limitations do not cover the issues related to understanding the value adding capacity of the process. In manufacturing the process is valuable when it implies the necessary production operation influencing the qualities of the end-product that follows the product design. In R&D, the value of the process is hard to evaluate. The most common example is the theory and hypothesis stage. The researchers address the task set with the proposition of the solution. Even the most modern CAD systems and modelling cannot guarantee the limited number of cycles required to test and decline the wrong ideas to come up with the solution for future product design. Testing and modelling takes the most part of the research project. Eventually, the cycles that test the ideas that would be considered potential-less are seen as waste. At the same time, this waste carries certain value, not for the end-customer, but for the company: all steps of R&D projects are recorded and every idea tested broadens the creative potential of the division. Finally, this leads to the conclusion that value stream mapping is difficult for R&D and leads to confusion in understanding the necessary, but wasteful operations, wasteful ones, value-adding and non-value adding, but necessary.

2. Lean Innovation brings additional requirements to the research information system. As the processes of various departments are connected, the information system must hold the potential to support the increasing efficiency: ability to support multiple parallel workflows, wide means of communication, module of recording and analysis. Moreover, usage of software for Lean tools is highly recommended. The drawback will it that case is the pack of information system capacity that will result in waste in form of duplicate operations, process step delays and information loops. Reintertsen and Shaeffer refer to these risks in terms of information batch reduction. Just like the manufacturing has volumes and inventory amounts, so does the flow of information in R&D must be controlled, visible and, most importantly, manageable.

3. Development of individual condition-based continuous improvement scenarios. It turned out that the steps of the R&D process, the standard step times, amount of cycles, resource consumption and size of the teams are often different. Using the Lean tools, the process may optimized and sustained. At this rate, the variability of the process is low. The higher the variability – the higher the risk of uncontrolled fluctuations and loss of

efficiency. Following the value stream mapping, the structure of the processes, including the owners, must imply the possibility of grouping.

The first R&D center to adopt LI was chosen the one originating in the company home country. This tendency is rather normal, when the HQ becomes the center of company excellence. In current case, financial, strategic and decision-making power is situated in the location different from the R&D and manufacturing "base". This particular R&D is currently more oriented on hardware improvements rather than packaging materials. The focus areas chosen were addressing the time losses related to the development routines that directly affect the capacity and utilization parameters. The goal was to decrease the time of prototyping and testing stages to reduce the times of dead end cycle times. Additionally, it was required to implement the effective controlling and continuous improvement approach. Importantly, this project only covered the processes potentially subjective to Lean. The ideation process was uninvolved. However, the ideation was affected later, when the project was scaled to other R&D's.

The project was conducted in 8 months, apart from the cultural aspect. During that time, the team was constantly communicating regarding the targets and goals to ensure the right direction of movement. First, the value stream mapping was done. As mentioned, the guidelines for that were blurry and the team has to involve people from the product department. Later, the team had to remap the value stream several times until the final satisfactory result. Again, during the value stream mapping the concepts of waste were reintroduced based on R&D information-centered specifics. A number of tools was selected to address prototyping and testing cycle times:

1. Front loading

   The idea behind front-loading is to collect as much knowledge as possible before the beginning of the project. Speculations claim that the cycle times and dead end ideation processes often come up due to the lack of data. Setting the accurate goal of the R&D project is critical. Front loading is about 2 things:

   - Allocating more resources to the project in the beginning
   - Delaying the important decisions for the sake of accuracy

   It is clear that there is a certain criteria of information sufficiency. Delaying the solutions does not literally mean not to do anything in the first steps. Understandable is the fact that this leads to the loss of the market initiative. Also, the higher resource allocation hampers the resource allocation before the project and may lead to higher costs. Still, the tool is

invaluable. The companies do not tend to delay the solutions, often mistaking the LI for agile approach and considering the real purpose of LI to speed things up. Nevertheless, the project initial phase extension might seem a loss of time, until the number of cycle times during the project is compared. The "examination" project in the end of LI adoption resulted in 1.5x decrease in testing and prototyping times compared to non-LI approach – waiting longer in the beginning wins more time later. Finally, front loading is very team-demanding and proves to be challenging for inexperienced teams.

2. Timeboxing

   The timeboxing teaches to manipulate the resources instead of time. The prototyping stage of the project took a certain amount of time based on previous experience. If the unexpected drawbacks emerged, the resources were constant but the duration of the stage increased. Timeboxing teaches to set a solid timeline, but to allow resource consumption variation. By doing so, 3 invaluable benefits are achieved: 1. The timelines are strictly controlled, allowing a more solid planning for the product development and other processes. 2. The knowledge is being collected faster and the team competences are boosted. Even with infinite resources and a limited time, the team learns to prioritize the operations, redistribute the workload more effectively and generally apply the resources with more reason. 3. Collection of statistical data. By selecting 2 comparable projects with many common processes, each stage may be evaluated by the consumed resources, if the timeline was the same. This allows pinpointing the actual differenced in project stages that uncover the potential for further improvements.

3. Prototyping

   Yes, prototyping is the part of the R&D process but with the next approach it may be the powerful instrument of optimization. The normal prototyping background is the intermediate testing of the promising hypothesis in a form of a real-life trial in a form of a physical object or a ready-made functional system. Prototyping aims for mistakes, roughnesses and minor point of interest that exceed the critical project aims. Prototyping as a mean of optimization offers much more: 1. The ability to combine various projects in one prototype to conserve the resources. Additionally, promoting evaluation of cross-influence of ideas may have a synergetic effect and lead to new discoveries. 2. A prototype is much more than a proof of the idea. The prototype may carry a strong inspirational role along with knowledge collection. With modern modelling system, the prototypes are no longer as expensive and long to build as before. This partially repeats

the argument 1 and allows for faster knowledge collection through visualizing the project stages in forms of the prototypes.

To conclude the LI implementation experience, in addition to the difficulties the company faced during the implementation process:

1. The industry-specific position of the company provided additional complications when addressing the value stream mapping of the R&D processes. A separate routine is responsible for the formulation of research project goals and targets. Considering the fact that the B2B and even B2C customers are often provided limited access to the development process, their critics sometimes arises as contradictory or overlapping. For example, the B2B customer provides the critics for the new addition to the hardware equipment. Since this equipment uses the packaging materials for operation, the B2B customers may have additional, but standalone critics for the packaging. This means that the R&D has to consider both sides and come up with the solution that is either flexible enough to cover all the critics, or the critics must be carefully evaluated to select the most important commentaries. Eventually, the R&D process value stream mapping becomes considerably more complex to sustain the balance between the research initial framework and the ability to be redirected at any stage based on the feedback.

2. The difficulty of balancing the current operations with the implementation of new techniques and ways of thinking. Generally, the means of cognitive opposition. In practice, this means that the new introductions to the way the personnel works and communicates may be understood as the greater good but have their drawbacks contradicting with the current ways of operation. Sharing information and consulting the personnel in that case is insufficient. The risks lead to incorrect understanding or application of new tools which multiplies the wasteful cycles and extends the project times.

3. Post-factum issues with the knowledge transferring to other R&Ds. The real value behind the LI implementation is generally the new way of conducting the research projects. While there is the collected knowledge on problem-solving and dealing with routine, an important part of the knowledge is delivered in tacit form. Sometimes it may referred to the “feel” or “intuition” the personnel relies on when making decisions. In fact, these

decisions are mostly based on the tacit knowledge emerging from practice and personal "inner" discoveries of the workflow.

This concludes the overview of the case company experience in LI with the consideration of the faced difficulties and issues.

5.7. Solutions

This section is to provide the intermediate conclusion of the company implementation experience and explain the solutions that took place to overcome the obstacles and risks on the way to better innovating. To sustain the logics of the previous section, the solutions have been divided into 2 categories:

Solutions, addressing the complications **before** the LI adoption:

1. Uncertainty regarding the wasteful and value-adding activities that complicated the process of value stream mapping. The VSM was done several times. The project was done in several knowledge collection –VSM cycles: the initial, the adjusted, the final. The first VSM was done to identify the starting point as a manner of sample to fixate the technique of VSM and compare the changes in further VSMs with the entrance of additional data. The adjusted data was collected based on the involvement of Product Development department representatives to provide the bigger picture of R&D in terms of the NPD, the resolution of the B2B + B2C feedback reception. It may be stated that the identification of the focus area, although assisted, did not provide the direction clear enough to do without the unnecessary cycles.

2. The R&D information system may only be readjusted for the upcoming changes after they have been made. However, before the project, the company formed a team of internal IT experts and the consultants to evaluate the current capacities of the information system including the potential for expansion and the practice-based expectations of the LI impact on it that would require changes. Eventually, after the project was done, the results were carefully collected and analyzed. With the feedback from the project participants, mostly R&D specialists that just got familiar with Lean, not to mention the R&D department champions, all the necessary changes to the system were

made. It must be noted that the changes were of incremental nature, as the capabilities of the information system were sufficient. Speaking of the LI adoption in general, the upgrade project of information system must be conducted right after the LI adoption. Moreover, based on upcoming projects, the process of changing information system is also continuous.

3. To compensate the process uncertainty, the processes were distinguished in a 2-way system: the processes with high level of variability and the routine processes with high level of control potential. Variable processes initially received a higher level of accepted risk of wasteful operations while the routine processes had to undergo deeper intrusions. This is explained by the fact that variable processes differ from project to project while the VSM is most efficient when applies to the matrix of processes rather than the individual ones.

Solutions addressing the complication **during and after** the LI adoption:

1. To compensate the B2B + B2C feedback issue, the company addressed the previous experience of R&D specialists in terms of communication with the Product Department. Selecting the pairs allowed to collect the 2-way project experience from various projects and, when combined, provided the necessary basis for "correct" VSM conduction. Also, the decision was made to contribute additional resources to preliminary feedback collection before the beginning of the project. In fact, it may be seen as the introduction of Front Loading approach before the actual initialization of the project.

2. To protect the personnel from mixing up the existing style of work with the new introductions, a decision was made to divide the upcoming projects by the timeline:

    - Projects already in progress did not receive any intrusions and were accomplished within the existing framework

    - Several projects during the LI adoption were selected for practice of the project changes. The others were conducted according to the existing framework.

    - After the LI was adopted, the projects were systematically switched to the new framework in parallel with education of the rest of R&D personnel

This way, the cognitive aspect was resolved; the specialist received the necessary theoretical background with the opportunity to get to practice afterwards.

3. In order to overcome the issue related to the inaccessibility of tacit knowledge, the concept similar to “Ba” transformation was adopted. A number of individual specialists was selected to share the knowledge with the group of specialists from another R&D center. This way, another R&D center was “infected” with the knowledge. In time, as the knowledge progressed, the tacit knowledge was transformed into explicit that, in turn, emerged in the organize-level form.

6. CONCLUSIONS AND DISCUSSION

The following research describes the core aspects of the implementation of Lean Innovation in the scale of a vast internal R&D conglomerate. The preliminary discovered theoretical findings covered the vast number of aspects to compare with the empirical discoveries to address the research questions.

The theoretical findings address the background issues related to market competition, the tendency of globalization, the distinction of MNE, its strategy, structure and, most importantly, the structure of it’s R&D. The case-related theoretical section was selected to address the overview of Lean, the phenomenon of creativity and Innovation, the NPD as the larger process that involves R&D and the theoretical contradictions related to Lean Innovation.

Finally, the empirical part struggles to show how the Lean Innovation process generally undergoes, what prerequisites of implementation are in place, how the company addresses the organizational issues. The empirical findings were transformed in the wide interpretation of the case study, covering different aspects and, most importantly, comparing the theoretical and empirical findings.

The set research questions were based on the proposition that the combination of Lean and Innovation is unacceptable as the rigid structure of processes built around Lean dramatically decreases the innovative potential of the firm. It must be argued that the number of limitations was in place and the research is based on the statement that internal R&D is still the most important and powerful innovation-generation force from the perspective of economics, creativity and management complexity. Additionally, it was intended to discover the possible

specifics of the particular industry case on the flow of LI project implementation. Finally, as a "bonus" question, the solution the company used to overcome the difficulties were discovered and compared with the theoretical findings.

The research questions were set as follows:

1. **Does the implementation of Lean Innovation negatively affect the creative potential of the firm (innovativeness)?**

No. According to the results of the research, the massive Lean Innovation implementation trend along with the observation of the results of various company cases, allows to state that the theoretical contradictions between Lean and Innovation are insufficient. Quite the contrary, Lean Innovation tends to provide the means to systemize the creative potential of the firm, allowing its improvement. The reason behind this statement is based on 3 conditions:

- By the time the research was made a number of companies already practiced Lean Innovation. This information was displayed in several core books addressing the phenomenon of Lean Innovation. Concluded is the fact that companies adopted LI in different scales and for different applications and there is still no known cases of LI hampering Innovations and showing stable decline in creativity. However, it may be speculated that this kind of information, while being sensitive for business, is not disclosed intentionally. In that case, the emergence of the real situation will take time.

- The reply from the company experts regarding the experience in collaborating with the consultancy firm claims that the difficulties the companies face when implementing must be addressed properly. Concluding, the companies may experience decline in creativity only when considerable implementation flaws are in effect. It may also be speculated, that the decision to limit the scale of LI may be the reason for negative effects as well.

- The case company experience verifies that one of the most important aspect of sustaining high levels of creativity does not necessarily relates to LI adoption, but rather originates from proper culture. Another important parameter is the accuracy of VSM and the definition of value and waste, along with the acceptable level of variability for the R&D processes.

2. **What are the main difficulties the company faces when implementing Lean Innovation?**

The main difficulties have been explained in the empirical section with the solutions addressed in a separate section. Generally, the case company experienced the difficulties of 3 types: IT-related, cognitive and organizational. Additionally, the difficulties were split into 2 categories: the ones faced in the beginning of the project and the ones that emerged in time of it. It is important not to mix the implementation difficulties with the prerequisites although the last do have overlaps with the "problems at start", for the prerequisites mostly explain some important aspects of company development that are both important in terms of competitive advantage support and decrease of implementation mistakes risk.

3. **What solutions can be proposed to overcome the difficulties during or after the implementation, if possible?**

The only "framework" for finding solutions is the solid problem-solving base of the company. The issues vary and each demands the necessary problem-solving competences from the relevant specialists. In addition, while the problem-solving skills develop based on personal, group and organizational experience, it may be underlined that the importance lies not in the concrete problems but the time it takes to find the solution and the consumed resources. Nevertheless, the issues the case company faced during the time of LI adoption, allows to state that most of the problems may be solved with the proper use of internal resources and with the benefits of the challenging, open-minded culture that inspires the solutions from any source.

Concluded is the fact that LI holds great potential for the companies and does not present the challenges impossible to overcome. The company that was successful in LI implementation possesses a considerable benefit in the speed and quality of generated ideas and enhances the process of turning those ideas into highly potent products and solutions.

Following the underlines of the work, it may be speculated that the topic has is generally of high importance considering the increasing complexity of the management concepts driven by rising market competition. So far, the current state of the topic disclosure allows understanding how the LI works, what it does, what are the benefits and what concerns must be addressed when implementing.

It may be additionally speculated that there are several general directions that require attention:

1. The individual organizational conditions. As indicated by practice, the real issues faced by the companies originate from gaps in the structure and organizational approach. While these variations are in place, it is incorrect to speak of the considerable coverage of the topic.

2. While Lean Innovation is most potent for the MNEs, there are still middle- and small-range companies that also receive their chance for adoption of the breakthrough or actual tendencies. The critical aspect is time and knowledge that dictates the vast knowledge on the topic available to tailor the disclosed solutions to the needs of the businesses of other scale. At any rate, companies of different size need different approach and the development of the acceptable framework is rich in promises of further research.

3. While there is relatively low probability of industry-specific variations in LI implementation, there would be a difference in product orientation. In other words, product-oriented R&D would hold differences from the service-based. Additionally, there is R&D for internal use that would also demonstrate own rules.

4. Compensating the lack of LI differences in experience for different industries, the difference may be contained in country-, region-, mentality-, economics-specific variations.

5. R&D is not the only source of Innovations and knowledge. Modern companies tap into collaboration networks, independent institutions, outsourced R&Ds, etc. Just like the Lean adoption for the company supply chain affects the collaboration with the suppliers, so will the Lean Innovation affect the way the company deals with the received knowledge on it's side. Additionally, it may speculated that if the company doesn't do Innovations on its own, most probably it would still do NPD and their intersection will be highly subject to changes the LI brings.

Concluded, it may be stated that the topic will remain actual for quite some time. The evolution of management systems may demonstrate the cycles of decades before the considerable changes take place. Even considering the overall increasing speed of time-to-market parameter, decreasing product lifecycles and overall orientation on "agile" business, it may be argued that the changes that allow to squeeze more productivity without contributing more resources and the bonus in form of a culture allowing to breed the specialists with the progress-oriented paradigms

massively, the Lean, along with Lean Innovation will remain a hit for the nearest decade in business optimization. And still have a long way to go.

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