IMPACT OF THE NATIONAL INNOVATION SYSTEM ON INNOVATION

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ABSTRACT
Purpose. Aim of this research is, firstly – to outline the theoretical aspects connected with the impact of the national innovation system (NIS) on innovation. Secondly – to create and test the methodology for the analysis of the impact of the NIS on innovation for detecting the main innovation barriers. Thirdly – to elaborate recommendations for the companies and the government to promote the implementation of innovation in Latvia by improving the NIS.
Methodology. The research is organized in three sections. Introduction has explained the background and necessity of this research. The three sections include short overview of the main concepts and problematic issues connected with the key concepts of this research, description of the methodology and analysis of the impact of the NIS on innovation and recommendations for the promotion of innovation in Latvia improving the NIS.
Proposed methodology of analysis is based on the analysis of literature carried out by the author of this research. It is tested on the analysis of impact of Latvia's innovation system on innovation and includes interviews with experts of NIS and survey of innovative companies.
Findings. After analysis of the NIS of Latvia there were identified innovation barriers referring to the NIS in general as well as to the separate functions of the NIS. The research identified the following three broad issues: 1) the main function that initiates the development of knowledge and innovation (influence of the direction of the search) is not being implemented; 2) lack of cooperation between NIS participants; 3) inefficient and fragmented management of the NIS. The main innovation barriers are: lack of financial resources, lack of qualified personnel and the lack of appropriate support services.
Originality. Proposed methodology of analysis may be used by scholars as well as policy makers to assess the impact of the NIS on innovation and to determine the main innovation barriers, to investigate the mismatch between policies and problems, identify policy gaps and devise better policies for the promotion of innovation.
This research can be used by owners/managers of companies in the making of decisions connected with the innovation process.
Category of paper: research paper.
Key words: *innovation, innovative company, national innovation system, innovation barriers, innovation system functions*

1.INTRODUCTION

The growing importance of innovation in the situation when markets are becoming increasingly global, lifestyle and needs of the customers are changing rapidly and technological opportunities are increasing quickly is widely recognized. Nowadays, the ability to innovate has become one of the most significant determinant of the development and competitiveness of the company. As the innovation is influenced by the numerous internal and external factors, the implementation of innovation is associated with high risk and high degree of uncertainty, it presents significant challenges to the management of the company. Therefore, to reduce the risk and uncertainty, the company needs to understand the nature of the innovation, it influencing factors (especially hampering factors), the available support instruments, as well as their development process.

Successful innovation processes in companies are important also for the government, as the development of the innovative entrepreneurship determines the country's economic development.

Innovation in the company and its influencing external factors are components of the NIS. To identify the main factors influencing and hampering innovation and to develop the appropriate support instruments it is necessary to carry out the analysis of the NIS.

2.OVERVIEW OF THE KEY CONCEPTS: INNOVATION, INNOVATIVE COMPANY, INNOVATION BARRIERS, NATIONAL INNOVATION SYSTEM, INNOVATION SYSTEM FUNCTIONS

Innovation is the key to economic development and competitiveness in the knowledge economy but there is still no single generally accepted definition and classification of concepts "innovation", "innovative company", "innovation barriers", "national innovation system", "innovation system functions".

Analysing different *innovation definitions* proposed in the literature it can be concluded that the term

"innovation" is used as the process (for example, Forest, 1991; Galanakis, 2006; Zizlavsky, 2013) and as the result (for example, Edquist, 2001; Parthasarthy and Hammond, 2002) (Gopalakrishnan and Damanpour, 1997; Quintana et al, 2011). Some authors provide broad scale innovation definition that can be used generally (for example, Baregheh et al., 2009 from Lisetchi and Brancu, 2014; Forrest, 1991), while other authors' definitions refer to a particular innovation type (for example, Parthasarthy and Hammond, 2002). Some innovation definitions explain the concept broader, including a number of aspects – innovation outcomes (for example, new formations, new products, processes, knowledge, services) and/or innovation objectives (for example, to compete successfully and to differentiate the company in the market), and/or used resources (for example, new or existing scientific or technological knowledge, equipment, software and human resources), and/or other aspects, while others – narrowly.

The two most important aspects defining innovation is the aspect of novelty and the economic benefit that innovation brings to the company. Therefore innovation in this research is defined as the development and implementation of new to the market or company or significantly improved product or process that brings economic benefit to the company.

There are different classifications of innovation in the literature, which greatly complicates the understanding of definitions of different types of innovation used by various authors and relationship between different types of innovation. Such a lack of consistency in the classification of innovation can lead to confusion on the subject of empirical research. However as the main innovation categories, which can cover different types of innovation mentioned by various authors product and process, technological and administrative, radical and incremental innovation can be mentioned (Rowley et al, 2011). In addition, any of the first mentioned four types of innovation can be both radical and incremental.

Factors determining innovation have been widely studied in the literature with the aim to understand what factors contribute to the development of innovation and relationship between these factors and activity of the company. Smaller is the number of studies that contain alternative approach and that are focused to the analysis of factors hampering innovation, their role in the innovation process and the extent to which they slow down, premature stop or prevent implementation of innovation (Mohnen et al, 2008; Silva et al, 2007; Lukjanska, 2010). Factors hampering innovation in the literature are called innovation barriers (Mirow et al, 2008 from Hueske et al, 2015). In this research division of innovation barriers into internal and external barriers is used. Internal barriers arise inside the company and are associated with the resistance to innovation (Holzl and Janger, 2013). External barriers result from the interaction of the company with other companies and other actors of the NIS (Holzl and Janger, 2013).

Among small number of studies focused to the research of innovative company only few studies provide clear definitions of the innovative company. Obvious classification of innovative companies also is not provided in the literature. In this research innovative company is defined as the company that has developed and implemented in the company or market new or significantly improved product or process that provides economic benefit for the company.

With the aim to understand and analyse the nature and development of innovation there have been developed a number of models, each of which focuses on different areas that were dominating in the period of their development. Rothwell has grouped these models into five historic generations – the technology push model, the market pull model, the coupling innovation process model, the functional integration model and the systems integration and networking model (Rothwell, 1993 from Hobday, 2005). Over the time the focus has turn from the linear to the systems models that are able better to grasp the complex innovation process in the company – the feedback and exchange of information, knowledge and other resources between the various stages of the innovation process and the external environment. Galanakis (Galanakis, 2006) indicates that a new generation approach – the innovation systems approach was created in the 1980s and 1990s.

There is a consensus between science and policy communities that the most appropriate tool for the analysis of innovation is the NIS approach (Ghazinoory and Bitaab, 2014; Hekkert et al, 2007; van Hemert et al, 2013). In this research NIS is defined as the set of measures implemented within the cooperation between the public and private sector to create, accumulate, change and use new knowledge with the aim to promote the implementation of innovation and subsequently – the sustainable development of the economy.

Overview and analysis of NIS definitions, functions and methods of analysis is provided in the articles "Measuring problems in small country National Innovation system" (Resele, 2014b) and "Measuring the functionality of national innovation system" (Resele, 2014a).

Innovation system include factors that determine innovation – all important economic social, political, organisational and other factors that influence creation, dissemination and use of knowledge (Edquist, 2008) and affect the learning capacity of organisations and hence the capacity to develop innovation (Lundvall,

1992). Edquist, Liu and White, Johnson and Jacobsson, Hekkert uses factors determining innovation and system specific functions as synonyms (Edquist 2001 from Suriyani et al, 2012; Liu and White, 2001; Johnson and Jacobsson, 2000; Hekkert et al, 2007). Weak performance of functions creates innovation barriers.

In this research as main or direct functions of the NIS are proposed two functions:

- development of new knowledge;
- use of knowledge,

and as support or indirect functions:

- influence on the direction of search;
- supply of resources;
- creation and change of the "rules of the game";
- formation of the markets;
- facilitation of information and knowledge exchange.

Analysis of the NIS functions helps to determine the impact of the NIS on innovation and to determine the main innovation hampering factors or innovation barriers. Description of the methodology and analysis of situation in Latvia is provided in the chapter two of this paper.

3.METHODOLOGY AND ANALYSIS OF THE IMPACT OF THE NATIONAL INNOVATION SYSTEM ON INNOVATION

3.1.METHODOLOGY FOR THE ANALYSIS OF THE IMPACT OF NATIONAL INNOVATION SYSTEM ON INNOVATION

Methodology for the analysis of the impact of NIS on innovation and for the identification of key factors hampering innovation developed in this research rests on the synthesis of the research of Bergek (2008), Chaminade et al (2012) and Hekkert et al (2007). It includes four steps:

- identification of structural components of NIS;
- identification and analysis of NIS functions;
- identification of innovation barriers;
- identification of key policy issues and elaboration of recommendations.

The first step involves setting the starting point for the analysis, i.e. defining the NIS in focus and identifying structural components of NIS – actors, networks institutions. In the second step functions of NIS are analysed describing what is actually going on in the NIS in terms of the seven key processes (two main or direct functions and five support or indirect functions). In the third step their fulfilment is assessed (how well they are implemented) and innovation barriers are identified. In the fourth step key policy issues related to the innovation barriers (innovation hampering factors) are defined and recommendations elaborated.

Identification and analysis of the NIS is based on the analysis of theory, strategic documents and regulations, studies, indexes and statistics, case studies, interviews with experts (representatives of actors of NIS) as well as survey of innovative companies.

To plot a complex picture of the NIS in Latvia and its impact on innovation viewpoint not only of innovative companies but also of representatives of all actors of Latvia's NIS is taken into account. There were carried out face to face interviews with 45 experts representing all actors of the Latvia's NIS from 21 February 2014 to 26 March 2014 and survey of technology innovative companies from 7 May 2014 to 7 august 2014 in this research.

Experts for the interviews were selected on the basis of the following criteria (Lamprinopoulou, 2014):

- belonging of the organization represented by the expert to the corresponding actors category of the NIS and role of the organisation in the NIS;
- knowledge, experience and contribution of the expert in relation to the NIS in general and/or certain its functions, and/or development and implementation of innovation policy;
- degree of influence of the expert in the organisation he/she represents.

Interviews of experts were carried out following twelve pre-prepared open ended questions.

The number of innovative companies, including technology innovative companies in Latvia cannot be determined since in the data base of Central Statistical Bureau (CSB) there are not included statistical data about innovation in the micro companies (companies with less than 10 employees). The lack of this information significantly affects the overall assessment of the innovations in Latvia in both domestic and foreign reports and surveys. According with the data of CSB in 2013 there were 93 775 economically active

individual merchants and commercial companies (excluding agricultural and fishing farms and self-employed persons who perform economic activity), of which 86.2% corresponded to micro company category in Latvia[2].

It should be also mentioned that CSB indicates company as an innovative if during the reference period (three years) it has implemented at least one innovation. Financial criteria that allow estimating the economic benefit the innovation brigs to the company are not used.

Taking into account the lack of information about innovative companies in Latvia as well as non-use of the financial criteria for the selection of the innovative companies as source for the survey of technology innovative companies edition about innovative companies in 2011 in Latvia that have implemented new products and services or new technologies (LIAA, 2012) as well as list of contestants of Export and innovation award in 2011, 2012, 2013 in the category "Innovative product" was used.

Investment and Development Agency of Latvia selects innovative companies following also financial criteria (LIAA, 2012) (two of the following criteria should be met):

- at least 25% of current sales are made up of products that have been introduced or significantly improved over the past five years;
- the profit generated by new products or services that are not older than five years is at least 10% of gross profit;
- sales derived from the introduction of new products or services have increased annual turnover of the company by more than 5%.

The survey in this research was conducted by means of electronic mail. A questionnaire was sent to the technology innovative companies e-mail addresses. 71 questionnaires were received.

The questionnaire included thirteen questions. Five questions concerned the company's general indicators. Two questions were related to the overall assessment of the NIS. Six questions concerned company's activities connected with the creation of knowledge and innovation. Intelligibility of questions was tested in the three companies before the questionnaire was sent out to the other respondents.

Experts of the NIS and managers/owners of the technology intensive companies were asked to evaluate the main innovation barriers for companies using five-point scale, 1 – having no impact, 2 – small impact, 3 – average impact, 4 – significant impact, and 5 – large impact.

Data processing and analysis was carried out using statistical methods, including correlation and analysis of variance, factor analysis, ranking, time series analysis.

3.2.ANALYSIS OF THE IMPACT OF THE NATIONAL INNOVATION SYSTEM ON INNOVATION IN LATVIA

There are many studies and surveys carried out by various organizations and researchers in the connection with the knowledge creation and use. Fulfilment of the NIS functions can be assessed using these sources of secondary data that can be classified as the external evaluation, such as the Global Competitiveness Report, the Innovation Union Scoreboard. Aim of this research was to obtain the internal evaluation of NIS from all its actors – creators of knowledge, users of knowledge as well as providers of the support functions.

Figure 1 contains evaluation from the experts about the innovation hampering factors – innovation barriers and their initiating factors.

[2] http://data.csb.gov.lv/pxweb/lv/uzreg/uzreg__ikgad__01_skaits/SR0043.px/table/tableViewLayout1/?rxid=cdcb978c-22b0-416a-aacc-aa650d3e2ce0

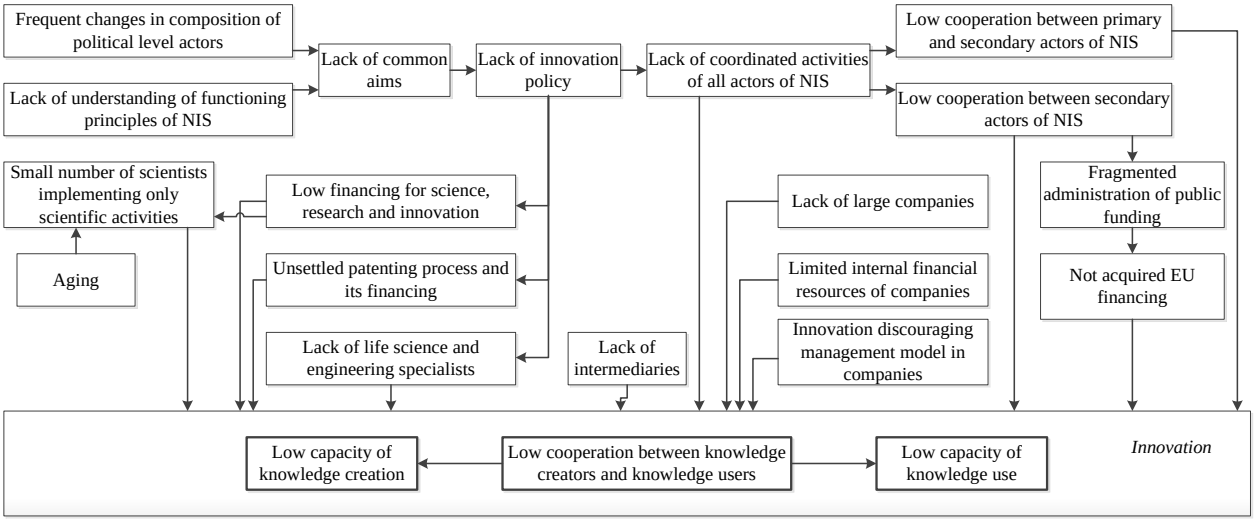

Figure 1. Main innovation barriers and their initiating factors: evaluation from experts
Source: composed by the author

Experts admit that formally all the necessary NIS actors exist but the NIS does not function because activities of its actors are not coordinated and focused on the achievement of common aim defined in the innovation policy. Cooperation between primary actors (knowledge creators and knowledge users), cooperation between primary and secondary actors (providers of support) as well as between the secondary actors was evaluated as insufficient. As the main reason for the week NIS and lack of innovation policy was mentioned frequent changes in the composition of political level actors. For example, since 1990 until 2014 17 education ministers have changed[3]. It was also mentioned that employees of public administration organisations lack understanding of functioning principles of the NIS and that dominant is the opinion that market will adjust everything.

The management capacity of public organisations was assessed as low that for example significantly impedes the absorption of the EU structural funds. Requirements stipulated in the laws and regulations are not being met and such a failure does not provide for any sanctions.

Both public and private sector funding for science, research and innovation is significantly small, besides administration of public funding is fragmented, as well as the achievable performance indicators are inadequate. Unstable and scares financing contributes to the situation that number of scientists implementing only scientific activities is small. Topical also is the problem of aging.

One of the main factors hampering capacity of knowledge and innovation creation was mentioned patent acquisition process and it's financing. Reference was also made to the lack of life science and engineering specialists.

According with the results of factor analysis answers provided by the companies about the main innovation barriers form four complex factors (groups of barriers) – financial limitation, disturbing market conditions, lack of support, uncertainty and risk, which together explains 67.85% of the variance. The first complex factor – financial limitation explains 22.85% of the variance and it includes four hampering factors: limited financial resources, lack of financial support, lack of government support, too expensive financial support. The second complex factor – disturbing market conditions explains 17.13% of the variance and includes: lack of customers' interest in innovative products or services, lack of competition in the domestic market, need to meet the legislative requirements of the Republic of Latvia, need to meet the requirements of EU and other international organizations. The third factor – lack of support explains 13.96% of the variance and it includes: lack of qualified personnel, lack of support services, support services do not meet the companies' needs, lack of information on technology. The fourth complex factor – uncertainty and risk explains 13.91% of the variance and includes: too high risk of failure, too high costs related to the introduction of innovation, lack of information on market demand.

According with the evaluation of representatives of universities and research institutes five main factors hampering innovation for companies is limited financial resources (4.8 from 5 point scale), lack of qualified personnel in the labour market (4.40 from 5 point scale), lack of external financial support (4.40 from 5 point scale), support services do not meet the companies' needs (4.25 from 5 point scale) and lack of government support (4.2 from 5 point scale) (Figure 2). Providers of the support as innovation barriers also indicated lack

[3] http://izm.izm.gov.lv/ministrija/vesture/pec-kara.html

of qualified personnel (3.9 from 5 point scale) and lack of financial support (3.5 from 5 point scale) adding also three internal factors – limited financial resources (4.05 from 5 point scale), too high risk of failure (3.48 from 5 point scale), too high costs related to the introduction of innovation (3.76 from 5 point scale).

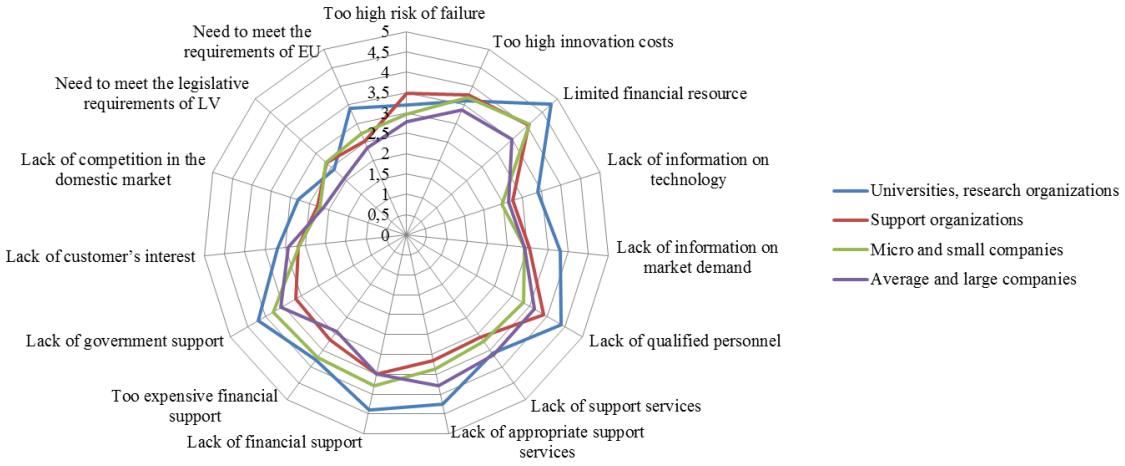

Figure 2. Main innovation barriers for innovative companies
Source: composed by the author

Universities and research institutes, as well as micro, small, medium and large companies indicate external factors more hampering innovation as internal ones, support organizations – internal factors. Significantly that support organizations that include government level actors as relevant mention also the factors that are evaluated by innovative companies as the innovation most hampering factors – lack of financial support and lack of qualified personnel. However, between the representatives of the government level actors' dominant is the assessment that the proposed support instruments meet the needs of innovative companies that is opposite to the evaluation of the companies. It can be concluded that supply of the support instruments does not meet the demand from the companies.

The evaluation of the main innovation barriers differs between different categories of the companies. Micro and small companies (MSC) as the main innovation barrier indicate limited financial resources (77% of MSC assess the impact of this factor as significant or large and 16% as average), lack of government support (57% of MSC assess the impact of this factor as significant or large and 36% as average), lack of financial support (63% of MSC assess the impact of this factor as significant or large and 26% as average). Lack of financial resources is not mentioned by medium sized and large companies (MLC) in the survey as the main hampering factor. As the main innovation barrier is indicated support services that do not meet the needs of companies (64% MLC assess the impact of this factor as significant or large and 29% as average), followed by the lack of support services (50% MLC assess the impact of this factor as significant or large and 43% as average) and the lack of qualified personnel (57% MLC assess the impact of this factor as significant or large and 29% as average). Lack of internal and external financial resources in the assessment of innovation barriers by medium and large companies holds only the fifth and the sixth place.

Assessment of the scientific activities and capacity of Latvian scientific institutions, Guidelines for the Development of Science, Technology and Innovation for 2014-2020 (STI Guidelines for 2014-2020) and the Global Competitiveness Report 2014- 2015 was used as the secondary sources of information for the evaluation of innovation barriers in this research.

While in the primary and secondary sources as the main innovation barrier mostly lack of financial resources is stressed, it should be remembered that the process of knowledge creation starts with the determination/selection/influence of the direction of the research, which is a function implemented by government (seldom – by companies). If this function is not performed effectively, respectively other NIS functions are not performed and the NIS does not work – its members do not cooperate – the activity is not directed at the achievement of common objectives.

Identification of the main innovation barriers provides information about problems that companies face in the innovation process. To remove or at least reduce the innovation barriers there should be appropriate activities both from the government and from companies' side. Recommendations to promote innovation both in the company and in the state level are provided in the chapter three of this paper.

4.IMPROVEMENT OF THE NATIONAL INNOVATION SYSTEM TO PROMOTE INNOVATION IN LATVIA

The planned public support instruments for this planning period (2014-2020) are highlighted in the STI Guidelines for 2014-2020.

Analysis of the STI Guidelines for 2014-2020 shows that greater number of activities is focused on the support of science and research. To promote innovation development it is planned to continue support of activities of technology transfer contact points, competence centres, business and technology incubators. It is planned to extend the amount of early stage financing instruments, as well as the availability of scientific infrastructure for companies. Corporate income tax discount for the companies that have made investments in the research and development (R&D) and development of the joint technology transfer platform in the form of 2-3 technology transfer centres where the technology transfer experts and expanded technology transfer services will be concentrated are the new planned activities for the years 2014-2020.

Based on the results of survey of innovative companies as the most necessary forms of support tax discount, support for the development of new products and technology and implementation in the production as well as support for the entrance in the foreign markets is mentioned. Important is also financial support of patenting and prototyping as well as receiving credit on preferential terms.

After comparing the planned state support instruments with the needed by companies it can be concluded that the offer partly correspond with the demand. There still is unclear support for many important activities, for example, patenting and prototyping.

From the analysis briefly described in this paper there could be developed several recommendations.

1. Internal innovation barriers can be prevented or reduced by companies on their own but to prevent or reduce external barriers it is recommended to the companies to cooperate with the other actors of the NIS.
2. It is recommended to *the managers/owners of the innovative companies* in cooperation with the Employers' Confederation of Latvia and other organizations representing interests of industry with the aim to promote the development of innovative entrepreneurship and improvement of the NIS, to guide the addressing of the following questions:
   a. development and adoption of the main law on innovation – "About innovative entrepreneurship", that defines and controls innovative entrepreneurship and foresees incentives for innovative companies;
   b. development of the appropriate innovation support infrastructure in the public sector – open and experimental laboratories, pilot factories, as well as providing support tools for the commercialisation activities;
   c. adoption of national programs, regulations, orders with the mutually coordinated periods of activity; provision of permanent financing and constant conditions of the most successful national support instruments;
   d. provision of continuous support for the intermediary services between the researchers and the entrepreneurs; development of the optimal model for this kind of service;
   e. raising awareness about the intellectual property (IP) protection issues, development of the support instruments for obtaining patents, arrangement of the IP protection issues in the laws and regulations, taking into account the examples of good practice of other countries, for example, Sweden;
   f. development of the support programs for academic staff and researchers for obtaining the business knowledge and skills, including contact hours with the entrepreneurs.
3. It is recommended to *the managers/owners of the innovative companies* in order to prevent or reduce innovation barriers to take the following activities:
   a. to evaluate company's resources and take into account existence of such external innovation barriers as lack of financial support, lack of qualified personnel, lack of appropriate support services;
   b. to develop the long-term strategy where company's activities are planned also at the international level;
   c. to evaluate the company's management model and its openness to innovation, if necessary, to make changes;
   d. to promote new knowledge and technology absorption capacity of the company's employees;
   e. to carry out training of the employees regularly and to provide an opportunity to participate in the exchange visits;
   f. to build a team of professionals with complementary expertise.
4. It is recommended to *Cross-sectoral Coordination Centre* to take following activities:
   a. to take the responsibility for the development and management of the NIS and the development and implementation of the innovation policy;

b. to perform purposefully the analysis if the NIS and on this basis to develop and control the implementation of the specific instruments aimed for the promotion of innovative entrepreneurship;

c. to be responsible for initiating laws and regulations and budget allocations;

d. to coordinate the flow of information about innovative entrepreneurship in Latvia;

e. to organize business experience exchange forums and informative educational activities;

f. to evaluate the effectiveness of the organisations providing public support in any form for the knowledge and innovation generation process, make the audit of their functions, to evaluate the performance indicators, based on the results obtained to perform the optimization of the number of the organisations;

g. to promote cooperation between the Ministry of Education and Science, the Ministry of Economy and other public authorities at all levels.

5. Additional recommendations for the promotion of innovation aimed at the prevention or reduction of the innovation barriers indicated in this research:

a. to develop and offer training programs for the change of mind-set and motivation of the entrepreneurs in order to facilitate the transition to the business model that is oriented towards the fast development, international entrepreneurship and sustainable competition;

b. to carry out the assessment of the technology absorption capacity of companies and to develop appropriate tools for the promotion of this capability;

c. to activate the municipalities for the search and development of the new forms of support of innovative entrepreneurship;

d. to develop the regional innovative entrepreneurship information centres or to expand the functions of the existing innovation supporting organizations;

e. to activate the development of the scientific/technological/industrial parks, which operate in the accordance with the world practice by attracting the national, EU and foreign direct investment;

f. to achieve the tax reduction to a level where all the taxes do not exceed the taxes in the neighbouring EU member states and to introduce the tax incentives to boost the number of companies involved in the research, development and innovation;

g. to encourage credit institutions also to evaluate and provide financing for the innovative projects;

h. to ensure the advance payments for the implementation of the companies' projects approved in the various EU programs;

i. to introduce the instruments for the support of the protection of IP abroad;

j. to increase the public procurement and to promote the public-private partnership projects;

k. to develop and support risk financing program for the early-stage innovative entrepreneurship.

5.CONCLUSIONS

1. This paper contains the main results, conclusions and recommendations of the doctoral thesis.

2. Conclusions and recommendations of this research were sent to the 71 innovative companies that have participated in the survey. Answers were received from 9 companies.

3. None of the owners/managers of the 9 companies have objected to the conclusions and recommendations. Recommendations as a whole were evaluated as good and possible to use in the promotion of the implementation of innovation. Some respondents have suggested preparing some recommendations more detailed.

4. As important issues promotion of the cooperation between entrepreneurs and scientists/researchers, the need to approximate the qualification of workforce to the needs of companies, the promotion of the justice in the country, the promotion of the access to the markets, the optimization of public administration, the improvement of the innovation support infrastructure in the public sector, the establishment of the joint coordinating centre, was highlighted.

5. There is a need for additional research of the impact of the NIS on innovation, of the innovation barriers especially the internal barriers. The illustration of the methodology on the basis of analysis of one NIS is not sufficient to draw conclusions on the usefulness of the framework.

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