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**DOREL TAMM**

# Alignment between the factors of the innovation process and public sector innovation support measures: an analysis of Estonian dairy processors and biotechnology enterprises

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# TABLE OF CONTENTS

# THE LIST OF AUTHOR'S PUBLICATIONS AND CONFERENCE PRESENTATIONS

**I. Chapters in monographs**

1. **Tiits, M.; Kattel, R.; Kalvet, T.; Tamm, D.** (2007). Catching up, forging ahead, or falling behind? Central & Eastern European development from 1990 to 2005. (Extended Abstract). *In: IEEE Conference Proceedings: Atlanta Conference on Science, Technology and Innovation Policy*, October 19-20, 2007. Atlanta, GA, USA: IEEE, 2007, 1–4.
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*rentsi ettekanded-artiklid: Tartu - Värska*, 1.–3. juuli 2004. Berlin, Tallinn: Berliner Wissenschaftsverlag GmbH, Mattimar OÜ, 2004, 472–483.

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3. **Tamm, D.** Differences in indicators related to export competitiveness: the case of Estonian wood sector firms. *Majandusteaduse Seltsi I aastakonverents;* 20.–22. jaanuar 2006, Pärnu, Estonia.
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# INTRODUCTION

## Motivation for the research

The majority of countries attempt to support the innovativeness of their firms because innovativeness is seen as the most important component of competitiveness, while competitiveness is seen as the key to national economic performance and growth. Also, firms are interested in being innovative because successful innovative projects are usually linked to increases in profits and/or other indicators describing the economic success of the enterprise. At the same time, innovative projects may fail because of risks and uncertainty linked to the process and/or high costs for the enterprise. To decrease the risks and uncertainty for enterprises, the government could implement public sector innovation support measures targeting the most important problems in the innovation process. In doing so, innovation support measures have to be in accordance with enterprise needs to ensure that the process is efficient.

Inefficiencies in innovation support measures can be caused by several factors. First, the main elements of the different innovation support measures in Europe usually involve supporting R&D activities and facilitating key technologies. The influence of the country's environment, development stage and history on enterprise behaviour is often overlooked, although elements of the support system should take these specific aspects of the particular country and its enterprises into account. This may lower the efficiency of innovation support measures.

The second reason is linked to limited resources. Because financial resources supporting innovativeness in enterprises are limited, choices have to be made. In some cases focusing on one or several key technologies and/or industrial sector(s) is advocated by the public sector. However, the selection of the key technologies or sector(s) is rather risky because of the uncertainties linked to forecasts; no one can confidently predict which sectors or technologies will be strategically successful for the country in the future. If the country supports one or two technologies and/or sector(s) whose performance is excellent at the national level, the choice could already be erroneous because these sectors or developments in technology may lag behind compared to the top performers globally. The time factor also has to be considered. For example, similar sectors in different countries may evolve at different speeds due to different framework conditions. That is why instead of focusing on specific sectors and/or technologies, certain innovation process factors or innovation process stages causing problems for most firms in a country could be selected and public sector measures constructed to focus on those problematic areas.

To do that, every country has to identify the barriers or problematic stages of the innovation process for enterprises in that specific country and design innovation support measures accordingly. In other words, there has to be alignment between factors influencing the innovation process and innovation policy measures. Without such alignment, resources may be wasted and the efficiency of the innovation policy measures lower than expected. For example, in Eastern Europe, productivity levels are lower than expected in terms of R&D, innovation and production capabilities. In those countries, R&D employees do not generate as many publications and patents as the rest of the world. This may be caused by inefficiencies in the innovation system's framework (Kravtsova, Radosevic 2009: 1).

The implementation of support measures and possible inefficiencies in them are evaluated rather often. In Estonia, the most recent evaluation was conducted by the National Audit Office of Estonia, and the results of that report were very critical of Estonian support measures. In this thesis, the (in)efficiency of innovation support measures is evaluated on the basis of the alignment concept. The use of the alignment concept in analyses of innovation support measures and policy evaluations is not very widespread. In many policy evaluations misalignment is emphasised as one of the problems causing inefficiencies in innovation systems, but no operationalized method has been developed. This thesis develops a method for evaluating innovation support measures based on the alignment concept – a toolbox for analysing alignment is elaborated and implemented. This may be the first attempt to operationalize the use of alignment in policy evaluations. The toolbox is universal and can be implemented in different countries and for different national innovation systems.

To develop a toolbox for evaluating alignment, a synthesis of previous innovation process models is conducted and an overview of factors influencing the innovation process in enterprises is compiled. Compiling innovation process factors helps summarize the results of earlier empirical research and reveals areas needing additional research (i.e. gaps in existing research).

## The aim and research tasks of the thesis

The aim of the thesis is to provide suggestions on how to increase the efficiency of public sector innovation support measures based on the results of alignment analysis. In this thesis, alignment analysis is based on a comparison between the factors of the innovation process in one specific sector and specific country, and the innovation support measures implemented in that specific country. The analysis reveals the areas where factors of the innovation process causing problems for enterprises are not targeted by innovation support measures and so misalignment exists. To achieve the aim of the thesis, the following tasks are set up:

1) introduce existing innovation process models and current criticisms of these models;
2) develop an innovation process model to analyse alignment issues;
3) present and analyse factors of the innovation process based on the innovation process model developed;
4) discuss the chronology and criticisms of the national innovation system approach;

5) analyse and discuss reasons for public sector interventions based on system failures;
6) carry out an analysis of public sector innovation support measures within the framework of the national innovation systems (NIS) approach;
7) develop a framework for analysing alignment between factors influencing the innovation process in enterprises and public sector innovation support measures;
8) analyse the importance of Estonian dairy processors and biotech activity;
9) formulate research propositions and present a short description of the research methodology;
10) present the results of the analysis of the innovation process in Estonian enterprises and existing Estonian innovation support measures;
11) conduct an analysis of the alignment between factors influencing the innovation process in Estonian dairy processors and biotech enterprises, and existing Estonian innovation support measures;
12) provide a synthesis of the research results;
13) develop suggestions on how to increase the efficiency of public sector innovation support measures.

## The structure of the thesis

This thesis comprises two chapters. The structure is presented in Figure 1. The literature review concerning enterprise level innovation processes makes it possible to understand the innovation process and divide the innovation process into distinguishable stages. There are five generations of models of the innovation process. The earlier models of the innovation process are linear and rather simple. These models simplify the innovation process too much, but they are often taken as the basis for designing innovation support measures. Policy makers often forget the importance of the linkages between different stages of the innovation process and the variety of actors involved. The fifth generation of innovation process models are more complex and also consider the networks and feedback loops between different stages. To achieve the aim of this thesis, a new innovation process model is developed based on previous models.

After developing the innovation process model, factors influencing the innovation process are discussed, analysed and grouped according to the developed model. Although all factors of the innovation process are important for introducing successful innovation to users, not all of them cause problems or dominate at one particular time and in one particular enterprise. The importance of innovation process factors at a single point in time and in a single region rests on several different circumstances existing in the internal and external environment of the firm.

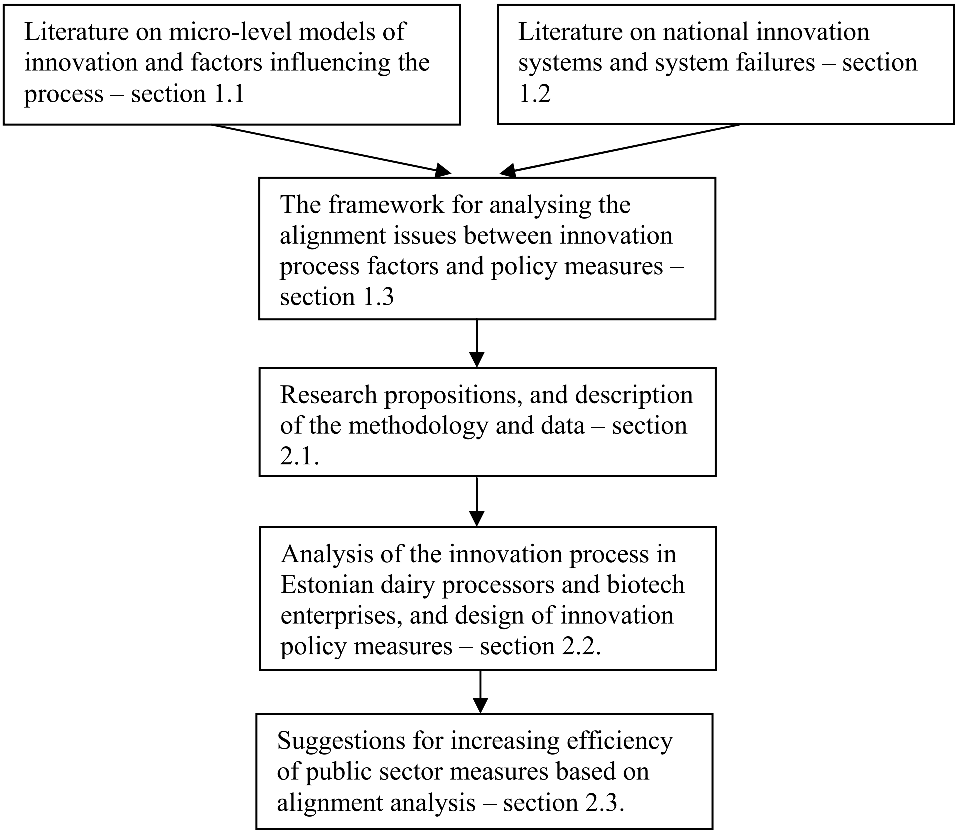


**Figure 1.** The structure of the dissertation

Section 1.2. provides an overview and synthesis of the literature relating to the national innovation system approach. This literature provides the framework for analysing public innovation support measures. The design and implementation of innovation support measures are linked to two interconnected topics – the functions of the innovation system and system failures. If the functions of the innovation system do not exist or are not efficient, and/or some barriers in the innovation process cause problems for enterprises, this may create or be caused by system failures and may require intervention by the public sector. System failures can be seen as one reason why inefficiencies exist in the innovation system or as the outcome of those inefficiencies. According to the system failure approach, problems cannot be analysed in isolation. For example, to remove a barrier from the innovation process, focusing on that particular barrier may not result in a solution. It may be the case that the barrier cannot be removed without the removal of other problems and barriers. That is why concepts like infrastructural, capabilities and governance failure are discussed and a framework for classifying system failures is developed.

Section 1.3. covers the issues of policy measures within the framework of innovation systems, and the development of a framework for alignment analysis. Alignment analysis stems from the innovation process and factors linked to it. This thesis studies the alignment between innovation process factors and innovation support measures.

The empirical part of the dissertation, the second chapter, is also divided into three sections. The first section of the empirical part includes the propositions and descriptions of the data and methodology. An overview of Estonian dairy processors and biotech enterprises is also provided. Dairy processors include only enterprises processing raw milk into different products and not the producers of raw milk.

The alignment issues in this thesis are analysed based on those two separate groups of enterprises, which are chosen because of the differences and similarities existing between them. Dairy processors have been classified as belonging to a traditional manufacturing industry and biotech enterprises represent high-tech enabling technology. At the same time they are interlinked and some cooperation takes place between those two areas in Estonia. This enables us to study alignment based on two rather different economic activities, which at the same time are interlinked. Linkages are a very important part of the innovation system approach. Through linkages and flows systems are defined.

The second section of the empirical chapter of the thesis includes an analysis of innovative activities and the innovation process in dairy and biotech enterprises, and the Estonian National Innovation System including the design of public sector measures. The information about the innovation process is based on the data gathered during interviews, which were conducted by the author of the thesis, and the results of the questionnaires. From the public sector only the most important organizations for innovative enterprises are chosen – the Ministry of Economic Affairs and Communication, the Estonian Ministry of Education and Research, Enterprise Estonia, KredEx and the Estonian Agricultural Registers and Information Board. The public sector organizations selected are active in designing and implementing policy measures focused on enterprises from those two groups.

The last part of the thesis is focused on alignment analysis, and the analysis results are presented and discussed. In this thesis alignment is analysed from the viewpoint of enterprises linked to particular activities – dairy processors and biotech enterprises. After the synthesis of the empirical results, suggestions for increasing the efficiency of public sector innovation support measures are elaborated and presented.

## Limitations

The first set of limitations of the research is linked to the comparison between innovation process factors highlighted in the theory and the factors of the innovation process in Estonian enterprises. The comparison of factors highlights the common elements between factors influencing the innovation process in Estonian dairy processors and biotech enterprises, and the innovation process factors highlighted by previous studies. Previous studies have analysed many factors causing problems or positively influencing the innovation process taking place in enterprises, but the list of factors is still not comprehensive. This may create a situation where data reveals additional factors not mentioned by previous studies, but testing the additional factors is not in the focus of this thesis. Problems with incomprehensive lists of factors may also cause some problems for the analysis of innovation support measures. Although the framework of factors influencing the innovation process based on the theory is not comprehensive and there are different ways to group these factors, it still provides a good overview of different aspects of a successful innovation process and creates a suitable starting point for the analysis of alignment.

An additional limitation of this research is linked to the delimitation of innovation support measures. Innovation process factors are influenced by the broad range of different policies, and therefore, it may be said that alignment analysis has to include all measures that help enterprises increase their innovativeness. This means that innovation policy encompasses education policy, monetary policy, foreign policy, science policy, technology policy, etc. In this thesis though, analysis is limited mainly to Estonian innovation support measures implemented by Enterprise Estonia, KredEx, and the Estonian Agricultural Registers and Information Board (EARIB). In other words, measures designed and implemented directly or indirectly for enterprises to help them with issues arising during the innovation process. So, the analysis is limited to only part of the measures influencing innovation process factors, which is in accordance with the objective of the thesis. At the same time, the toolbox developed in this thesis does not set limitations on the number of policy measures and enables, therefore, the analysis of a broader set of policy measures.

In this thesis, the alignment analysis studies the match between factors influencing the innovation process in dairy and biotech enterprises, and Estonian innovation support measures. Therefore, a comparison is conducted between existing issues related to Estonian enterprises and Estonian innovation support measures. It is important to remember that the results of the analysis of alignment should be considered as describing a single moment in time and not a dynamic process. The dynamics can be introduced into the model by using the developed method over a specific time line. The frequency of the analysis depends on the aims of the study. If the aim of the study is to analyse the impact of the policy measures, the analysis could be conducted before and after the implementation of the programme. This method can also be used to develop a specific package of innovation support measures, and not only for the evaluation of existing policy measures.

It may be said that based on the limitations described above only part of the Estonian innovation system has been studied. At the same time, some kinds of limits have to be set otherwise the analysis becomes too diffused. It is a rather wide spread practice to limit the research to a specific area, time and region, and not focus on the whole system (Edquist 1997: 18). Some of the linkages and effects may then be left outside the scope of the study, but this may not influence the results if the objectives set take into account and acknowledge these limitations. At the same time, the limitations set in this thesis do not limit the use of the developed method on broader sets of problems.

In this thesis, alignment is analysed based on industry/activity case studies and the data was gathered through the interviews. Although innovation process factors and public sector involvement in the innovation process are also covered by the Community Innovation Surveys (CIS), this was only used to verify the results of the interviews. More elaborate use of the CIS is limited for several reasons. First, the list of innovation process factors is significantly shorter in the CIS than the set of factors used in this thesis. Second, public sector involvement is covered rather superficially in the CIS. Third, biotechnology firms are almost not covered by the CIS.

While doing the qualitative research, the limitations of particular methods also have to be taken into account. The problem with the case study method is the potential bias of the researcher and interviewees. For that reason all the limitations have to be carefully analysed beforehand to avoid this problem and decrease its negative influence on the data collection and the presentation of research results. Discussions with supervisors and the presentation of the preliminary results at conferences helped to decrease the bias of the researcher in this thesis. Additional limitations of case study method and an overview of precautions taken by the author are discussed in greater detail in 2.1.2.

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All the mistakes and errors found in this dissertation are the responsibility of the author.

# 1. THE ALIGNMENT BETWEEN THE FACTORS INFLUENCING THE INNOVATION PROCESS IN ENTERPRISES AND PUBLIC SECTOR INNOVATION SUPPORT MEASURES: CONCEPTUAL FRAMEWORK

## 1.1. Theoretical concepts of micro-level models of the innovation process and factors influencing the process

### 1.1.1. Theoretical concepts of innovation and micro-level innovation processes

The importance of innovation and the innovativeness of firms are highly recognized by many authors. For example, Keith Smith (2000a) stated that innovation is the central element in competitiveness and through the competitiveness of firms innovation also affects the economic growth of countries.

Innovation itself is a rather complex concept with many definitions. The simplest and very general definition of innovation states that innovation is achieved when enterprises do something different (Knight 1967: 478). This definition does not specify what that "something" is and how it is implemented. Therefore, everything an enterprise does differently and for the first time in its everyday activities may be considered an innovation. Rametsteiner and Weiss (2006) also emphasize the change aspect when defining innovation. For them innovation is intentional discontinuous change in the inputs, processes or outputs of an enterprise (Rametsteiner, Weiss 2006: 566). Here the word "intentional" shows that the innovator has to be aware of the change and knowingly strive for it.

In addition to the above rather general definitions that emphasize the aspect of the change, other definitions of innovation add the aspect of economic value. Some of these definitions are presented in Table 1.

Innovation should create economic value for the company. It does not matter how the value appears. It may be linked to a decrease in costs, an increase in productivity or profit, the creation of jobs or something else. Without the potential for economic value, enterprises would not innovate and introduce changes.

Therefore, the definitions of innovation may be grouped according to two categories. The definitions belonging to the first group only emphasize novelty and/or the extent of the change, while the second group emphasizes economic value in addition to novelty. No matter which group we refer to, the most important thing is still that innovation involves implementing a new idea. As Knight (1967: 479) stated, innovation is not just having a new idea, the idea also has to be introduced in practice. The prospect of obtaining economic value out of a new idea and/or change is the main reason that enterprises innovate. It is also important to remember that innovation is not limited to technical change, but may also include additional dimensions of economic change (Hall, Rosenberg 2010: 2).

**Table 1.** Definitions of innovation that emphasise the value of the concept

| **Author** | **Definition of innovation** |
|---|---|
| Edquist 1997 | New creations of economic significance. They may be sold as novelties, but are more often new combinations of existing elements |
| Forrest 1991 | Innovation is the development and commercialization of an idea |
| Galanakis 2006 | The creation of new products, processes, knowledge or services by using new or existing scientific or technological knowledge, which provide a degree of novelty either to the developer, the industrial sector, the nation or the world and succeed in the marketplace. |
| Parthasarthy, Hammond 2002 | A manufactured product, relatively new to the industry, developed and marketed by firm; it may emerge from existing scientific/technological information (through extension or synthesis) or new information. |
| Smits 2002 | Innovation is the successful combination of hardware, software and orgware, viewed from a societal and/or economic point of view. |

Source: Composed by the author

The definitions in Table 1 show one additional aspect that typifies existing definitions of innovation. Namely, although all the definitions presented in Table 1 mention economic value in one way or another, several of them are rather limited in scope. For example, Parthsarthy and Hammond's definition encompasses only product innovations. Galanakis's definition is rather technology oriented and disregards the importance of markets. Those limitations are usually introduced to bring out and/or emphasise the focus of the study. In the current thesis innovation is defined similarly to Edquist (1997): innovation is a new creation and/or change with economic value for the enterprise. Although innovation may also be defined as the process of innovation (Axtell *et al* 2000: 266), in this thesis the words innovativeness, innovative and/or the innovation process will be used to describe the process.

Often just defining innovations is not sufficient for studying this phenomenon and everything accompanying it. Therefore, authors have also elaborated and introduced several typologies to distinguish innovations. The division and definition of different innovations helps us conduct a more thorough analysis of innovation because different types of innovations may behave, influence and be influenced by surrounding processes and the environment differently.

The most commonly used typology of innovations is product innovation, process innovation, organizational innovation and market innovation. Product innovation is usually defined as the introduction of new products and services. Process innovations cover all changes in the production process. This includes changes in inputs, equipment, tasks, workflow and information flows linked directly to production processes. (Damanpour 1991: 561) Organizational innovations encompass changes in the internal environment of the company; that is, change in supportive functions such as changes in procedures covering marketing, purchase and sales, personnel policy, administration, management, the structure of the company etc. Market innovations include entering new markets and segments, and implementing new marketing methods. (Avermaete *et al* 2003: 10)

Product, process, organizational and market innovations are not completely separable and independent from each other. Process innovation can often induce organizational innovation, or vice versa. Product innovation almost always causes changes in the production process i.e. process innovation. The other types of innovation mentioned above may also be interdependent and/or influence each other. This interdependence is analysed by Avermaete *et al* (2003), who showed the links between different types of innovations. Their approach is depicted in Figure 2.

Avremaete *et al* mention idea under product innovation, but according to the definitions of innovation employed in this thesis, an idea cannot be an innovation in itself. An idea has to be implemented and result in economic value before it may be classified as an innovation. After being implemented, the idea takes the form of either a product, process, organizational or market innovation. Therefore, the author of this thesis does not include idea under product innovation.

The typology developed by Damanpour *et al* (1989) is similar to the previously presented typology. Damanpour *et al* (1989) divide innovations into administrative and technical innovations. Technical innovations are linked to production process technology (transformation of inputs into outputs) or to the introduction of new products or services. Technical innovations are similar to product and process innovations. Administrative innovations are more linked to supportive functions rather than the core activities of enterprises, in other words, the structure of the enterprise, its administrative processes, and management. It includes the relationships, procedures, roles and rules inside the organization, and between members of the organization and the external environment. Administrative innovations are not directly connected to new outputs of the firm, but they influence the development of new products and services indirectly. (Damanpour 1991: 560–561; Damanpour *et al* 1989: 588–589) Therefore administrative innovations can also be defined as organizational innovations. Market innovations are not so explicitly described in this typology. They may belong to both of those groups depending on the characteristic of the market innovation. If a market innovation includes changes in procedures or rules it is an administrative innovation, if it is linked to the introduction of specific product/service innovations onto the market, it may be considered a technical innovation.

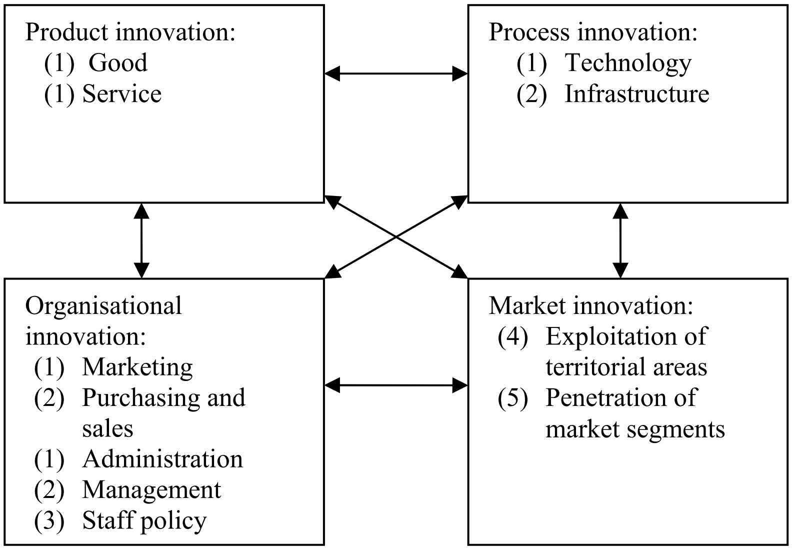



**Figure 2.** Types of innovation and their interdependence (Avermaete *et al* 2003: 10)

Technical and administrative innovations may also be interlinked. Introducing technical innovations could result in administrative innovations and *vice versa*. At the same time these two types of innovations usually influence each other over a different period. Damanpour *et al* (1989: 598) showed that administrative innovations influence technical innovations over a longer period. Technical innovations usually influence administrative innovations over the same period. (Damanpour *et al* 1989: 598)

Another way to differentiate innovations is to look at how radical the innovation is. This typology is closely linked to the first group of innovation definitions because more radical innovations are also more novel and this may be defined along the change spectrum (degree of change) in the performance (process, product etc) or structure of the enterprise (Knight 1967: 482, Brentani 2001: 170). That means that the degree of novelty may range from totally new products/services/processes (known as radical and discontinuous innovations) to products/services/processes with minor changes (also called incremental, continuous and evolutionary innovations). The novelty of the innovation can also be analysed on the basis of whether the innovation is only new to the firm or also new to the market (Brentani 2001: 170).

Abetti has developed a 5-level scale from radical innovation to incremental innovation. Level 1 describes innovations with the highest degree of novelty and level 5 describes incremental innovation with few improvements. An overview of this 5-level scale is presented in Table 2. (Abetti 2000: 209) The more radical the innovation, the more changes it causes in the surrounding environment. Damanpour (1991: 561) emphasizes changes in the enterprise itself (its structure and functioning) accompanying the introduction of innovation.

**Table 2.** Levels of the extent of change in innovations

| Level | Description of the extent of the change | Extent of change |
|---|---|---|
| 1 | Unique original product or system, which will make existing ones obsolete, based on proprietary technology beyond the state-of-the-art, highly specialized and customized, major R&D | Highly radical change |
| 2 | New product or system with original state-of-the-art proprietary technology that will significantly expand the capabilities of existing ones, specialized product with many adaptations, significant R&D | Radical change |
| 3 | New product with proprietary technology, but may be duplicated by others, mix of standard and special features, average R&D | Intermediate change |
| 4 | Significant extension of product characteristics with original adaptations of available technology, product with standard variations, limited patent protection, minor R&D | Significant incremental change |
| 5 | Incremental improvement over existing products, application of current technology, standardized product, not patent protection, no R&D | Minor incremental change |

Source: Abetti 2000: 209

Another important point linked to radical innovation is that sometimes these innovations are not easily accepted by the firm's shareholders because they encompass high risks (Galanakis 2006: 270). At the same time, while radical innovations are usually more risky and require more resources from the firm during the development stage, the benefits of success are also higher – higher profits, increased competitiveness and so on compared to successful incremental innovations (Brentani 2001: 171). But in addition to the risks linked to radical innovations, the ease of copying them may also play an important role. The idea may be novel and result in high benefits, but if it is easy to copy the accompanying risks may not be worth taking. The high level of risk associated with radical innovation may be one of the reasons why incremental innovation usually prevails in economies.

Knight (1967) developed another typology for innovations similar to the previously described typology. He divided innovations into routine and non-routine innovations. The definition of routine innovations is similar to continuous/incremental/evolutionary innovations – one also might say that these are programmed changes. These kinds of innovations are, for example, changes in car models, styles etc. In general they are small changes in products or processes. Non-routine innovations are similar to radical innovations and because of the high risks accompanying the innovation process for radical innovations, the introduction of radical innovations may result in either the success or failure of the entire enterprise. (Knight 1967: 484)

All these typologies may also be linked to product life cycle theory. Utterback and Abernathy (1975) have stated that during the earlier stages of a product's life cycle the dominant type of innovation is product innovation. During the latter stages the emphasis moves towards process innovation with the aim of decreasing production costs. Life cycle theory introduced by Utterback and Abernathy can also be linked to radical and incremental innovations. Radical innovations usually mark the introduction of a new product or process to the market. Incremental innovations prevail in the latter stages of process and product development. (Utterback, Abernathy 1975: 641–645)

Figure 3 links all previously mentioned typologies of innovation. The horizontal axis covers the extent of the change; the object of the change is presented on the vertical axis. The extent of the change is divided into two groups, but it may be divided into many more groups, for example, into 5 if Abetti's 5-level scale is taken as a basis. Figure 3 shows that the extent of change may cover all the objects of the change and objects of change may be either radically or incrementally changed.

The definitions and typologies mentioned above and shown in Figure 3 may create the impression that innovation encompasses rather trivial processes, but this is usually an overly simplistic view of the innovation process, although the majority of the first innovation models described the process in precisely that way. The first innovation process models dominating through the 1950s to the mid-1960s emphasized the importance of basic science as a source of innovative ideas because many of the new products during that period were based on new technologies and scientific discoveries. These models are known as technology-push models. The process of innovation was seen as a linear process starting from basic science and ending with sales. The role of markets was not considered to be important. Therefore, it was thought that innovativeness could be supported through investments in basic research and/or research taking place inside firms. (Rothwell 1994: 7–8; Bernstein, Singh 2006: 562) In many countries, even nowadays, the majority of innovation policy measures are based on this simple linear model and are therefore rather R&D oriented – grants for research in biotechnology, target values for R&D investments etc (Kline, Rosenberg 1986: 286, Lundvall 1988: 358).

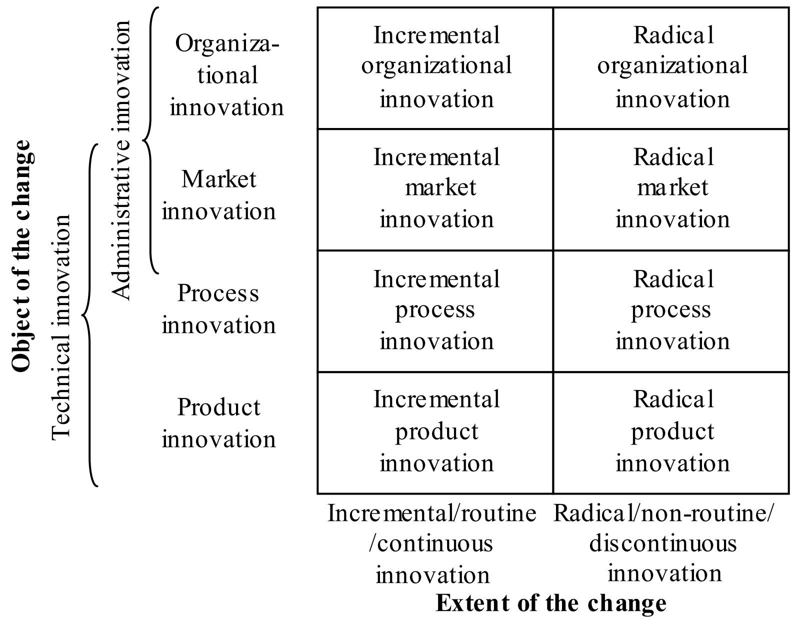



**Figure 3.** Links between innovation typologies (composed by the author)

From the mid-1960s to the early 1970s, market-pull innovation process models prevailed. The source of new ideas in those models was 'the' market. Back then enterprises mainly competed over market share and the aim of R&D was to modify existing technologies and products to fit market demand. So R&D had a reactive role to ideas coming from the demand side. (Rothwell 1994: 8; Forrest 1991: 442; Bernstein, Singh 2006: 562) Focusing on markets may cause problems for enterprises and enterprises may only be engaged in incremental innovations. At the same time they may miss important developments in basic science, which could be a source of radical innovations. (Rothwell 1994: 9) Demand oriented policy measures implemented by governments include, for example, public procurement, tax incentives, subsidies for consumers, regulations etc (Edquist 1997: 22).

In today's context it cannot be said that ideas for innovations originate only from scientific research or from market needs, and therefore, the linear models could be considered as describing exceptional situations. Both sources of ideas have to be considered during the innovation process and it may happen that for successful innovation both sources have to be exploited simultaneously. Sometimes it is not possible to satisfy the market without new technological solutions, and in other cases the market has to be prepared for new discoveries and new technological ideas have to be adjusted to suit market needs. (Kline, Rosenberg 1986: 277–279) Therefore, even technology-push models have to consider the market side and *vice versa* (Mowery, Rosenberg 1979: 141). From the economic point of view innovations need acceptance from society and the markets to result in economic value (Arrow 1974: 15–17).

Besides emphasizing the market or basic science as a source of ideas, the linear nature of the innovation process is also not realistic. The linearity does not describe the complexity of real-world innovation processes (Forrest 1991: 441; Bernstein, Singh 2006: 562). Linear models fail to take into account the feedback loops, which are important for eliminating mistakes or improving the innovation through turning back to the earlier stages of the process and revising the process. The external environment of the firm is also often ignored. (Forrest 1991: 441; Kline, Rosenberg 1986: 286–288) Therefore, feedback loops and interlinks between different stages of innovation process models and with the firm's external environment have to be taken into account while modelling the innovation process (Edquist, Hommen 1999: 64).

Some of the aspects mentioned above are taken into account in Twiss's Activity Stage model (see Appendix 1). This model includes the external and internal environment of the firm, the information exchange between R&D and marketing departments and the stages of the innovation process, and two sources of ideas – the market and technological and scientific progress – which where separated in the technology-push and demand-pull innovation process models.

Although Twiss's model is more advanced than the technology-push and demand-pull models, feedback loops between different stages of the innovation process and the revision of the process are still not considered. Feedback loops and two-way linkages are taken into account in the innovation process models prevailing in 1970s (Rothwell 1994: 9). These models (also called Coupling Models) portray the process as sequential, but they also consider that the process is not always continuous. One of these models is presented in Figure 4. (Rothwell 1994: 9–10, Galanakis 2006: 1224) This model takes into account feedback loops and the revision of the process, but disregards the firm's internal context. So these models could be considered a halfway step towards more systemic innovation process models.

Systemic innovation process models emphasize the complex environment of the enterprise and the need for constant and intensive information exchange within the firm and with the external environment (Bernstein, Singh 2006: 563). They also emphasize the speed of the innovation process. It is important to shorten the development time and enter the market as soon as possible. This does not mean, however, that the enterprise has to be the first one on the market because usually the first introduction of a (radical) innovation is not totally in accordance with costumers needs, and failures are common. This is linked to not knowing exactly what customers need and look for in radical innovations. Radical innovations often need some additional incremental innovations and a cumulative learning and diffusion process before meeting the needs of customers or before customers realise the benefits of the innovation. (Kline, Rosenberg 1986: 286; Hall, Rosenberg 2010: 5) The negative side of being first is analysed more thoroughly for example by David J. Teece (Teece 1986: 285).

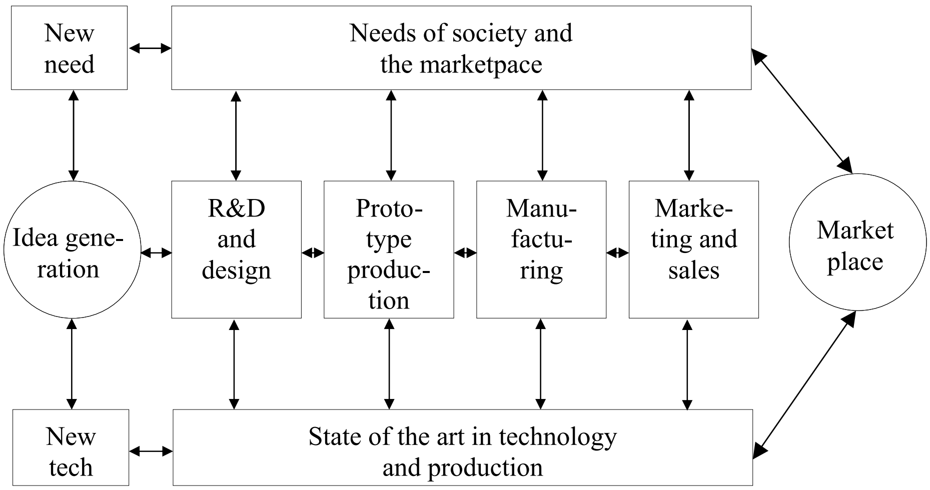
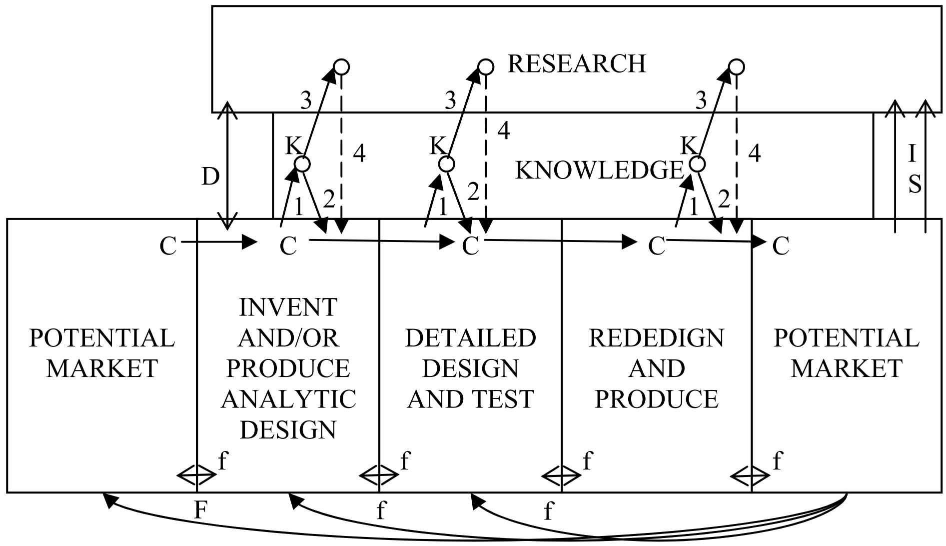



**Figure 4.** The Coupling Model of the innovation process (Rothwell 1994: 10)

One of the systematic models, Kline-Rosenberg's Chain-Linked Model is presented in Figure 5. In this model the innovation process begins and ends with the potential market. Feedback loops are portrayed through links marked with an f and an F. F shows very important feedback loops – feedback from the last stage to the first stage of the innovation process. Links between the market and research are taken into account through 3 types of links: link I (usage of enterprises' outputs e.g. microscopes in science), and S and D (indirect connections). The links between science and the central chain of innovation process are marked by D and K–R. Therefore, science influences all stages of the innovation process.

The authors of this model divide science in two – known science (stored knowledge) and new science (research needed to solve the problems appearing during the innovation process) (Kline, Rosenberg 1986: 291). Therefore, research is defined rather broadly and it does not encompass only (basic) science done in research institutions. Research in this model is considered to be a "problem-solving tool" (Oslo Manual 1997: 24). The same definition is also taken as the basis in this thesis.

This model also introduces design to the innovation process. The authors define it as a form of incremental innovation, although it also may include radical innovation (Kline, Rosenberg 1986: 286–287). One of the deficiencies is that the model disregards the internal environment of the firm. At the same time it may have been taken into account indirectly through feedback loops and monitoring activities.




S Support of research in sciences underlying product area to gain information directly and by monitoring outside work. The information obtained may apply anywhere along the chain.
K – R Links through knowledge to research and return paths. If problem solved at node K, link 3 to R not activated. Return from research (link 4) is problematic – therefore dashed line.
I Support of scientific research by instruments, machines, tools, and technological procedures
C Central chain of innovation
D Direct link to and from research from problems in invention and design

**Figure 5.** Chain-Linked Model developed by Kline and Rosenberg (Kline, Rosenberg 1986: 290, modified by author)

The latest models of the innovation process also known as SIN (*System Integration and Networking*) models emphasise the networks of the customers, suppliers, competitors and public sector institutions. Models also include ICT tools to support and hasten the innovation process and information exchange between relevant actors. (Galanakis 2006: 1225) The movement towards a systematic approach in innovation processes, emphasizing links and networks can be explained through various recent trends and developments. Some of those developments are (Smits 2002: 867–873):

- structural changes in economy – the rise of the tertiary sector along with the disappearance of barriers between all three sectors and the integration of the industrial and service sectors;
- increasing number of actors involved in the innovation process, which broadens the decision-making process;

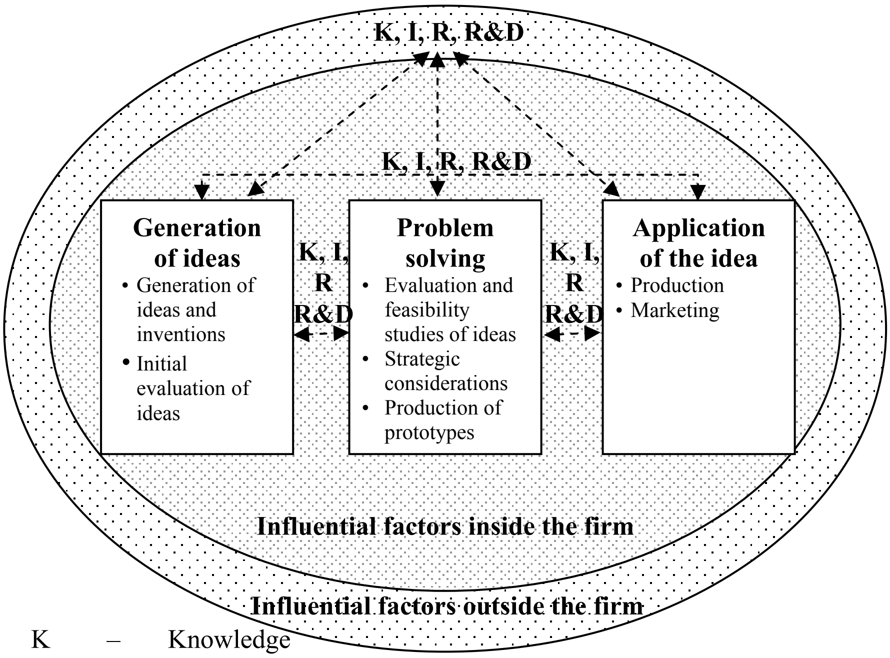
- changes in roles of universities and research institutes, which change the knowledge infrastructure – a move towards applied research and an orientation towards society.

All the models presented above have some shortcomings programmed into them. Many of the models presented above fail to consider the idea screening stage of the innovation process. Without thorough information search and screening of ideas, the development of the new product/process/service may not even begin. In addition, the public sector and different external organizations (e.g. foreign investors, venture capitalists) and institutions (e.g. rules and norms of society and legal environment, inheritance, connection between people) are rather often ignored in these models. One can argue that these aspects are taken into account indirectly through the external environment, but because of the influence of these actors on innovation processes they should be considered in a more explicit manner. The public sector and its institutions and organizations are taken into account in the literature on national innovation systems covered in section 1.2.1.

Taking into account the aim of the thesis – to identify alignment issues linked to public policy measures and the needs of enterprises in Estonia, and some of the shortcomings described above, the author of this thesis modified and adjusted existing models. The aim of the previous discussion was not the development of a new innovation model, but the construction of an innovation process model based on existing literature and suitable for the fulfilment of research questions raised in the thesis. The innovation process constructed by the author is presented in Figure 6.

In Figure 6 the innovation process is divided into three stages – the generation of ideas, problem solving and the application of the idea – and it is intended to describe all or most types of innovation. Although the innovation process seems to be linear in Figure 6, interlinks and feedback loops exist between the different stages (dotted lines between stages) and the stages of the innovation process are embedded in the internal and wider external environment with which the firm has constant interactions during all three stages.

The idea generation stage includes the generation of inventions and ideas. An invention may be defined as a material object linking a need and a solution that is used to satisfy the need (Arthur 2007: 282). In this thesis the concept of idea encompasses both inventions and ideas. The idea generation in the enterprise may be independent from or dependent on one particular innovation project initiated by the management of the company. Therefore, the generation of ideas may be the first step in an innovation project initiated by management or it may be itself an incentive for starting a new innovation project. The sources of ideas are not limited; they may originate from markets, business partners, universities, research institutes, R&D departments and the employees of the firm. Ideas may include new information and knowledge or be based on existing information and knowledge combined in an innovative way or implemented in a new context. Opportunities for innovation may also arise from economic opportunities, changes in economic circumstances, social challenges and/or technology itself. (Arthur 2007: 278–9)




K – Knowledge
I – Information
R – Resources
R&D – Research and development

**Figure 6.** Innovation process taking place in enterprises (composed by the author)

The idea generation stage also includes the preliminary evaluation of ideas by the creator (self-evaluation of the idea) or R&D department. More thorough screening, evaluation of ideas and construction of feasibility studies takes place in the second stage. The separation of the generation from the official evaluation of the idea increases the quality of the idea generation process through setting no limits to the creativity of idea generators (McAdam, McClelland 2002: 91).

The second, problem-solving stage of the model includes screening and feasibility evaluation because the number of ideas generated in the first stage may be very high. Even if the number is not high, the feasibility of every idea has to be assessed. Ideas have to be compatible with the company's mission and vision, and issues of the commercial and technical feasibility have to be discussed (McAdam, McClelland 2002: 87). Thus, this stage deals with the evaluation of ideas, the selection of the most feasible idea and preliminary solutions for problems that may rise in the implementation stage.

The last stage of the model is the application of the idea. This stage encompasses the activities linked to the introduction of the idea in practice –giving real economic value to the idea. For example, during this stage problems may arise from producing the innovative product and marketing activities.

The two-way arrows in Figure 6 represent the feedback loops between the three stages of the model. Feedback loops include exchanges of knowledge, information, finance and labour resources between different stages of the process and continuous support from internal or external R&D. R&D in this thesis is defined as a "problem-solving tool" (Tunzelmann 1995: 9).

Effective functioning of the feedback loops requires much effort from managers, and may also include changes in organizational routines to increase the willingness to cooperate between different departments or teams of the enterprise (i.e. supportive internal environment and its influential factors). It also has to be kept in mind that the process depicted in Figure 6 does not have to run from beginning to end; for example, the process may be reversible or terminated at any point in time. Thus, when some barriers are discovered during the problem-solving or application stage, the next step could be a new round of generating ideas. If the barriers are immovable, the process can be terminated or put on hold until the problems can be solved.

All three stages of the innovation process and feedback loops are also influenced by several external factors of the firm. Factors such as demand, market regulation, the financial system of the country, infrastructure, knowledge, and physical and human resources all influence how innovation works within the firm. Existing information and knowledge including new ideas coming from different sources, and additional and complementary knowledge for the whole process also affect the innovation process and not only at the initial stages, but the process as a whole. To obtain economic value out of an original idea it is necessary to find production solutions, conduct market research and/or change the structure of the firm and so on. All these additional and/or complementary activities require some kind of research, which may not have to be done by the enterprise itself.

This innovation process is rather general and therefore it may be used to describe and analyse the development of different types of innovations – radical, incremental, product, process, organizational, market, etc. This process also does not limit the number of innovation processes taking place in one firm. Firms may develop several innovations in parallel. The central chain of the model may and should in this case also be linked to those parallel processes through information, knowledge, resource and R&D exchange.

In general, innovation and the innovation process are rather confusing concepts to analyse because of the high number of definitions of innovation and innovation process models. The most important aspect when defining innovation is the value it brings to the company. Therefore, innovation in this thesis is defined as a creation and/or change resulting in economic value for the enterprise. Concerning the classification of innovations, this thesis divides innovation into product, process, organizational and market innovation. In terms of models, there is a clear movement towards a systematic approach in the literature. The linear view of the innovation process in general fails to encompass the complexity of the innovation activities taking place inside the firm. The systemic view emphasises feedback loops and knowledge exchange between different stages and departments inside the firm, and an innovation-friendly external environment. Firms do not innovate in isolation but within the framework of an external system with different actors (Smits, Kuhlmann 2004: 7). Taking all this into account, the three-stage innovation process was constructed by the author of this thesis. This innovation process is used as the basis for analysing alignment issues related to factors of the innovation process and innovation support measures.

### 1.1.2 Factors influencing the innovation process of enterprises

The stages of the innovation process described in 1.1.1. are influenced by numerous factors. Some of the factors may influence only some stages of the innovation process or several of them at the same time. For example, the factors linked to idea generation may be different from the factors influencing the implementation of the idea, but there may also be some factors influencing both of those stages. Therefore, more thorough analysis of the factors influencing the stages of the innovation process must be conducted and presented.

By comparing and analyzing published articles and earlier findings, the number of factors, their significance and the direction of their influence differs (Balachandra, Friar 1997: 176). The list of factors is long and the number of authors that have studied the factors influencing the innovation process of enterprises is great. Appendix 2 presents an overview of earlier studies of factors influencing the innovation process and its stages in enterprises. This should not be seen as an exhaustive list because the creation of an all-encompassing list of factors is not possible. The appendix lists studies that discuss factors of innovativeness that have negative or positive effect on the innovation process.

On the basis of the studies listed in Appendix 2, several important aspects arise. One of the aspects is the level of detail. Some of the authors mention factors at a very general level (e.g. factors like market, technology, etc.), while others highlight factors at a more detailed level. In addition, the direction of the influence of the factors on the innovation process, the significance of its influence and the definitions of the factors involved vary. The reasons for these differences may lie in the different conditions under which the studies were conducted, and/or the type of innovation studied. Also, the theoretical approaches in the articles differ (e.g. New Product Development literature vs. National Innovation System literature). This heterogeneity of articles provides a good overview of different factors influencing the innovation process and enables us to compose a list of factors.

Because there are many factors that influence the innovation process in enterprises, the division of the factors is necessary. Figure 7 depicts the basis for grouping the factors of the innovation process. The factors are divided into seven different groups according to their connection to the stages of the innovation process presented in Figure 6 – factors influencing the 1st stage of the innovation process (idea generation), the 2nd stage (problem solving), the 3rd stage (idea applications), the 1st and 2nd stages (with mutual feedbacks), the 2nd and 3rd stages (with mutual feedbacks), the 1st and 3rd stages (e.g. 'user-led innovation'), and finally factors important for all three stages of the innovation process with a full set of feedback loops (see Figure 7).

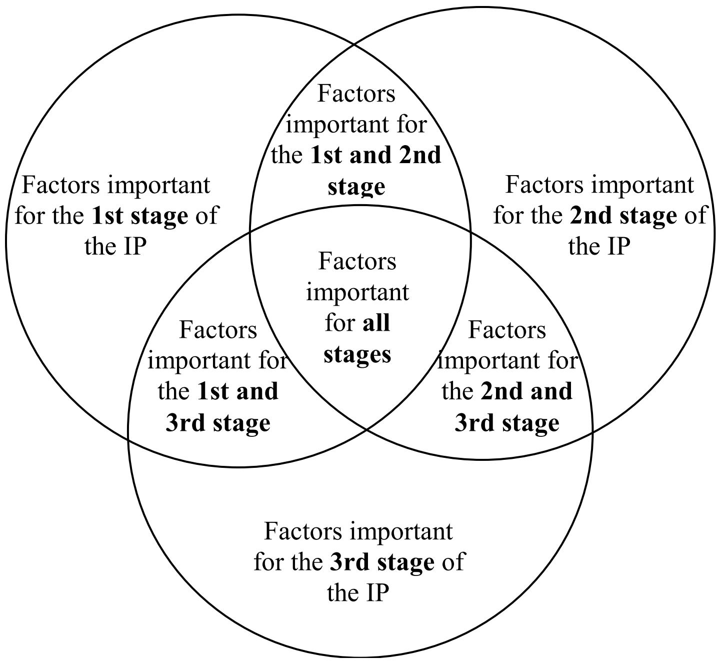



**Figure 7.** Contextual framework for grouping factors of innovation in enterprises (composed by the author, IP = innovation process)

In addition to these seven groups, a supplementary division within each of the seven groups is introduced to systematize the multiple factors brought out by previous studies more explicitly. One widely used possibility for this subdivision is to divide the factors in terms of whether they are external or internal to firm. According to Hadjimanolis (1999), external factors can further be divided into supply, demand and environment related and internal factors into resource, culture and system, and human nature related (Hadjimanolis 1999: 561–562). In this thesis, factors are only divided into external and internal factors as one of the most often used criteria. The division of factors into external and internal allows us to emphasise the interconnection and links between these two levels, and stress the need for a systematic approach when analysing factors of the innovation process.

The external factors cover factors firms cannot influence, and describes the environment where the enterprise is located. The internal factors cover factors that can be more or less influenced by the enterprise itself including factors like strategic decision-making by owners and/or management, procedures for and regulations surrounding the everyday activities of the enterprise and firm's everyday activities. On the basis of the studies presented in Appendix 2 and employing the division described above, the factors influencing the innovation process were grouped and systematized (see Appendix 3).

Before discussing factors mentioned in Appendix 3 more thoroughly, one has to keep in mind that not all of the factors are important for the innovation process in a particular enterprise at a particular time. The existence and importance of factors affecting the innovation process in a particular enterprise depends on its business model, the source of the idea, the type of innovation, the external environment etc. For example, some time ago, internal formal R&D was regarded as a very important and valuable aspect of the innovativeness of the enterprise. Firms unable to finance internal formal R&D were thought at risk of being outperformed by competing enterprises. Today, the situation has changed a bit. The ideas for new products/processes/services do not have to originate only from inside the firm and from formal R&D. Good ideas may arise from market trends and/or the use of somebody else's R&D results/outcomes, already existing knowledge and so on. (Chesbrough 2004: 23)

Differences in the importance allocated to the various factors may also be caused by limited rationality at the firm level. This concept describes the situation where only some specific streams of knowledge and technology are known to the enterprise, and this limits its ability to predict the results of particular decisions and choices (Smith 2000a: 87). This also means that firms are looking for possibilities to innovate on the basis of their existing knowledge base, resources, skills, networks, in other words, along their own development trajectory (Smith 2000a: 89, 90). The differing economic and social environments and developmental stages of the country also influence the importance of factors relevant to the innovation process. All these considerations enable us to factors brought out by earlier studies and factors mentioned by enterprises as factors of the innovation process taking place in their enterprise at a particular time.

Table 3 presents factors influencing the three stages of the innovation process separately. Table 3 is composed on the basis of Appendices 2 and 3. In Table 3 the factors influencing the stages of the innovation process are presented in an aggregated manner.

*Factors influencing stage 1*

External factors affecting the idea generation stage of the innovation process are linked to the influence of competitors' innovation behaviour on the enterprise's innovation strategy and behaviour (Achilladelis *et al* 1971: 44). If competitors are focused on the development of new products and innovativeness forms a large part of the economic activities of the business community, any viable firm should go along with this trend. Otherwise it will not survive.

**Table 3.** Factors influencing the three stages of the product innovation process

| | Idea generation (1st stage) | Problem solving (2nd stage) | Idea application (3rd stage) |
|---|---|---|---|
| External context | • Influence of competitor's activities on idea generation initiative | • Market conditions for new products<br>• Attractiveness of and opportunities for new products | • Possibility of out-sourcing some parts of production<br>• Adaptability of innovation by users |
| Internal context | • Framework for idea collection<br>• Environment to support employee innovation/idea generation<br>• Assessing and interpreting emerging patterns and future trends<br>• Organising creative workshops | • Framework for idea screening<br>• The alignment between market opportunities and technology<br>• Characteristics of new products<br>• Suitability of new products with current business model<br>• Solutions for transforming the idea into innovation | • Importance of marketing<br>• Formal planning of launch strategy<br>• Production processes<br>• Product quality<br>• Product price<br>• Marketing and distribution |

Source: composed by the author

There are four internal factors influencing the idea generation stage. The ideas for new products could originate from different internal and external sources. Therefore, it is important to have a formal and effective framework for gathering information and monitoring emerging trends. Flint (2002) emphasized the relevance of the formal process to gather customer information and observe the trends in demand to be able to react when opportunities arise. Monitoring the behaviour and needs of consumers during the idea generation stage may help avoid making mistakes in later stages of the innovation process (Stewart-Knox, Mitchell 2003: 62). But the ideas may originate also from other sources besides customers, for example, from universities and research institutes. Therefore, it is important to create linkages also with organizations outside the commercial sector. Without those linkages the enterprises may miss information about new useful research results and the creators of knowledge may not recognize the economic potential of those results. (Martin, Scott 2000: 439) To cover all potential external and internal sources of ideas including experts, partners, research institutions and so on, it is important to create a framework that covers as wide a range of sources of ideas as possible. (Sowrey 1990: 28)

Besides creating an effective framework covering the potential sources of ideas, it is also important to develop an internal environment to support employee idea generation. Potential components of this kind of environment are the recognition of employees as a source of innovation ideas (McAdam *et al* 2004: 218), allowing employees to use some part of their day to develop ideas, supporting the working on unofficial projects (the projects of new product development which may have been officially stopped by management because of a lack of success) and the availability of an internal venture capital (VC) fund for creative new ideas (Ernst 2000: 15). The majority of those aspects usually apply only to R&D employees but it is possible to implement them also for other employees.

The last group of factors under stage 1 include activities like assessing and interpreting emerging patterns and future trends in the external environment, and organising creative workshops. To turn the trends observed and interpreted into opportunities and usable ideas it is important to organise creative workshops. To increase the usefulness of those workshops the composition of the team has to be thought through carefully. Different perspectives and skills have to be present in the creative team with the aim to diversify opinions inside the team. (Kohn 2005: 692)

*Factors influencing stage 2*

The second stage of the innovation process encompasses screening the ideas coming from the first stage, choosing ideas for implementation and solving problems linked to the implementation of the idea. While screening the ideas two important external factors play a role – market conditions, and attractiveness/opportunities for the new product. When the firm's target market for the new product is a market marked by weak competition, there is a greater chance of succeeding through providing customers something different. Also, large and growing markets provide several opportunities for introducing new products to customers because of the niches a new product can occupy. (Zirger, Modesto 1990: 873–874; Hultink *et al* 2000: 13) The concentration of buyers is also important for innovation. It has been found that low and high levels of buyer concentration are linked positively with the success of innovations through the ease of communication. (Panne, *et al* 2003: 317)

Factors related to the internal context under stage 2 are the framework for idea screening, aligning market opportunities and technology, the characteristics of the new products, the suitability of the new product within the current business model, and solutions for transforming the idea into an innovation. Employees should have some kind of formal procedure and/or general rules according to which they can screen ideas. Employees engaged in this stage should have a broad knowledge of market trends and technologies to exploit.

The new idea and product has to be evaluated on the basis of how it suits the firm's internal environment, future plans and opportunities. Cooper (1984) emphasises the importance of the alignment between technological prowess and the market, and good quality feasibility assessment. The enterprise has to be technologically sophisticated and maintain a market focus. Previous experience helps enterprises find effective solutions for the production, design and launch of the new product. (Cooper 1984: 160, 163) The new idea and product also has to suit the business model of the enterprise.

The characteristics of the product form another important group of factors. The characteristics of the product that should be considered when screening the ideas include: unique attributes, good value for money, superiority in meeting customers' needs and relative product quality (Cooper, 1994: 61, 63; Zirger, Maidique 1990: 873). It has also been found that highly innovative products (radical innovations) have a greater success rate than medium innovative products, because the success originates from the unique advantages of the innovation, although empirical results in this area are contradictory. Radical innovations encompass also higher risks and the introduction of a radical innovation may not be in accordance with customers' needs. (Panne *et al* 2003: 322–323) These aspects are discussed more thoroughly below.

*Factors influencing stage 3*

Factors influencing this stage are linked to the application of the idea – the production, marketing and sales of the innovation. Therefore, during this stage the idea selected in stage 2 of the innovation process is turned into an economically valuable innovation. External factors in this stage are linked to the potential to sub-contract some stages of production (Achilladelis *et al* 1971 Vol 2: 36, 53) and the adaptability of the innovation by the users. Possibly latter is the most important factor of the external context at this stage (Achilladelis *et al* 1971: 46, 56). To increase the adaptability of the innovation by the users, some additional post-innovation changes might be required (Mytelka, Smith 2002: 1472), but the extent of the changes cannot be great. Otherwise, consumers might consider the initial launch premature and the upgrade might be disregarded.

The internal context encompasses the importance of marketing, the existence of formal planning of a launch strategy, production processes, product quality and price, and marketing and distribution. In this thesis, marketing is defined as activities leading to sales. The acknowledgement of the importance of marketing means that the top management of the enterprise provides the marketing department with the necessary resources, the marketing department acts proficiently and/or it has higher status than other departments of the enterprise (Balanchandra, Friar 1997: 282, 286, Zirger, Maidique 1990: 871). It is also important to have marketing capabilities inside the enterprise. At the same time the higher status of marketing activities and the marketing department may create barriers in communication between different units of the firm, and therefore, this may hamper the innovation process.

To be able to execute proficient marketing, it is important to have a formal launch plan. Having a formal plan helps to increase the efficiency of activities, for example, positioning the new product accurately and keeping the costs of marketing under control. (de Brantani 2001: 176–178)

The implementation stage is also linked to the production process, product quality, product price, marketing and distribution. During the production process the technology used for producing the product has to correspond to the requirements accompanying the production and sales volume of the new products. Therefore, modifications may be introduced into the manufacturing processes. All this may cause resistance from employees engaged into those processes. (Achilladelis *et al* 1971 Vol 2: 35, 53) This means that attention must be paid also to employees; they have to be informed and prepared to adopt the changes.

Product quality is achieved when the identification of as many defects as possible has taken place before sales (Achilladelis *et al* 1971 Vol 1: 5; Vol 2: 52, 56). Quality is important because the first impression is an important determinant in product adaptability by consumers. Also, the price of the products has to encourage adaptability. Garrido-Rubio and Polo-Redondo (2005) suggest that while finding a suitable price for the new product it is better to use a skimming strategy instead of penetration strategies, meaning that the price of the innovation should be higher than the competitors' price. This kind of pricing sends a signal to the customers about the novelty and uniqueness of the product and helps to create a stronger market position. (Garrido-Rubio, Polo-Redondo 2005: 38)

Besides the quality and price of the product, other factors linked to marketing and distribution are also important. Hultink *et al* (2000) found that launching a broader assortment of products is linked to higher success rates for retail and industrial products (Hultink *et al* 2000: 15). This may be linked to the fact that when launching several products simultaneously synergies may arise. At the same time, the study conducted by Dhamvithee *et al* suggests that releasing too many new products simultaneously may cause lower success rates, and therefore, focusing on fewer products may be accompanied by higher success rates (Dhamvithee *et al* 2005). These results may seem contradictory, but the contradiction may be explained because these studies had different research objects. Hultink *et al* studied tactical launch decisions, while Dhamvithee *et al* analyzed the number of innovation processes. In conclusion, the enterprise has to find the optimal number of simultaneous innovation processes to execute and products to launch on the market at the same time.

Table 4 encompasses factors influencing two stages of the innovation process at the same time. First, factors influencing the 1$^{st}$ and 2$^{nd}$ stage of the innovation process are discussed and analyzed followed by factors influencing the 1$^{st}$ and 3$^{rd}$ stage and the 2$^{nd}$ and 3$^{rd}$ stage.

*Factors influencing stages 1 and 2*

Factors influencing these stages are linked mainly to formal R&D activities inside and outside the enterprise. These activities are not only important for the first stage; the second stage of the innovation process also needs the results of research to solve problems that may arise during the problem solving process.

The IPR (*intellectual property rights*) system is mentioned within the external context. The IPR system may hinder the transfer of external knowledge. At the same time, patents also enable firms to protect their research results and appropriate the results of innovations. This may increase firms' willingness to be engaged in the innovation process because high appropriability increases the incentive to innovate. (Martin, Scott 2000: 440) Therefore, there are rather opposing opinions regarding the patent and IPR system of the country.

**Table 4.** Factors influencing two stages of the product innovation process at the same time

| | Idea generation and problem solving (1st and 2nd stage) | Idea generation and idea application (1st and 3rd stage) | Problem solving and idea application (2nd and 3rd stage) |
|---|---|---|---|
| External context | • IPR system | | • Availability of new production technology and raw materials |
| Internal context | • Existing R&D activities<br>• Clearly defined problem<br>• Execution of R&D activities | • Framework for fluent flow of ideas<br>• Employee's work characteristics | • Consistency between existent technology and the production of new products<br>• Demand for inputs<br>• Evaluation and testing of invention<br>• Revenue aspects of the product |

Source: composed by the author

Factors of the internal context are linked to the existence of R&D activities inside the firm, the clarity of problem definition, and the execution of R&D activities. R&D activities are mentioned in several studies either in the form of R&D activities/department and/or R&D intensity (R&D expenditure/sales). In some cases R&D is defined quite narrowly encompassing only actual research activities and investments in it (see for example Parthasarthy and Hammond 2002). In other cases the definition of R&D is broader encompassing market needs and linking the needs to existing technologies (Chin, Sing 2000). In general, it is recognised that investments into R&D increase the innovativeness of firms, but R&D increases innovations with diminishing returns to scale (Panne *et al* 2003: 320–321). The definition of problems also influences the success of the innovation process. Clearly defined problems should include four elements (Cooper 1994: 69): specification of target market, product concept, delineation of positioning strategy, and product characteristics. If the problem is clearly defined this also facilitates the selection process where the ideas are compared against these criteria.

The execution of the R&D process is also important and requires good planning, adequacy and effective execution. An adequate, well-planned and executed R&D process has been mentioned in several studies as one of the factors linked to innovation (Balachandra, Friar 1997: 282; Zirger, Maidique 1990: 871–872; Achilladelis *et al* 1971 Vol 1: 5; Vol 2: 40; Hadjimanolis 1999: 566). An effective R&D process also includes the transferability of the results to and/or the engagement of a person or group with good knowledge and skills in production, marketing and distribution (Abetti 2000: 212).

*Factors influencing stages 1 and 3*

Factors influencing both of these stages have not been widely analyzed in previous studies. Some of the factors linked to these stages are the existence of the scheme for suggesting new products/processes (suggestion program) for employees (Ernst 2002: 32, Carrier 1998) and employee's work characteristics. The suggestion programme is a framework through which employees can suggest new ideas to management. It is one way to collect the ideas from employees of the company through creating a set of rules followed by both employees and employers throughout the program's existence. One very important part of the programme is rewarding the employees whose ideas get implemented. (Carrier 1998: 63, 67–68) This factor is similar to factors influencing the idea generation stage (i.e. an environment that supports employee innovations/idea generation). The difference is that here the feedback from the application stage to the idea generation stage prevails. It is also important to remember that suggestion schemes encourage employees to present their ideas without getting involved in the innovation process.

Besides the existence of the suggestion program, which increases feedback between stages, it is also important to consider factors affecting the employee suggestion-making process. To increase creativity, employees and their job description have to have some particular characteristics. Some of the important characteristics are autonomy, confidence to do things and concern for how to improve activities and solve problems. (Axtell *et al* 2000: 280)

*Factors influencing stages 2 and 3*

Factors belonging to this group mainly influence the part of problem solving which is linked to launching new product production; therefore, forming a link between the second and the third stage of the innovation process. The production of the innovation need new manufacturing processes if the existing processes are not suitable or need some kind of modification. So it is important to take into consideration the availability of new and necessary production technologies existing outside the firm. (Achilladelis *et al* 1971: 53–54) The same also applies to raw materials. The new product may need inputs that are not available or the price of this input is too high to be used in this particular innovation. (Balachandra, Friar 1997: 282) All these aspects have to be taken into consideration during the innovation process.

The internal context includes factors like consistency between existent technology and the technology needed to produce the new product, demand for the inputs, evaluation and testing of inventions and revenue aspect of the product. These factors include, for example, the influence on the production of other products and changes in production routines. (Achilladelis *et al* 1971: 53–54)

Testing factors in this stage include small-scale testing or prototype testing. Factors like trial production and customers testing prototypes describe the activities of this stage in the best way. (Ernst 2002: 5–7, 10) Also, a preliminary evaluation of the revenues from the new product has to be conducted. Indicators such as the performance to costs ratio and the contribution margin to the firm are the two main indicators that need to be analyzed. (Zirger, Maidique 1990: 871, 873)

*Factors influencing all the innovation process stages simultaneously*

The last and the most populated group of factors influence all the stages of the innovation process simultaneously. These factors are presented in Table 5. It may appear that some of the factors presented in Table 5 have already been mentioned and discussed above, but the generalization of factors belonging to this last group is higher than for those described earlier. The factors presented in the Table 5 summarise the more detailed sub-factors brought out by earlier studies. Therefore, it might be necessary to use Appendix 3 as a source for additional information. For example, the factor "firm's characteristics" includes sub-factors such as age, size and whether the enterprise is part of a consortium. At the same time, the structure of the firm is brought out separately, although it also might be considered a sub-factor of the firm's characteristics. The distinction is made because of the importance previous studies have paid to links between the structure of the company and innovativeness.

Factors of the external context influencing all the stages are linked to the overall conditions prevailing in the particular country. Factors such as the legal and economic environment, the conditions in the resource markets and existing innovation support measures may in one way or another all influence the innovation process taking place in enterprises.

Legislation in the country influences and guides the activities of enterprises in their everyday activities (Chin, Sing 2000: 475). Business and labour legislation, laws for agreements and contracts, and regulations for new standards and technologies and so on form a significant part of the firm's existence. The important aspect of the legal environment is also a risk related to the innovation process. Innovation activities are linked to high risks and uncertainty, which in some sense also may be considered a sub-factor of the economic environment. Risks are related to the lack of financial resources, the amount of financial resources needed for innovation processes, the timing of returns on investments, the possible failure of the innovation, standards for new products/technologies and so on. (Frenkel 2003: 132; Martin, Scott 2000: 439) These types of risks may be decreased through a transparent legal environment.

**Table 5.** Factors influencing all stages of the product innovation process

| | Factors influencing 1st, 2nd and 3rd stage of innovation process |
|---|---|
| External context | • Legal environment<br>• Economic environment<br>• Conditions of resource markets<br>• Public and private sector innovation support measures |
| Internal context | • Firm's characteristics<br>• Structure of the company<br>• Internal innovation culture<br>• Tapping into (information) network<br>• Existence and harmony between different strategies<br>• Existence of long-term innovation or new product development (NPD) strategy<br>• Commitment and role of management<br>• Characteristics of employees<br>• Training of employees<br>• Customer/market orientation<br>• Organization of innovation process/NPD project<br>• Evaluation of innovation process/NPD project |

Source: composed by the author

The economic environment influences the stages of the innovation process in several ways. For example, differences in enterprises business models exist between countries. This is also linked to competitive advantage and how much emphasis is put on innovation. Developing countries usually compete on the basis of low production costs (Figure 8). Competitiveness in more developed countries is not based only on cost advantage. Enterprises and industries in those countries are competitive because of the low unit costs of production input, higher productivity and/or innovations. (Reiljan, Tamm 2006: 78) Therefore, the importance of different components of competitiveness is different according to the development stage of the country. The emphasis on innovative activities is therefore greater in developed countries than in developing countries.

| | Low | Medium | High |
|---|---|---|---|
| Innovations | **X** | **XX** | **XXX** |
| Productivity | **XX** | **XX** | **XX** |
| Production costs | **XXX** | **XX** | **X** |

Development stage of a country

XXX – most important factor of competitiveness
XX – important factor of competitiveness
X – less important factor of competitiveness

**Figure 8.** Potential sources of competitiveness (Reiljan, Tamm 2006: 78)

Another sub-unit of the economic environment, competitive environment, affects the innovation process in enterprises through creating competitive advantage over competitors through innovation (Balachandra, Friar 1997: 282). This aspect is closely linked to the concept of anticipated and actual market power. Anticipated market power is connected to the potential monopolist power that might be given to a firm via innovations currently active in a competitive market. (Dhamvithee *et al* 2005: 7)

The next largest group of external factors influencing the innovation process in a firm is linked to the conditions of resource markets. Well-functioning labour and financial markets are important for innovative firms (Martin, Scott 2000: 440). Financial markets should offer many alternative opportunities for financing the innovation process; the awareness of those projects should be high and transaction costs (legal costs, business planning etc) should be as low as possible (Freel 2000: 76; Martin, Scott 2000: 439). Also, the differences between supply and demand for qualified labour should be as small as possible in order to facilitate innovation.

Besides the conditions in the labour and financial markets, trends in technology development also influence the company. New technologies may help to improve communication between different departments, facilitate finding solutions to problems necessary to solve during the innovation process and so on. At the same time, it should be kept in mind that the development stage of the country and trends in new technologies in specific country are linked to the concept of path-dependency. Path-dependency describes the influence of the previous steps in technological development on the current stage of technology development. (Kingston 2000: 688) Path-dependency is not only linked to the country; this concept is also important at sector and firm level. At the firm level, firms have a specific knowledge base, which has a strong influence on their ability to interpret and absorb new and additional information and knowledge. Their knowledge base is limited and linked to their previous development and activities. Therefore, there are some specific areas and knowledge which firms understand and some which they do not. (Smith 2000a: 87)

Last factor of the external context is the government's innovation policy with measures implemented through public and private organizations. These measures are supposed to be designed to have a positive effect on the innovativeness of enterprises by helping firms with factors that decrease their innovativeness. Innovation policy measures should remove as many barriers from the innovation process as possible and/or to increase the awareness of the usefulness of innovations (Chin, Sing 2000: 475). To do that innovation policy measures should be aligned with problematic factors.

At the same time barriers cannot be looked at in isolation. Very often they are interlinked and the removal of one will not remove existing problems and facilitate the execution of the innovation process for enterprises because other barriers still exist, hampering the process. Therefore, the barriers may form a system, and they have to be looked at in a systematic way. The system failure approach involves helping to analyse the systemic side of the barriers. For example, if policy measures do not remove the barriers to the innovation process there might be several reasons. One of those reasons may be the lack of government support for firms and/or the low capacity to implement innovation policy measures (i.e. government failures). Therefore, innovation policy measures can themselves be considered a barrier to innovation. (Hadjimanolis 1999: 565, Freel 2000: 75–77) The system failure approach is discussed more thoroughly in 1.2.2.

The factors of the internal context influencing all stages of the innovation process are linked to the characteristics of the enterprise including size and age, procedures, rules, and the setup that exists in the enterprise and is implemented by the management. Although the direction of the influence of factors like age and size is not clear because of the ambiguous results of previous studies, they do have an influence on the innovation process. Martin and Scott (2000) found that the small size of the company may be one reason for innovation failure because of the large costs of the innovation process and accompanied risks. Larger firms can absorb the risks more easily because of the availability of and easier access to internal and external resources (Martin, Scott 2000: 439, 443; Dhamvithee *et al* 2005: 17). At the same time, small enterprises enjoy some other advantages. Small firms are more flexible and can react to changes and opportunities in the external environment quicker than large firms. (Dhamvithee *et al* 2005: 6) The same ambiguity of research results exists also in respect to the age of enterprises. The direction of the influence of age does not differ only across the studies conducted by different researchers, but also across studies conducted by single researchers. For example, in his early writings, Schumpeter mentions that innovations are mainly introduced by new firms entering the market, and these may outperform the existing firms. (Kingston 2000: 686) In his later writings Schumpeter supports the view that larger and older firms are the main innovators (Avermaete *et al* 2003: 11).

The innovation process in the firm is also influenced by the organization's structure, internal innovation culture, information networks, alignment between strategies including the existence of an innovation strategy, the commitment of the management, the characteristics and training of employees, customer/market orientation, and the organization and evaluation of the innovation process. All of these factors encourage fluent communication and cooperation between the employees of the firm through clarifying objectives and how to reach them.

Good communication is better in organizations with flexible structures, which allow more informal contacts and communication between actors inside the firm. Flexible structures also decrease hierarchy through decentralising decision-making and bureaucracy, increase the equal status of departments, and encourage an informal atmosphere, creativity, diversity and the capabilities of employees, increase the flexibility of the company, and thereby also the effective use of resources, which all positively influence product development inside the firm. (Chin, Sing 2000: 476; Panne *et al* 2003: 319; Wan *et al* 2005: 266; Kahn 2005: 523–524)

At the same time, attention to negative aspects must also be paid while using flexible structures such as an organic structure. Organic structures provide quite a lot of freedom, but it is also important to have some control implemented across the stages of the innovation process. (Panne *et al* 2003: 319) Control has two functions in firms – an entrepreneurial function and an administrative function. The latter is linked to systems of financial resources and reporting, the former to the recognition of technological opportunities. (Pavitt 1998: 445) Well-defined control criteria should be used during the innovation process. During the first stages, control should be weaker than during the later stages. (Bernstein, Singh 2006: 564–570) At the same time, it has been found that direct control increases the feeling of being constantly observed and this decreases the innovativeness of employees. Therefore, it is important to disguise direct controlling with guidance activities. (Chin, Sing: 2000: 477)

The correct organizational structure also supports the creation of an internal innovation culture. Several authors have mentioned either innovation friendly climate or innovative culture as factors supporting the innovativeness of enterprises (Ernst 2002, Johnson 2001, Panne *et al* 2003, McAdam *et al* 2004). In general, an innovative culture may be defined as recognising the need to innovate and the importance of innovations (Panne *et al* 2003: 312, Wan *et al* 2005: 265). Although the idea of the innovative culture has not been studied very broadly, the elements of it have been. A number of studies have focused on action, programs and/or schemes, which can be considered part of an innovative culture. (Ernst 2002: 23) Some of those elements have been mentioned above, such as suggestion schemes, facilitating communication, availability of internal VC funds etc. Others are closely linked to the challenges the job should offer a person with the aim of increasing their willingness to change: a complex and challenging job (Oldham Cummings 1996: 625) and a diversity of responsibilities (Axtell *et al* 2000: 281). It is also important to nourish an entrepreneurial spirit and risk-taking behaviour as part of an innovation friendly climate (Wan *et al* 2005: 267, Abetti 2000: 214).

An innovation culture has to foster risk-taking behaviour because innovation activities are linked to risks and uncertainties. Uncertainty is dependent on the number of innovations in a firm at a certain point in time and how radical those innovations are. The greater the number and/or the more radical the innovations, the greater the level of uncertainty. Many firms may not be able to absorb those risks. In some cases uncertainty is not acceptable for the firm's shareholders, although the firm's management initiates new product development projects. Therefore, innovations have an uncertain nature (Wan *et al* 2005: 266) and firms have to take this into account. But even if one innovation process fails, still some knowledge has been gained, and this may be essential to the success of future innovation projects. (Godoe, Nygaard 2006: 1707)

At the same time, all aspects mentioned above have to be in accordance with the enterprise's strategy. It is important to develop and maintain a strategic focus towards innovativeness and new product development. (Abetti 2000: 216)

Pavitt argues that innovation failures arise mainly from the procedures existing in firms and organizational forms. Firms often fail to absorb the technological knowledge because of missing or flawed procedures and organizational forms. (Pavitt 1998: 434–435) The clarity of vision, alignment of strategic goals (including the new product development strategy), and established procedures help to frame innovation inside the firm. Framing decreases the differences in defining and interpreting innovation by different groups of employees and eliminates confusion, and facilitates the implementation of the innovation process. (Johnson 2001: 343) Existing formal strategies, formal planning and other procedures on the one hand, and the flexible structure of the firm and creative freedom on the other, may seem to be a little contradictory at first. One side requires rather strict planning processes and control, and the other side helps to create a friendly and relaxed atmosphere. To achieve both aims, a balance between the two sides should be found and established. This depends on the skills, competence and commitment of the managers and owners of the enterprise. Therefore, the success or failure of the innovation process is also dependent on the commitment of management and the style they use to manage the firm and employees. The right time, cost and information management is closely connected to the success of the innovation process. (Cozijnsen *et al* 2000: 159) Besides, the right management of time, costs and information, also other elements of management style have to be in accordance with innovativeness and the creation of an innovation friendly climate. That means that managers should also recognize the contributions that employees make to the innovation process, involve them in the decision-making process, divide innovation activities into clear tasks and responsibilities, be supportive and non-controlling of employees, eliminate the barriers from the cooperation activities of multi-functional teams and so on (McAdam *et al* 2004: 213, 218; Panne *et al* 2003: 316; Oldham, Cummings 1996: 611; Axtell *et al* 2000: 281; Zirger, Maidique 1990: 872). This increases the creativity, motivation and willingness of employees to contribute to the innovation process and decreases the resistance to leadership (Oldham, Cummings 1996: 611; Cozijnsen *et al* 2000: 158). All in all, the use of a consultative management style is more suitable for innovation-oriented firms than an authoritarian style (McAdam *et al* 2004: 218).

According to Berstein and Singh (2006), the management style should change across different stages of the innovation process. Management should be strongly engaged in the process during the first stages. The social and informal sides are important – it is important to encourage people to find new ideas through rewards and time for generating ideas. During the latter stages of the innovation process, the management style should be more formal and administrative. (Bernstein, Singh 2006: 564–570)

Although support from management is widely recognised as a factor with a positive influence on the innovation process, there are some studies that suggest it may cause failures as often as successes, especially when management fails to evaluate the progress of the innovation process objectively (Panne *et al* 2003: 322). When top management does not terminate the project when they are supposed to terminate it according to the mid-process evaluations because they are too attached to the project, this may cause the project to fail. At the same time, when they terminate the project as soon as something goes wrong without giving the project a chance to improve, a potentially successful innovation may be lost. (Ernst 2002: 28)

In addition to all the factors mentioned above, the innovativeness of the company is also dependent on the characteristics, capabilities, education and training of its employees. Characteristics of employees like age, gender, educational level, creativity, cognitive style and learning ability have been studied rather thoroughly (Bernstein, Singh 2006: 562). For example, previous experiences, failure and/or success with a specific product/technology, knowledge of methods and methodologies, the influence of a person's education and qualification influence the expectations and hopes of that person. These also influence the ability of the person to grasp the results of a specific experiment or situation. This may result in either mental rigidity and/or a resistance to new ideas (Kingston 2000: 688–693), which then influences the innovation process of the firm. Unsworth *et al* (2000) found that motivated, competent, and creative employees are a valuable asset to the innovative firm because competent and skilled employees influence the whole innovation process. Overall it would be very useful for the company to have employees with an enabling mind-set, meaning that they are willing and capable of taking the initiative, suggesting improvements, accepting failure as one way of increasing experience and understanding the vision of the firm (Chin, Sing 2000: 475).

Schumpeter once mentioned that the intellect is not the only important thing in idea generation and the innovation process. Competences, skills and knowledge, including market and technical intelligence, and the ability to find solutions to problems existing in the path of the innovation process are also very important. (Kingston 2000: 686) To increase the skills, competence, knowledge and problem-solving capabilities of employees, training has to be organized (de Jong, Vermuelen 2006: 594; Balachandra, Friar 1997: 282). The training of employees influences all stages of the innovation process and helps to increase the quality of the process through increasing the number of skilled and competent employees. The existence of training programs in firms also attracts employees with greater potential and capabilities (Chin, Sing 2000: 476; Freel 2000: 76). When a firm is attractive to potential future employees it can choose the most capable, competent, and skilful of them, and in this way increase its innovation capability (Freel 2000: 69). Unfortunately, formal education and training programs may be rather expensive for small and medium sized enterprises to uphold because of the high costs without any help from public sector policy measures. At the same time, the managers of the firm may also train their employees themselves, but this needs competent managers committed to the enterprise, to innovation and to the employees.

Factors like the customer orientation of the firm also influences the innovation process. Firms have to be in touch with their market and customers to anticipate and/or fulfil emerging demands. Therefore, marketing capabilities and an in-depth understanding of customers and the market place are essential for successful innovation. (Zirger, Maidique 1990: 871; de Jong, Vermuelen 2006: 594) Unfortunately, rather often the innovation process is more focused on technological aspects of the product than marketing aspects (Cooper 1994: 64). Marketing activities should support every stage of the innovation process starting with idea generation and preliminary market assessment and definition of the target market and ending with trial sales and the launch (Cooper 1994: 65–66). If market orientation exists during the whole innovation process, firms are able to develop products to satisfy customer needs precisely in accordance with customer values (de Brentani 2001: 177).

Some authors also argue that customers should be directly involved in every stage of the innovation process. Cooper (1994) emphasizes the importance of customer inputs in the innovation process, and suggests testing the outputs of different stages of product development (e.g. prototypes, working models etc) among potential customers. At the same time, other researchers although recognizing market orientation and understanding customers, do not support the involvement of customers in the development process. Ernst (2002) points out that market orientation and customer integration into the development process are two different things, and the latter is not always useful. Panne *et al* (2003) state that the involvement of customers in the development process has controversial outcomes. Customer involvement may lead a firm to develop only incremental innovations, because customers are able to evaluate their demands within the framework of existing goods and products and may not be able to predict their future needs (Panne *et al* 2003: 324).

Successful product development needs input from different departments of the firm like R&D, engineering, manufacturing, finance, marketing and so on. The product development team has to be cross-functional. (Cooper 1994: 70, Ernst 2002: 14) This facilitates inter-departmental learning and links different skills and competences existing inside the firm (Smith 2000a: 92). At the same time, it is not enough to just form a cross-functional team. The team members also have to collaborate and communicate, and involve other members of the organization when necessary (Dhamvethee *et al* 2005: 12). Inside the firm there has to exist a willingness to change ideas, information and knowledge (Wan *et al* 2005: 263, Ernst 2002: 15). Managers cannot assume that collaboration will be spontaneous because rather often it is not. Therefore, additional efforts to create an environment supportive of collaboration (including a flexible structure, an innovation friendly culture, commitment of management, the creation of communication channels etc) have to be made. (Abetti 2000: 213)

Other aspects that have to be specified by senior managers regarding the new product development team include (Cooper 1994: 70, Achilladelis *et al* 1971 Vol 2, Ernst 2002: 15, Hadjimnolis 1999: 566, Abetti 2000: 213):

- the division of the team's time – focused only on one project *versus* several projects simultaneously,
- the range of the team's responsibilities – responsible for the entire project *versus* only some phases of the process,
- the division of the tasks between team members – one member should not be responsible for too many tasks,
- the existence of a technology gatekeeper (experts of new technologies and their development).

To effectively execute the innovation process, the process has to be well organized. It has been suggested that the new product development process be divided into several smaller stages to increase the clarity of tasks, divide responsibilities and define activities (Cooper 1994: 74, Panne *et al* 2003: 316). Dividing the process into several stages also introduces explicitly defined decision points into the innovation process. Cooper (1994) defined decision points as quality control check points for deciding whether to go forward with the particular project or terminate it.

The last sub-factor of the internal context covers the evaluation of the innovation process/new product development project. The division of the innovation process into several different phases introduces decision points. These decision points mark the milestones in an innovation process, where the evaluation of the previous activities should take place. At every decision point, a decision about continuing or terminating should be made. (Ernst 2002: 9) The evaluation should cover aspects like the adequacy of resource allocation, efficiency of resource utilization, quality of the execution of different sub-processes of product development and the commitment of the project staff (Ernst 2002: 15, 24; Achilldelis *et al* 1971 Vol 1: 5; Cooper 1994: 72). Unfortunately, evaluation in enterprises is often discarded or poorly executed by managers. One of the reasons is the lack of experience/knowledge for choosing the right indicators for the evaluation. (Cooper 1994: 71)

Within the internal context there are factors mentioned, which are not under the total control of the enterprise. For example, the enterprise can choose whether to use a flexible structure and tap into networks with the aim of cooperating with different partners, but all this takes place in the external environment, within the social fabric. When there is a prevailing mistrust of partners in society, an enterprise looking for cooperation partners may not be able to achieve this even if it is ready to do so.

Of course, one must say that even if all the factors important for the innovation process are in place and effectively executed, there is no guarantee that the firm will be successful, although the probability of success in that situation is definitely higher. Often the success or failure of innovation is determined by mere luck. Luck has been mentioned by different authors and often considered very important as the innovation process is full of uncertainties and there is plenty room for chance. (Kingston 2000: 708; Abetti 2000) However, others take the position that "fortune favours the prepared mind".

The above presents the factors of the innovation process. The first division of factors was conducted across different stages of the innovation process and their overlapping areas. In the second step, factors were divided inside previously formed groups according to whether the factors are linked to the external or the internal context of the firm. Several of the abovementioned factors cover the activities of interaction, cooperation and collaboration with organizations and institutions outside the firms. Many factors are similar but grouped under different subgroups according to how they are linked to either stages or the externality or internality of the innovation process from the firm's perspective.

In this thesis the division of factors into external and internal makes it possible to highlight the importance of the links between different factors and the connections between the firm's internal and external environment. Firms have to consider the legal and economic environment of the country, policy measures implemented by the public sector and so on, while dealing with micro-level processes, procedures and structures inside the firm. Almost all of the stages of the innovation process – idea generation, problem solving and application – are influenced by both internal and external actors and factors. Therefore, firms continuously function in a complex system. The systematic approach to innovation is presented and analysed in the next section.

## 1.2. Contributions from the literature on national innovation systems for public sector innovation support measures

### 1.2.1. The development of the approach to a national innovation system

Innovations cannot be looked at in an isolated environment. To multiply the impact and/or influence of the innovativeness of enterprises or to increase the innovativeness in the first place, there also has to be a supportive environment with key factors in place. One important aspect of a supportive economic environment is effective and efficient interactions between different organisations and institutions to lessen the complexity and uncertainty of the innovation process for the innovators. But even a supportive environment influences innovators through different constraints and incentives. The external environment, actors, organisations and institutions with different interactions and influences form a system for using knowledge for economic gains. This system creates the surrounding conditions for the innovation process. (Edquist 1997: 1–2)

Discussions about national innovation systems as an approach started from the incentive to explain the differences between countries on the basis of capabilities, strategies and revealed performance. These differences seemed to have a tendency to be stable over time. (Dosi 1999: 35–36) The notion of a national innovation system originates from Friedrich List, who developed the concept of the national system of political economy already in 1841 (Freeman 1997: 24). List tried to explain why there is a change in countries dominating the world's economy. He explained this through the economic, social and cultural factors of the countries. (Archibugi, Michie 1997: 6) List emphasized the aspect of implementing public-sector policy measures to enhance economic growth. The majority of these measures were linked to learning and education to increase knowledge about different technologies. He also considered the importance of learning from other more developed countries and enhancing the results through combining foreign and domestic knowledge. (Freeman 1997: 24) List was aware of linkages between domestic and imported technology and of tangible and intangible investments (Freeman 2002: 193). The above was closely linked to accumulating "mental capital" and through knowledge accumulation facilitating economic growth (Johnson *et al* 2003: 2).

Although List mentioned many components of innovation systems, the national innovation system approach came about at the end on 1980s (Edquist, Hommen 2008: 1). The first to use the term national innovation system (NIS) in published form was Chris Freeman in 1987, followed by Lundvall's publications in 1988 ("*Innovations as an interactive process: from user-producer interaction to the national system of innovation*") (Edquist 1997: 3, 4). Freeman defined NIS in his book of 1987 as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Edquist 1997: 8; Archibugi *et al* 1999: 3). He was focusing on national-level policies and the institutional framework influencing the firms' activities, and he considered innovations to be new technologies (Smith 2000a: 76).

The study published by Lundvall is a micro-level study about user-producer interactions based on search strategies and learning activities without specifically involving the national level. Therefore, at the heart of this approach lie groups of users and producers interlinked with each other and forming the components of a national system. (Smith 2000a: 76) Although Lundvall emphasized the importance of interactions between users and producers (Lundvall 1988), the users were defined rather broadly encompassing also institutions and organizations outside the market (Edquist, Hommen 1999: 67). Therefore, in Lundvall's approach, NIS was defined rather broadly including "all parts and aspects of the economic structure and institutional set-up affecting learning as well as searching and exploring – the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place" (Edquist 1997: 8). He also emphasised that the definition of the system of innovation has to be kept open enabling flexibility for studying the subsystems and processes of the NIS (Edquist 1997: 14).

At the beginning of nineties two important books on national innovation systems were published. The first of them was written by Lundvall in 1992 (*National Systems of Innovation Towards a Theory of Innovation and Interactive learning*) and the second by Nelson in 1993 (*National Systems of Innovation: A Comparative Study*). The first focused more on developing the theoretical aspects of NIS and on interactive learning, user-producer interaction, and innovation. The latter included 15 case studies of national innovation systems from different countries and did not focus so much on the development of theory. (Edquist 1997: 4; Edquist, Hommen 2008: 4; Archibugi, Michie 1997: 3) After these books were published, the national innovation system approach became widespread and studied by several researchers resulting in a large number of definitions of NIS differing from each other in terms of scope. Narrow definitions like Nelson's from 1993 are similar to a triple helix approach, including links between research institutions, firms and government in the area of R&D efforts. Broader definitions like Lundvall's define the national innovation system as including interactive learning, tacit knowledge, economic and political freedoms, norms, culture and so on, besides formal R&D. (Johnson *et al* 2003: 4, 13) At the same time, researchers using the narrow definition usually do not reject the wider institutional environment. They refer to those institutions as the "rules of the game". (Smith 2000a: 77)

In general it could be stated that narrow definitions take into account the organizations directly involved in searching, exploring, knowledge acquisition and diffusion, while the broader definitions consider also the wider socio-economic system – all aspects of the external environment influencing learning, searching and exploring activities (Freeman 2002: 194, Johnson 2008: 4, Smith 2000a: 76). The socio-economic system includes different sub-systems such as the political, religious, scientific, technological, cultural and entrepreneurial. It is important that these sub-systems are in accordance with each other to facilitate the innovation process effectively (see Figure 9). (Freeman 2002: 195) At the same time, even broader definitions of NIS do not explicitly mention the importance of international links or links with foreign organizations, systems and institutions.

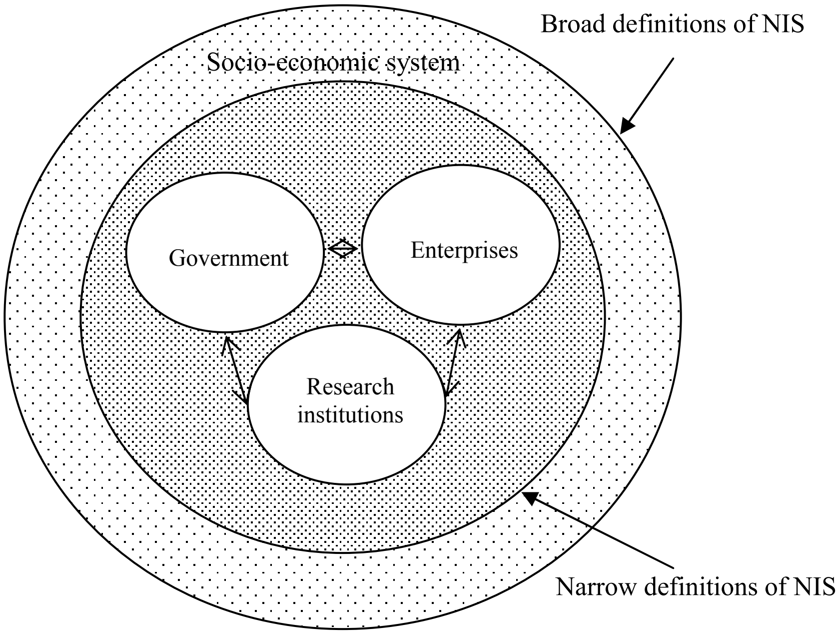



**Figure 9.** Broad and narrow definitions of the national innovation system (composed by the author)

Although there are two types of definitions of the innovation system, researchers do not recognise one more than the other. The narrow and broad definitions of NIS exist side by side. Researchers using the broader definition rather often ignore the narrow definition and *vice versa*. (Edquist, Hommen 2008: 5) In this thesis, NIS is defined as a system including organizations, the links between them and the wider socio-economic environment surrounding the actors in the system, in other words the broad NIS definition is used.

Besides national innovation systems, researchers also distinguish between regional innovation systems (RIS) and sector/technological innovation systems. These concepts are introduced below.

The definitions of the national innovation systems could also be used to define the regional innovation system by simply adding the regional aspect (Howells 1999: 67). Within RIS, innovation activities are linked to one specific territory, and innovativeness is influenced by cooperation between local actors and location-specific resources (Isaksen, Remøe 2001: 288). At the same time, the word “region” could be used for geographic areas including several nations like the EU or areas within a single country. Therefore, it is important to define the region using terms like continental, sub-continental or sub-national innovation systems. (Freeman 2002: 191–192)

The reason for developing the concept of regional innovation systems may be explained by the non-homogeneity of regions inside the national innovation systems or the homogeneity across national systems. Howells highlighted three dimensions supporting the importance of the regional innovation systems. These dimensions are (Howells 1999: 72):

1) the existence of a regional government structure;
2) regional industrial specialisation, its evolution and development;
3) core/periphery differences.

Regions may differ in terms of all those dimensions or just some of them, but different regions have also several aspects in common. For example, every region inside a country or one supranational union is influenced by similar laws and/or regulations. The differences in those cases may arise from delivering or implementing the system of laws and/or regulations. (Howells 1999: 77) This could be considered a top-down perspective to RIS.

RIS could also be seen from the bottom-up perspective. Differences between regions have probably arisen because of different micro-processes in one particular region (Howells 1999: 81–82). These differences may then be magnified through international, national and/or regional regulations, laws, division of power etc.

The factors of the regional innovation systems analysed by Radosevic (2002) are presented in Figure 10. Radosevic emphasises that regional innovation systems include more linkages and institutions than only intermediaries supporting the innovativeness of enterprises. Therefore he supports the broad definitions of innovation systems. Also, it has to be kept in mind that the factors of RIS have a multi-level character, which means that every factor may be influenced by international, national and regional factors and development. The importance of the factors may also differ across regions. (Radosevic 2002a: 88)

The original figure by Radosevic did not have two-way arrows between the factors, which he named determinants of the regional innovation system. Furthermore, there were no connections between the factors themselves either. At the same time, the factors and the regional innovation system do influence each other, and the factors are interlinked through several processes of the region. For example, the social capital of the region may be influenced by the existence and effectiveness of the regional innovation system. Also, the linkages between actors are influenced by the strength of the social capital in the region.

Although Figure 10 was originally developed to describe the factors of the regional innovation system, it could be used for national and sector innovation systems too. The factors are similar for all types of innovation systems, only their importance and influence may differ.

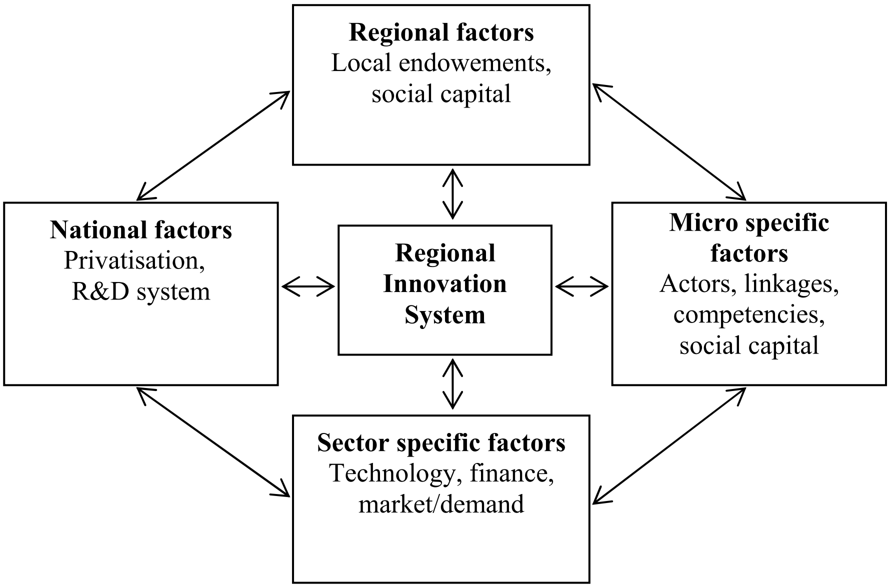



**Figure 10.** Factors of regional systems of innovation (Radosevic 2002a: 88, modified by the author)

Sectoral systems of innovation may be defined as "a collection of activities organized around a common technological or knowledge base in which individual enterprises are likely to be either actual or potential competitors with one another" (Edquist *et al* 2004: 428). Using this definition the sectoral innovation systems could also be considered similar to technological (innovation) systems. The main dimension of sectoral innovation systems is the sector and of technological (innovation) systems, technology (Carlsson *et al* 2002: 233). Sectoral and technological innovation systems assume that a specific sector or technology has characteristics enabling us to isolate it from the rest of the economy (Carlsson *et al* 2002: 236). Sectoral systems include firm and non-firm organisations and different types of relationships between them within one specific industrial sector. Institutions (rules of game) are also encompassed. (Edquist *et al* 2004: 428) Sectoral innovation systems and technological systems may be limited to a specific industrial sector or technology, but they also may include other sectors and/or technologies because in many cases it is difficult to specify the boundaries very explicitly (Johnson *et al* 2003: 3–4, Edquist *et al* 2004: 428). One can say that the boarders of a sectoral innovation system are easier to define than the boarders of a technology (innovation) system because technology can influence several sectors and other technologies.

Concepts from national to technological innovation systems are also linked to policy measures. Innovation policy measures concentrated on national innovation systems are usually more general and horizontal, creating the framework conditions for innovation processes rather than supporting one specific sector/

technology. To support technological innovation systems, the policy measures should be more specific and directed to a specific technology platform. (Godoe, Nygaard 2008: 1699–1700)

As already mentioned above, national, regional and sectoral innovation systems might cover different geographical areas (see Figure 11). Sectoral innovation systems and technological (innovation) systems are not something separate from national and regional innovation systems and *vice versa*. There is an interdependency between these systems. For example, technological systems may influence the dynamics of national and regional innovation systems. (Archibugi *et al* 1999: 2) Costello discovered in 1993 that the correlation between different industries in one country was stronger than the correlation between the same industries across countries. Therefore, it could also be said that NIS influences sectoral innovation systems within one particular country, and the same can be said about RIS (Archibugi, Michie 1997: 13).

| | | | | |
|---|---|---|---|---|
| Supra-national | ✓ | ✓ | ✓ | |
| National | ✓ | ✓ | | ✓ |
| Sub-national | ✓ | ✓ | ✓ | |
| | Technological Innovation System | Sectoral Innovation System | Regional Innovation System | National Innovation System |

**Figure 11.** The geographical coverage of different types of innovation systems and their linkages to each other (composed by the author)

Regardless of what type of innovation system is under analysis all the innovation systems consist of components, relationships and attributes. Components are defined as actors and rules of the system. Relationships are the connections between the system's components. System's components influence each other and the system as a whole through mutual relationships. The last part of the system consists of attributes, which are the properties of the components and relationships. (Carlsson *et al* 2002: 234)

National, regional, and sectoral innovation systems are defined rather similarly. All of them include 5 sub-systems: the business sector consisting of innovators, imitators, and laggards; supporting structures including all organizations that do not behave according to the rules of market; interactions and links encompassing non-market links between actors of the system; institutions and markets; and the culture and social structure (Teubal 2002: 234–247). The main difference lies in the boundaries of the system. National innovation systems are limited by the boarders of the country, regional innovation systems by the boarders of the region, and sectoral, by the boarders of sector. However, limiting these systems is not as easy at it may seem. This aspect is discussed more thoroughly under the criticism of the innovation system approach.

The following part of 1.2.1. covers aspects similar to all types of innovation systems. First, the theories influencing the innovation system approach are discussed, then commonalities between the different innovation system approaches are analysed. Finally, criticisms of the innovation system (IS) approach are presented.

The innovation systems approach is influenced by interactive learning theory, evolutionary theory, the capabilities concept and the path dependency concept. In addition to interactive learning and evolutionary theory, new growth theory, development literature and industrial economics have contributed to the innovation system approach. New growth theory emphasizes the importance of knowledge in long-term growth and analyses the uneven distribution of knowledge across countries. In the development literature and industrial economics, the concept of a "system" is explained. (Dosi 1999: 39) But these theories and approaches are not discussed in this thesis.

Learning is the focus of the innovation system approach. Inside the innovation system, interactive learning has to take place between the system's actors to facilitate knowledge exchange. (Edquist 1997: 5) These interactions are influenced by the institutional set-up of the society; in other words, the environment surrounding the actors (Edquist, Hommen 1999: 67) and the capabilities of different actors and institutions in the system. There are two types of capabilities important for the innovation system approach – innovation and social capability. Innovation capability can be defined as the ability to develop new products, services, processes, procedures and/or use and improve existing products, services, processes and procedures (Lester 2005: 6). Therefore, innovation capability describes the firm's ability to use existing resources for innovation activities (Yoruk, Tunzelmann 2002: 2). Innovation capability could be equated with the ability to successfully absorb and take advantage of new opportunities created by the market, science and technology (Lester 2005: 6). Social capability according to Abramovitz is the ability to implement and introduce institutional changes into society. Economic growth cannot be explained only through the accumulation of capital and labour, institutional changes have a very important role to play in explaining economic growth rates in different countries, especially institutional changes facilitating innovation systems. (Freeman 2002: 192)

Another way to divide capabilities is to divide them into four – selective capability, organizational ability, functional ability and learning ability. The first is defined as the ability to monitor changes in the external environment and select viable ideas and solutions to take advantage of those changes. (Carlsson *et al* 2002: 235) Therefore, this ability is important for the first and second stage of the innovation process described in the previous sub-chapters. Organisational ability is linked to the organization's management. It is the ability to organize and coordinate the activities taking place inside the firm. (Carlsson *et al* 2002: 235) Firms with high organizational ability should be able to deal with the factors of the innovation process described under the internal context in 1.1.2. better than other firms. Functional ability describes the capability of the firm to execute everyday functions (Carlsson *et al* 2002: 235). The fourth type of capability is defined as the ability to learn from the past, interpret changes in the internal and external environment correctly, and employ appropriate actions to exploit economic opportunities (Carlsson *et al* 2002: 235). Functional and learning ability cover all the stages of the innovation process showed in Figure 6.

The second important theory influencing the innovation system approach is evolutionary theory. Evolutionary theory describes the process of technical change in three steps (Edquist 1997: 6):

1. The start-point in the evolution is the existence or reproduction of particular entities (technologies, knowledge, management styles).
2. These existing entities are influenced by some phenomena/objects, which introduce novel entities to the existing system.
3. There is a selection mechanism for choosing viable entities from among existing ones (market selection).

The process described above is never-ending because novelties are introduced and selections made on a continuous basis. At the same time these activities are based on the previous development of the entities influencing the process of introduction and selection. Therefore, evolutionary theory also emphasizes the importance of path dependency. Path-dependency means that every system has a memory and it influences the development of that system (Smits, Kuhlmann 2004: 7). The path dependency concept enables us to explain some of the differences in innovation systems in different countries (Edquist 1997: 6).

Through evolutionary theory and the path dependency concept, constant change in the system, including the selection of ideas, knowledge patterns, partners and so on, is described and explained (Archibugi *et al* 1999: 6). The system at any particular moment in time is usually rather different from the same system at another time (Carlsson *et al* 2002: 234). However, the use of evolutionary theory does not help us predict how innovation systems will develop in the future. Based on evolutionary theory one could say that the system has been in constant change and it will definitely change in the future, but the direction of the change is not predictable because it depends on the introduction and selection processes. (Archibugi *et al* 1999: 6)

Interactive learning theory and evolutionary theory are interlinked. Learning is one of the mechanisms that helps introduce inventions/ideas and select viable outcomes (Edquist 1997: 7). Therefore, learning is linked to the dynamics (evolutions) of the system because through learning, the system and interactions between actors change (Archibugi *et al* 1999: 5). Through learning, societies transform into knowledge-based societies. Movement towards knowledge-based and learning societies is noticeable on labour markets. There is an increasing need for employees with higher skills, competences and qualifications. (Lundvall 1999: 20) Also, through learning, knowledge is diffused, which is very important because if knowledge is only created but not diffused an increase in competitiveness and growth may not be attained (Dosi 1999: 43).

As already mentioned, there are many definitions of and approaches to innovation systems. This has led to many inconsistencies between the different approaches (Edquist, Hommen 2008: 4), but there are also some commonalities between them. The common characteristics/essential features of different approaches to innovation systems are (Archibugi, Michie 1997: 8–10; Edquist 1997: 16–29; Johnson 2008: 6; Teubal 2002: 238–240; Woolthuis *et al* 2005: 609–610):

- innovation and learning are at the centre of the different approaches (including education, R&D and training);
- different determinants of innovation are included in all approaches to innovation systems;
- historical and evolutionary (e.g. selection of the strongest and generation of variety, heterogeneity inside the system, science and technology capabilities, path dependency, cumulativeness) developments are taken into consideration;
- there does not exist a single optimal innovation system because everything is in constant change, there only exists uncertainty;
- innovations appear in an environment of non-linear interactions between different organisations and institutions (interdependency between (key) agents);
- innovation activities are influenced by the surrounding environment (industrial structure, strength and weaknesses of science and technology etc);
- the majority of the approaches to innovation systems cover all types of innovations;
- there are institutions (rules of the game) implemented by legal and social organisations/actors through which the uncertainties linked to innovation activities are decreased, conflicts and co-operation between organizations and individuals are managed, incentives for learning and innovative activities are provided and resources towards innovation activities channelled;
- innovation system approaches are often rather vague because of the differences in the definitions of key elements;
- innovation system approaches are frameworks, not theories.

The theories and concepts influencing the innovation system and its characteristics are presented in Figure 12. In addition to aspects depicted in the figure it is important to keep in mind that because of path dependency, cumulativeness and the existent actors and capabilities of the system, there is the potential for the system to become locked-in to some kind of development stage. If the system is inward-looking it may not be able to notice the trends outside of its boundaries, which may result in missing new and necessary opportunities for further development. Lock-in failure is described more thoroughly in 1.2.2.

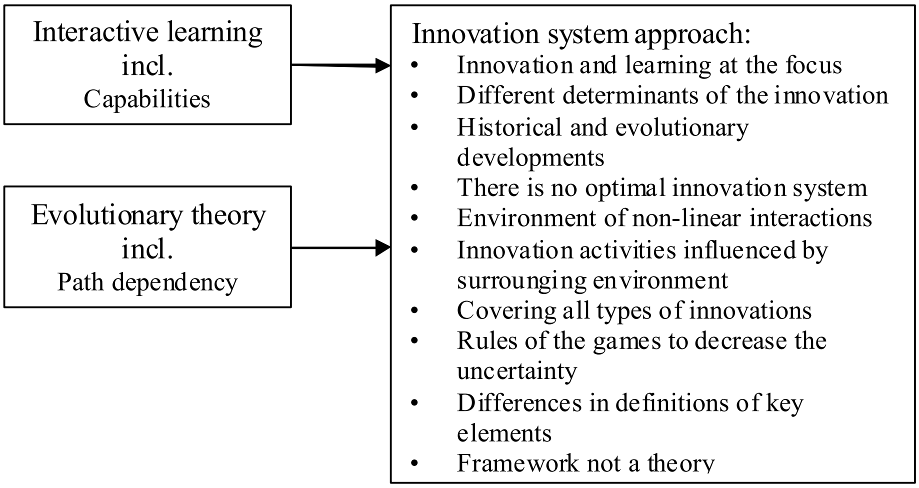



**Figure 12.** Overview of innovation system approach (composed by the author)

The innovation system approach is criticized on the basis of different elements. An overview of these will now be presented. Also some solutions for overcoming the shortcomings and improving the innovation system approach are discussed.

It is very difficult to define the *boundaries for the innovation system* (Rametsteiner, Weiss 2006: 566). The innovation system should encompass all relevant organisations and institutions in the innovation process and the linkages between those actors (Edquist 1997: 14). At the core of the IS approach are firms who are interlinked with other firms and/or non-firm organizations. The latter group includes different types of organizations starting from research institutions and ending with several interests groups. The links between actors may differ in type and kind. (Högselius 2006: 32–33) All this is influenced by the different rules in society – rules of the game. Therefore, the definition of relevance and the determination of important organizations and institutions are usually influenced by the background of the analyst and objective of the study. (Edquist 1997: 14)

One way to bind the innovation system is to take into account the geographical and/or technological aspect of the system. Everything outside this kind of limited system forms the external environment. (Högselius 2006: 38) In this way national, regional, sectoral and technological innovation system approaches converge. But usually this does not help because even then the boundaries of one specific technological innovation system are not easy to define. The innovation system should encompass all the important aspects influencing the innovation process, but determining those aspects is difficult and dependent on the current knowledge base about the innovation process (Edquist, Hommen 2008: 6). The second possibility is to analyze only small parts of the system, limit the research to very exact borders and times, and not focus on the whole system (Edquist 1997: 18). This may also influence the results of the study because some of the important links and actors may be excluded from the research.

In addition to difficulties in limiting the system at one particular time and making the approach less vague, the *dynamics and constant change of innovation systems* renders the analysis even more difficult. Up until now IS studies have often been rather static and retrospective, and not enough attention has been paid to the processes and changes in the future (Carlsson *et al* 2002: 236, Högselius 2006: 31). Therefore, one can say that the innovation system approach is more focused on the operational side of the system rather than its transformation (Teubal 2002: 237–238). Although the dynamic aspect of the system was already acknowledged and considered in the 1990s, the IS approach has still mainly been used to describe the system ex-post and not ex-ante (Lee, von Tunzelmann 2005). So it has mainly been used to describe and compare existing systems. This approach has not yet been explicitly used enough for system building (Johnson *et al* 2003: 14).

These two aspects of the innovation system could be improved through quantifying some characteristics of the innovation system. Quantification would also help to measure and or evaluate the performance of different systems with the aim of comparison (Carlsson *et al* 2002: 234). Unfortunately, *quantitative characteristics of the systems* have not yet been defined. The quantification of the systems may help to analyse the flows and interactions taking place inside the system. (Lee, von Tunzelmann 2005: 426)

Although the national innovation system approach has primarily been developed by scientists from developed countries, aspects of *developing countries* have also been taken into account. While writing the chapter "Small National Innovation Systems Facing Technological Revolutions: An Analytical Framework" for the book "Small Countries Facing a Technological Revolution" in 1988, Andresen and Lundvall took into account the writings of Hirschman and Stewart encompassing the issues of developing countries (Johnson *et al* 2003: 3). Regardless of this, the IS approach has still mainly been applied to developed countries. In order to use the IS approach in developing countries, some modifications to the innovation system approach have to be made. For example, greater focus must be placed on capabilities instead of resources, the importance of knowledge as a source for economic development and the significance of institutions and organizations. Capabilities should not include only learning and innovation capabilities, but also the freedom of people to choose the kind of life/knowledge they want/consider useful. It is also important to understand that learning takes place inside and outside of the education system and formal R&D activities. It takes place all the time and through this process knowledge diffusion also takes place. Therefore, it is important when studying developing countries to emphasize the generic characteristic of learning and knowledge more and the importance of institutions supporting learning and innovation. (Johnson *et al* 2003: 8–12)

Linked to the development of the country, small countries with their particular problems are also somewhat neglected in the NIS approach. If we do not define size based on some quantified indicators (inhabitants, geographical area etc), but based on the country's negotiation power in international relationships (being the weak part in international negotiations and unions), the problems of small countries are very similar to the problems of developing countries (Kattel *et al* 2010: 66). Therefore, the aspects of size and developmental stage are problematic in the NIS approach.

The *definition of institutions* within the framework of IS usually depends on the author. Some researchers define institutions as formal structures or technological systems, some as social norms and regulations and some researchers include both aspects (Edquist 1997: 26, Johnson *et al* 2003: 7, Lee, von Tunzelmann 2005: 426). One way to resolve this problem of confusion could be to use North's distinction between institutions and organizations (Högselius 2006: 32). On the basis of North's definitions, organizations are the actors in the game and institutions are the rules of the game. Institutions are divided into two – formal and informal institutions. Formal institutions are codified rules (laws, regulations, statutes) and informal institutions are uncodified rules (traditions, norms etc). (Högselius 2006: 32–33) In addition to the vagueness of the definition of institutions, other key components of innovation system are also defined and used ambiguously (Edquist, Hommen 2008: 1).

The *linkages and flows between organizations and institutions, and inter-organizational links* encompassed in the IS approach are very important (Högselius 2006: 33). Through linkages and flows the systems are defined. At the same time interactions are not analyzed, mapped and described thoroughly enough. These issues may become an obstacle because if the linkages and flows are not studied more thoroughly it could affect the study of these systems in the future. (Archibugi *et al* 1999: 6–7)

The NIS approach may be considered mainly a *macro-level approach*, with micro-level processes being taken into account only at a general level. Therefore, the IS approach could be seen as a top-down approach. The behaviour of individual firms inside the IS (how firms react to NIS, how firms adjust their strategies, how NIS influences the innovativeness of the firms etc) has not been sufficiently studied although firms have an important role to play in the innovation systems approach. (Archibugi *et al* 1999: 8; Kattel *et al* 2010: 79) There is no single theory within the national innovation systems approach linking the macro and micro level (Mytelka, Smith 2002: 1477). A connection could be made on the basis of the functions of innovation systems.

Focusing on the functional side of the innovation system helps us to eliminate and/or diminish some criticisms of the approach. It helps to limit the system (only institutions important for some functions are taken into account); moreover it can be used as a way to describe the current state of the system, its dynamics, performance and effectiveness. IS functions can improve the comparative aspects (different systems may have different institutional settings, but if the functionality is good, differences in institutional settings are not so important). (Radosevic 2007: 8–11; Johnsson 2008: 1) This also permits linking the public policy measures to the innovation system approach. If there is a list of functions an innovation system has to perform, the implementation of policy measures can help support those areas that are not functioning efficiently – that is, system failure exists.

The functional side of the innovation system is discussed more thoroughly in the 1.2.2. How and whether the above-presented criticism is taken into account in this thesis is presented in Table 6.

**Table 6.** Critique of systems approach and how this is taken into account in the current thesis

| Critique | Response |
|---|---|
| Difficulties linked to boundaries of the innovation system | Only innovation processes taking place inside enterprises are taken into account and innovation support measures are limited to specific public sector organizations. |
| Dynamics and constant change of innovation system are not taken into account | To achieve the aim of the thesis the operational side of the innovation system (current status) has to be analysed. On the basis of the results suggestions for change are made. |
| No quantitative characteristics of the system are defined | The development and defining of the quantitative characteristics of NIS is not the focus of this thesis. |
| More focus is necessary on the aspects of developing countries | Estonia is a catching-up country. To take this into account, aspects like capabilities, path dependency and the significance of organizations are also included in the analysis. |
| The definition of institutions has to be clear | The author of this thesis uses North's distinction between institutions and organizations. |
| The importance of linkages and flows has to be emphasized | This thesis takes into account linkages and interrelationships between enterprises and precisely identified public sector organisations. |
| Attention to micro level should be paid | The starting point for this analysis is the innovation process taking place inside enterprises (i.e. at the micro level). |

Source: composed by the author

Because of the broad criticism, it is important to conduct more research in the area of innovation system to decrease some of the ambiguities and eliminate the most important shortcomings of the approach. This helps us move from the innovation systems approach to innovation system theory. (Edquist, Hommen 2008: 1) Right now it is rather difficult to find one optimal approach for an innovation system because the IS approach itself is still evolving (Edquist, Hommen 2008: 3).

No firm exists in isolation. It is always surrounded by the external environment composed of different actors and rules. Firms, surrounding organizations and institutions, and the links between the actors form the system of innovation, which has been and continues to be studied by several authors. This has resulted in the multitude of different approaches and types of innovation systems. At the same time, there are some commonalities between the different approaches. All of them are influenced by interactive and evolutionary theory. Also, every researcher recognizes that there is no optimal innovation system. Innovation systems are in constant change due to the changing relationships between actors and institutions, and the changing internal and external environment of actors. Although the innovation system approach is rather heavily criticised, it helps us to analyse the different innovative environments and their components, relationships and attributes, including alignment issues between innovation support measures and factors influencing the innovation process of firms.

### 1.2.2 The functions of innovation systems and system failures

Although the innovation system approach is gaining more popularity among researchers and policy makers, it is still hard to apply the approach to specific policy settings and designs because it is too general (Teubal 2002: 233) and does not provide many direct suggestions for building an innovation system (Johnson *et al* 2003:14). To improve the situation and facilitate the usage of the innovation system approach the functional side of it is becoming more and more analysed and studied by different researchers.

The main function of the innovation system according to Edquist and Hommen is "to pursue the innovation process – i.e. to develop and diffuse innovations" (Edquist, Hommen 2008: 8). Carlsson *et al* (2002) state that "The function of an innovation system is to generate, diffuse, and utilize technology". These main functions mentioned above are rather general and declaratory, and do not give very useful and precise guidelines for constructing an innovation system for a country. This supports the existing opinion that IS is more a theoretical approach than a practical tool for designing an innovation policy. That is why a more detailed list of IS functions is needed. (Hommen, Edquist 2008: 460) Such a list was presented by Rametsteiner and Weiss (2006). They brought out three functions of innovation system (Rametsteiner, Weiss 2006: 566):

- reduction of uncertainties through information provision,
- management of conflicts and cooperation,
- provision of incentives.

An even more detailed lists of functions are presented in Table 7 summarizing functions mentioned in four different studies. These lists are more comprehensive and useful for policy design than the abovementioned functions of IS.

Högselius highlights 12 functions of innovation system. All of these (except the last) may be influenced by the formulation of public policy (last function) because through it all other functions can be influenced, created and/or supported. Högselius also mentions the formulation of vision as a function of IS. This function does not exist explicitly or implicitly in the other approaches presented in Table 7. The author of this thesis supports the exclusion of vision as a function because a system as an entity cannot have a vision. A common vision may and should be shared by the actors in a system and through this shared vision actions moving towards that target can be implemented.

**Table 7.** Different approaches to the functions of innovation systems

| **Högselius (2006)** | **Jakobsson and Bergek (2006)** | **Edquist and Hommen (2008)** | **Johnson (2008)** |
|---|---|---|---|
| • formulation of visions;<br>• articulation of demand for new, improved and/or cheaper products;<br>• creation of new knowledge;<br>• competence-building;<br>• formation of new firms and other organisations;<br>• market entry and exit;<br>• adaptation of organizations to accommodate innovation;<br>• networking;<br>• provision of finance;<br>• consultancy, advice and lobbying activities;<br>• creating, changing and abolishing institutions;<br>• formulation of public policy. | • market formation (creation, increase in volumes, and mass marketing);<br>• knowledge development (breadth and depth of the knowledge base) and its diffusion;<br>• support to entrepreneurial spirit and activities;<br>• influencing the search activities and investment behaviour;<br>• resource availability and mobility;<br>• creation of legal environment suitable for innovation systems;<br>• development of positive externalities. | • provision of know-ledge inputs to innovation process (provision of R&D, creation of new knowledge, compe-tence building)<br>• demand-side activities (formation of markets, articulation of quality requirements)<br>• provision of constituents of IS (creating and changing organisations and institutions, and networking)<br>• support services for innovating firms (incubation, financing, consultancy services) | • identification of the bottlenecks in IP;<br>• creation of knowledge to solve the identified bottlenecks;<br>• recognition of the potential of innovation;<br>• creation of incentives to be engaged in IP;<br>• creation of markets for innovation;<br>• decrease resistance to change;<br>• facilitate knowledge and info exchange;<br>• supply of resources (incl. competencies);<br>• guidance for the search processes (e.g. standards and regulations);<br>• reduction of social uncertainty. |

Sources: Composed by the author on the basis of Högselius 2006: 34–36; Jakobsson, Bergek 2006: 691–693; Edquist, Hommen 2008: 10, Johnson 2008: 12

Högselius's listing of functions has some additional shortcomings. First, the function that mentions the adaptation of organizations to accommodate innovation does not take into consideration that besides organizations, institutions and society as a whole also have to be ready to accommodate innovations. Second, there is no mention of labour as a necessary resource for innovation activities/policy. Both of these aspects are taken into account in Johnson's approach. Johnson (2008) compared the findings of different researchers of innovation systems to compose the list of the functions common across studies. The author of this thesis takes the approach presented in Edquist and Hommen (2008) as a basis because this list is the most explicit and representative overview of IS functions.

Most of the functions mentioned in Table 7 cover all seven areas of the innovation process in Figure 6. For example the function "Influencing search activities" is linked to the generation of ideas, problem solving and the application of the idea. Also, the overlapping areas of those stages are linked to this particular IS function.

To create and/or support the functions mentioned in Table 7, several policy measures can be designed and implemented. Edquist and Hommen (2008) define innovation policy through the main function of IS. According to them innovation policy is defined as "Actions by public organizations that influence the development and diffusion of innovations" (Edquist, Hommen 2008: 9). There are different policy measures designed to support the main and sub-functions of IS. For example, the creation of knowledge may be influenced through education policy, grants for scientists and researchers, financial support for R&D activities executed in enterprises, tax incentives etc. The external and internal context of the firms is more or less influenced by government interventions, and enterprises have to exist in this system of links and interconnections; in other words, innovations and technological changes take place "within a social fabric" (Archibugi, Michie 1997: 1). This describes the situation where firms perform the important role of innovating, but the innovation process taking place in a firm is influenced by many other institutions and organizations surrounding the firm, so the innovation process is influenced by interactions between the firm and its environment (Archibugi, Michie 1997: 1–2; Smith 2000a: 73).

There exist differences between firms' environments including institutional contexts across innovation systems, and this affects the macroeconomic performance of countries. The differences in systems may arise from capabilities, and governance systems and activities including policy measures to intervene in the economic activities of organizations and institutions. (Smith 2000a: 74) Differences also may arise from barriers existing in enterprises' innovation processes.

For a long time there has been discussion on whether the government should intervene in market processes and the economic environment or not. It is accepted by different researchers that some intervention is necessary to create the general framework for economic processes through laws, regulations and so on. But how much government should intervene to support innovation processes and in what circumstances is still under discussion.

There are different approaches discussing whether the government should intervene and how much. Mahmood and Rufin (2005) argue that the governmental role should be larger when the country is far from the technological frontier, and should be focused on directing the resources for imitation to take place in firms. When the country is close to the technological frontier, the role of government should decrease and limit itself to a facilitating role and indirect intervention methods. (Mahmood, Rufin 2005: 339) Therefore, the movement towards the technological frontier means that the country moves from economic and political centralization towards economic and political decentralization. At the same time, issues like coordination, government failures and problems appearing during the transition from centralization to decentralization have to be considered. (Mahmood, Rufin 2005: 355–356) This is also true for catch-up countries.

The reasons for and circumstances in which the public sector should intervene have rested on two concepts: market and system failures (Edler, Georghiou 2007: 952). Market failure can be defined as a situation where the market is not able to achieve optimality without public sector interventions (Jacobsson, Bergek 2006: 690; Rolfo, Calabrese 2006: 249). Therefore, market failures are based on neo-classical theory according to which the existence of market failures should result in interventions from the public sector (Frenkel 2003: 118). In this framework, market failures are linked mainly to the under provision of public good because of the uncertainties, externalities (inability to appropriate the positive externalities of knowledge/innovation), imperfect information (lack of information or difficulties linked to accessing the information, special characteristics of scientific knowledge), inability to invest because of the lack of private sector interests and missing markets (Jacobsson, Bergek 2006: 690; Rolfo, Calabrese 2006: 249; Godoe, Nygaard 2006: 1698). Most of the time market failure in the area of innovation appears through insufficient financial resources for investments in risky and innovative activities (Reid 2009: 13). Innovation policy measures linked to market failure, for example, cover the costs of the innovation process or support VC funds (European Innovation… 2008: 15).

At the same time, the concept of market failure is not in line with the innovation systems approach, which is influenced by interactive learning and evolutionary theory. The quest for an optimal solution and equilibrium is simply not possible in an environment with uncertainties, imperfect information, evolutionary characteristics, and dynamics. (Hommen, Edquist 2008: 458; Jacobsson, Bergek 2006: 690) Optimality is not definable in reality and therefore the comparison between optimality and society's current situation is also not possible. As a result the concept of market failure based on neo-classical theory should not be the basis for public sector interference in the economic system of a country. (Hommen, Edquist 2008: 458)

Markets are not the only actors in the economic environment of a country. There are other actors and institutions besides markets surrounding the innovative and economically active firm. Therefore a broader set of failures has to be taken into account to explain the need to intervene by means of public policy, when conditions for and functions of IS are not present and/or ineffective. (Jacobsson, Bergek 2006: 690)

The innovation systems approach encompasses several important functions that IS has to fulfil effectively (see Table 7). For example interactions between actors need to take place, the rules of the game need to be implemented and operating, the evolutionary process has to function, firms have to have innovation capabilities etc. If these functions are not in place or are ineffective, a system failure will appear. (Hommen, Edquist 2008: 459) As a result, the theoretical backgrounds of system failure and market failure concepts differ somewhat. The latter is based on neo-classical theory, with the focus on optimality and the ways to achieve it, whereas system failure concept grows out of evolutionary theory and IS approach, and tries to compare different systems and evaluate their efficiency in fulfilling IS functions. (Hommen, Edquist 2008: 459) So, even if some of the problems or failures may appear the same according to the two concepts (e.g. lack of information exchange, low level of investments into basic research, existence of externalities and uncertainty) the reasons for the problems and proposed solutions to remove it are different. In the market failure framework the public sector intervenes if markets cannot achieve optimality, whereas in the system failure framework the public sector intervenes when some of the functions are inefficient or non-existent compared with the needs of society, other innovation systems or the same innovation system as it functioned in the past. Therefore in the framework of system failure policy makers do not choose whether to intervene or not on the basis of rational selection with defined constraints to achieve the optimal solution, but because policy makers act in the same kind of uncertain environment and have to learn and adapt their behaviour accordingly.

The differences between the two approaches can also be demonstrated based on their approach to knowledge. As already mentioned above learning, information, and knowledge exchange are important aspects of the innovation system approach. When markets cannot regulate the knowledge exchange, the market or system failure appears. According to the market failure concept, knowledge is a public good because the dissemination costs of knowledge are low, and after dissemination it is very hard to deny access to this knowledge. Furthermore the value of the knowledge does not lessen if an additional person possesses it. This is also the reason why knowledge is not usually tradeable in markets, because it is very difficult to put a price on it; the value of the knowledge is unknown to the user before actually using or having it. (Lundvall 1999: 22) Therefore the public sector should encourage investments in knowledge. The private sector has almost no opportunity to appropriate the positive externalities fully and therefore has no interest in investing in those activities. (Grant 1996: 111; Hall, Rosenberg 2010: 7) Other authors state that knowledge is not a pure public good because not all of the knowledge is in a codified form (Grant 1996: 111). Furthermore, in order to understand new knowledge and apply it, a person has to have the ability to understand the knowledge. This ability is closely linked to his/her education. If the person does not have the ability to use the knowledge it has no value for him/her. This actually increases the interest of the private sector to invest in knowledge creation because they can thus limit other people from using it. (Grant 1996:111)

System failures can be revealed in different ways. In transition countries, system failure may be linked to several issues arising from the history of the country i.e. linked to path dependency. In transition countries the following problems exist, and need to be faced when designing the NIS and/or public sector innovation policy measures (Varblane *et al* 2008: 377–279):

- underestimation of the role of the public sector in national innovation systems,
- domination of the first generation innovation process model and ignoring the demand side,
- contrast between high- and low-tech sectors,
- excessive focus on foreign direct investments,
- lack of social capital and existence of network failure,
- low level of knowledge diffusion and learning capability.

Different authors have emphasised different types of system failures and different areas where the failures might appear. Keith Smith (2000a) has brought out four areas where the system failure can appear and therefore the need for intervention is necessary. These areas are (Keith 2000a: 94):

- creation of infrastructure,
- "transition failures",
- lock-in failures,
- institutional failures.

Internal physical infrastructure is very important for enterprises, but it is also important to have an external science-technology infrastructure encompassing research institutions, databases, regulatory institutions and functioning ministries. Private institutions do not usually want to invest in science-technology infrastructure because of associated problems with investment appraisal, lack of appropriability of benefits, and the characteristics of the existing public good. Besides physical infrastructure, institutional infrastructure also has to be in place. Institutional infrastructure includes the implementation of regulations, standards, health and safety rules, an increase in innovation awareness and so on, which has been a primary task of countries. Therefore these areas need public sector attention and intervention if necessary. (Smith 2000a: 94) In Reid 2009, the concept of framework failures is used instead of failures in institutional infrastructure (Reid 2009: 14). Therefore the failures linked to infrastructural provision and investments in science-technology infrastructure cover the factors influencing all three stages both separately and together, and overlapping areas of the innovation process according to the model employed in this thesis.

"Transition failures" are linked to a firm's inability to interpret the knowledge and opportunities existing in its environment. One of the reasons may lie in the path dependency. It brings along three problems. First, firms fail to solve the problems outside of their existing capabilities. Second, they may not notice the changes in demands, creating new areas in markets and technologies. Third, firms may not notice and/or recognize the major changes in technology regimes or paradigms. (Smith 2000a: 95) Some authors use the term "capabilities failure" describing rather similar situation as "transition failure". Capabilities-failure is defined as a firm's inability to learn, lack of flexibility inside the firm and/or resources enabling them to adapt to the changes (Woolthuis *et al* 2005: 610, 614). In other words companies and even countries are unable to act in a way which is most beneficial to them (Reid 2009: 13, European Innovation… 2008: 15). In some sense capabilities failure may be considered a cause of "transition failure" (Woolthuis *et al* 2005: 612). Therefore these types of failures are linked to the factors influencing the first, second, third stages noted above, and all overlapping stages of the innovation process.

Although different researchers describe the capabilities failure at the level of enterprises, similar situations may occur at a national level. If this occurs then lock-in failure exists. Technologies are not only linked to a firm's production processes; they are also embedded in the social and economic environment of a specific country. Therefore new technologies do not have to compete only with existing technologies, but also with environments where the existing technologies are based. Some nations may fail to absorb the change in technology paradigms and be locked-in to a particular development stage because of the path-dependency and small size of the country. (Smith 2000a: 95–96) Another type of capability failure at national level has occurred within the EU. In many EU member states there has been a growing need to support innovations through financial support. One way of doing this is via structural funds. At the same time, many countries have not been capable of absorbing financial support coming from EU. (Reid 2009: 27) This is closely linked to government failure as described below.

The institutional structure of the country (public and private institutions, regulations, policy and economic system, social institutions etc.) may also experience failure and therefore hinder the development of the firms and country (Smith 2000a: 96, Woolthuis *et al* 2005: 610). Institutional failure can exist due to the inefficient or non-existent coordination between different kinds of institutions and organizations as the outcome of a wrongly-chosen governance style. For example, a mismatch between the aims and needs of public sector policy measures, created institutions and organisations etc. might exist. While implementing different policy measures it has to be kept in mind that the measures should complement each other and not to work against each other. (Hommen, Edquist 2008: 469) In smaller countries, institutional failures may also be caused by the personalization of institutions. In societies where "everyone knows everyone" interlinks between organisations, and coordination and cooperation aspects may be influenced by interpersonal relationships. (Kattel *et al* 2010: 76)

Institutional failure is sometimes defined as governance failure. Governance may be understood as managing of collective actions. These collective actions may occur within firms, public sector organisations, etc. Governance can be organised via markets, hierarchies (corporate and political hierarchies), and networks. (Yoruk, von Tunzelmann 2002: 4) As a result failures in those areas can exist. Failures in political hierarchy can be defined as governmental or policy failures. Policy failure is linked to problems in public interventions including a low level of policy-making capacity (Reid 2009: 14).

Network failure can be divided into weak and strong network failures. Weak network failure arises from a lack of interaction between different agents of innovation system (Woolthuis *et al* 2005: 610). The lack of interactions may be caused by lack of willingness to exchange the ideas and knowledge and/or contradictory aims of institutions (Ekboir 2003: 583). At the same time, the networking activities are important for the innovation process because it is through this that knowledge and ideas are changed. If there is no interaction between different institutions the innovation process may be very time consuming and/or non-existent. Strong network failure describes the situation where different institutions are linked together so closely that they do not notice opportunities coming from outside the network (Woolthuis *et al* 2005: 610). Strong network failure can also be revealed through a situation where the stronger organization dominates the system and in so doing decreases the efficiency of other organizations (European Innovation… 2008: 9). Using this definition, strong network failures are closely linked to lock-in failures.

In helping to eliminate governance and some other types of system failures, intermediaries play a very important role. The concept of intermediaries covers different types of organisations – brokers, third parties, agencies with the aim of providing the support to innovation process etc. (Howells 2006: 715) Intermediaries may help to facilitate technology transfer and through that, technology diffusion, but these organizations also can be creators of linkages, interactions and networks between different firms, firms and research institutions etc. to facilitate the information and knowledge exchange. (Howells 2006: 716–717) All these aspects are essential for innovation. The functions of intermediaries may be one or more of the following list: information scanning and gathering, storage, information assimilation through communication, application, advice/consultations etc. Through these activities, intermediaries can link together organisations and technology fields, which were not connected earlier and thus, create new uses for technology. (Howells 2006: 719) Therefore, intermediaries may help to failures in society. Which problems they will solve depends on the reasoning behind their creation. At the same time intermediaries, if they do not fulfil their functions properly, may also create system failures.

The failures noted above have been compounded in one figure (see Figure 13, below). The reader has to keep in mind that the definitions of some of the failures are rather similar and there are actually no explicit borders between some of those sub-concepts. For example, transition failure may overlap somewhat with corporate failure. Furthermore some institutional failures may be linked to transition and lock-in failures.

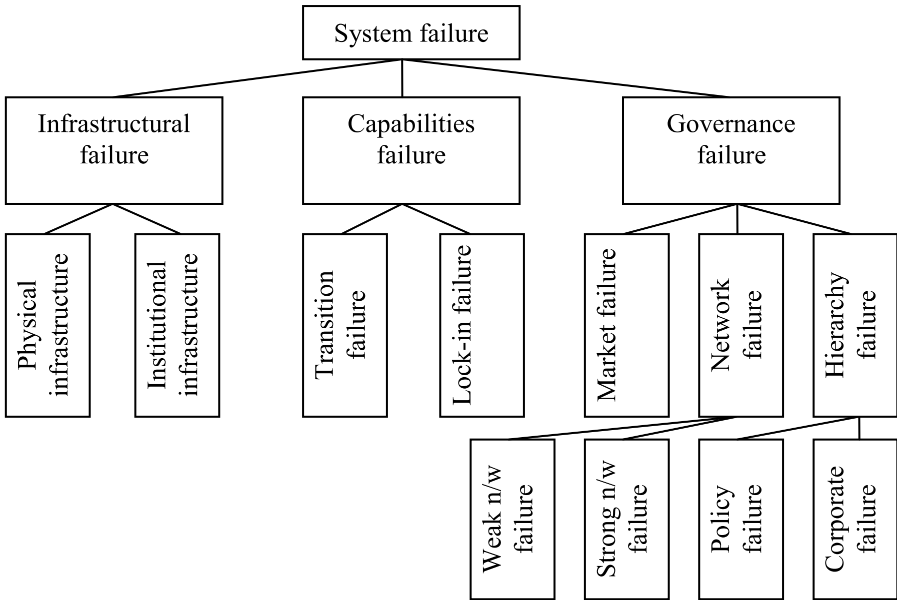



**Figure 13.** Framework of the system failure concept (composed by the author)

As seen above, the definitions of different types of system failures often overlap. As a result Woolthuis *et al* (2005) have elaborated the system failure framework for analysing possible areas for failures and separate them from each other more explicitly. They have divided potential failures into two groups: failures linked to the actors of the system and failures linked to the rules of the system. This framework is presented in Figure 14. (Woolthuis *et al* 2005: 611) Unfortunately there are some aspects which are ignored in this framework. First, the list of actors is not comprehensive. For example, public sector organizations like ministries, committees etc. are not presented in that framework. Second, the framework currently describes the situation where the failures appear only in interaction between actors and rules, but the system failure could also be caused either by the missing rules and/or missing actors. These situations cannot be placed within this framework. Therefore in this thesis the framework presented in Figure 13 is used.

All the aforementioned failures may exist in a country, regardless of its size and development stage. It is almost impossible to say what kind of failures are dominant in a country at particular stage of its development and specific size. Having said that, one might say that system failures are likely to play a more important role in developing and smaller countries than in developed and larger countries.

At the same time, at international level, dynamics of the importance of system failures can be brought out. In the past the main problem linked to innovations for policy makers has been lack of finances, which brings along market failure. Nowadays capabilities and the capabilities failure has become the centre of focus. (Reid 2009: 16) If the system failure is detected, the corresponding policy with its policy measures should be elaborated and designed to mitigate or remove the failure. But one has to keep in mind that The existence of system failure is not a sufficient condition for interventions by the public sector via different policies. Before intervention takes place, the public sector should be convinced that this failure could not be solved by market forces and/or private organizations, and that the public sector is able to solve or mitigate the problem through policies and their measures. (Edquist *et al* 2004: 430–431; Hommen, Edquist 2008: 458) There is always going to be uncertainty over the ability of the public sector to mitigate the failure, but there are ways to manage these uncertainties and risks.

| Actors (missing actors) / Rules (missing rules) | Demand side<br>• Consumers<br>• Large buyers | Companies<br>• Large firms<br>• MNCs<br>• SMEs<br>• Start-ups | Knowledge institutes<br>• Universities<br>• Technology institutes | "Third Parties"<br>• Banks, VCs<br>• Intermediaries, consultants<br>• Sectors organizations, employers |
|---|---|---|---|---|
| Infrastructural failure (ICT, roads, railroads…) | | | | |
| Institutional failure:<br>Hard (laws, regulations) | | | | |
| Soft (norms, values) | | | | |
| Interaction failure:<br>Weak failure | | | | |
| Strong failure | | | | |
| Capabilities failure | | | | |

**Figure 14.** Innovation system policy framework (composed on the basis of Woolthuis *et al* 2005: 611 with minor modifications)

If the public sector is not able to solve or mitigate the problem there might be several reasons for this. For example, government failure (also called policy failure) might exist. That means that the state does not have the necessary capabilities to solve the problem. The reason might also be that this particular failure cannot be removed through public sector interventions. (Edquist *et al* 2004: 430–431) Therefore to support the innovativeness of firms via the public sector support measures, it is important to find the balance between the pure market and the centrally planned economy. If a system failure exists, the intervention possibilities have to be evaluated from the viewpoint of other types of system failures, because elimination of one failure might create another one. (Lundvall 1999: 25–26) If the intervention is grounded, the proper activities should be chosen. Those activities may be in the form of designing and implementing new policy measures and/or terminating and/or changing already existing measures. (Hommen, Edquist 2008: 459) Termination of or change in already existing measures can be justified if the system failure was caused by the malfunctioning of the existing policy measures.

To make the innovation system approach more applicable, innovation system functions are introduced and analysed. Based on IS functions, systems can be created, effectiveness can be increased and performance evaluated. But if IS does not fulfil its functions effectively or if some of them are missing, a system failure appears and intervention from the public sector could be necessary. At the same time, the existence of a system failure is not a sufficient condition for the public sector to intervene, public sector measures have to be the best solutions for solving problems. In the next chapter, innovation policy measures will be analysed and discussed more thoroughly. Furthermore, reasons why efforts from public sector may not solve the problems will also be discussed.

## 1.3. Integrated framework for analysing the alignment between the factors influencing the innovation process in enterprises and public sector innovation support measures

### 1.3.1. Innovation policy measures within the framework of the innovation systems

The innovation process may be influenced by innovation policy. Innovation policy and its measures can be defined as hybrid of traditional, industrial and scientific policy (Rolfo, Calabrese 2006: 257). But this definition is rather general. A little more detailed definition is presented by Isaksen and Remøe (2001). They say that innovation policy should include the elements of industrial and scientific policies, but it also should encompass additional measures designed to increase the introduction of new products, services, and processes (Isaksen, Remøe 2001: 286). Or as it is defined in Reid (2009): “innovation policy is a set of policy actions to raise the quantity and efficiency of innovation activities whereby innovation activities refer to the creation, adaptation and adoption of new or improved products, processes or services" (Reid 2009: 1). Therefore innovation policy encompasses a set of measures/ tools/incentives to encourage innovations in society or achieve some innovation related goals set by society (Gogoe, Nygaard 2006: 1700). Usually those goals include an increase in the competitiveness of country's economy (Kuhlmann 2001: 954).

So, innovation policies have to support innovation activities through different measures, so innovation policy measures also have to create a favourable environment for these activities. (Tsai, Wang 2005: 257) Policy measure is defined as comprising instruments to implement a specific policy. Thus there are two important aspects in defining innovation policy. First, innovation policy has to create a favourable environment for innovative activities. This means that innovation policy is also closely linked to general economic policy, educational policy, social policy etc. Second, it seems to the author of this thesis that governments often forget that the end users of innovation policy measures should be firms not other organisations such as research institutes. Research institutes can be considered as an intermediate step or as supporting infrastructure to help firms to be more innovative, and they should be the end users of those science and research policy measures which are focused on the production of knowledge (Reid 2009: 1).

Innovation policy measures implemented by the public sector are influenced by two theoretical approaches: neo-classical policy measures (e.g. financial incentives) and policy measures according to an evolutionary systematic approach (Frenkel 2003: 120). According to neo-classical theory, firms are the main element of economic activities and they have to survive in a neoclassical market without any supportive organizations (Teubal 2002: 237). The neo-classical approach is based on the equilibrium and optimization behaviour of economic actors. Although aspects such as strategic interdependence between firms, uncertainty, asymmetry of information etc. are dealt within mainstream neo-classical theory, this approach sometimes fails in explaining some issues, which are present in the systematic approach. (Smith 2000a: 75) These issues encompass, for example, the importance of knowledge (only implicitly present in neo-classical theory), partly-private good characteristics of knowledge, the systemic nature of the innovation process (linear models in neo-classical theory), the non-optimality of the system, and the high importance of existing uncertainties and risks (Mytelka, Smith 2002: 1471–1472, Singh 2004: 217). Risks are always present in innovation activities. There are two reasons for this. First, innovation activities are executed by humans and therefore the results can never be predicted with certainty. Second, innovation processes include different actors from different organisations and institutions. The outcome of interactions of these actors is not certain. (Smits, Kuhlmann 2004: 8) It may be said that the classical approach emphasizes the economic model with rather isolated profit-maximizing firms with perfect information and almost no risks. It disregards the organizations and institutions interacting with and influencing innovating firm and ignores the fact that not all organizations are profit-maximizing entities. (Edquist, Hommen 1999: 68)

Several innovation policy measures implemented up until now have been influenced by neo-classical production theory. According to this theory, firms have to decide what to produce and how to produce it on the bases of production functions. Firms have information about current and future input prices, all the techniques and technologies (seen as knowledge) available for production etc. to solve the profit-maximising exercise and find the optimal solution. The knowledge in this theory is generic, codified, accessible without costs, and context-independent. When the external context of the firm changes, it changes its position without any problems and is able to find a new optimal point of production. (Smith 2000a: 82–83, 85) This leads only to processes and not product innovations. All the information is included in prices and therefore producers cannot receive any information about customers' needs, which are not already met by the supply side. Furthermore, users can evaluate new products only based on prices, which make the introduction of innovation very difficult. (Edquist, Hommen 1999: 71)

Neo-classical theory does not include any adjustment problems. In this framework the objectives of policies lie in freeing the markets, removing barriers from factor movements, increasing the competitiveness between enterprises, producing knowledge through publicly-funded institutions or providing subsidies to knowledge-producing firms, and solving the problems with a low level of appropriability of knowledge. (Smith 2000a: 82–83, 85) The policy makers possess perfect information and their task is to eliminate market failures preventing the system to reach optimality through implementing different incentives in the economy (Hommen, Edquist 2008: 470).

Modern innovation policy on the other hand is based on a systematic approach, and instruments emphasising the importance of learning, knowledge exchange, evolution, and coordination between different alternatives. Systematic instruments cover five functions supporting the functions of the innovation system presented in the previous sub-chapter (Smits, Kuhlmann 2004: 5):

- management of links and connections between different subsystems and actors;
- creation, deconstruction and governance of innovation systems;
- establishing conditions for learning and experimenting;
- provision of infrastructure for creation of strategic knowledge needed by actors;
- encouragement of demand and visions for the discovering and/or creation of new opportunities.

All firms' activities are based on some kind of knowledge base, which can be divided into three parts – firm-specific knowledge, sector-specific knowledge and general knowledge (Smith 2000a: 87). These types of knowledge are linked to each other and they evolve over time (Smith 2000a: 89). Searching, exploring, and learning are the most important activities for innovation inside innovation system approach. Therefore policy within the NIS framework has to deal with learning and knowledge originating from learning. (Smith 2000: 81) The management of links and connections between different sub-systems and actors may therefore be considered as one of the most important tasks of public policy support measures. Through interactions, knowledge is exchanged, opportunities identified, and new combinations created. (Edquist, Hommen 1999: 66)

To fulfil functions of systematic instruments, many different innovation policy measures have been elaborated. In order to group these different measures, several categorizations have been developed. OECD categorizes policies on the bases of factors relating to innovation which are divided into four categories: factors linked to enterprises (innovation dynamo), factors linked to science and technology institutions (science and engineering base), factors linked to knowledge transfer (transfer factors), and factors linked to the surrounding economic environment (framework conditions). (Oslo Manual 1997: 18–23) The OECD's innovation policy terrain is presented in Figure 15. The factors linked explicitly to firms are represented in the middle of the framework and they are surrounded by all other factor categories. The reason for this may be that innovation activities do actually take place inside firms, and all other factor categories influence and should support the innovativeness of the company more or less indirectly.

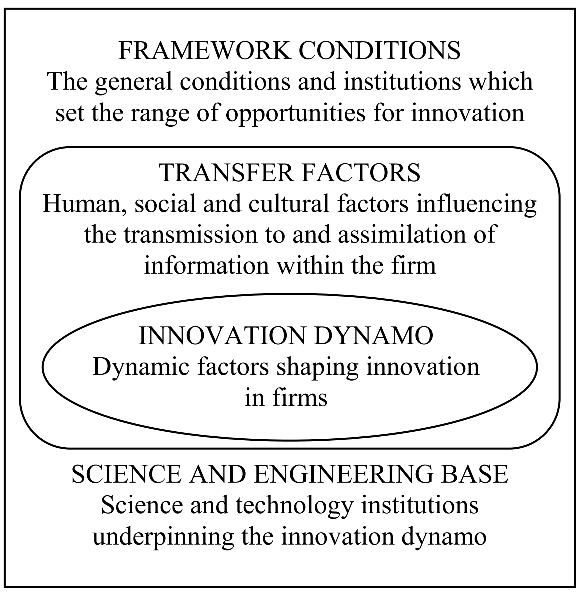



**Figure 15.** The innovation policy terrain (Oslo Manual 1997: 19)

Rolfo and Calabrese (2006) have divided measures of innovation policy into four groups: mission policies, diffusion and technology transfer policies, infrastructural policies, and territorial policies (technological districts, clusters). Mission policies are linked to financial resources for basic and applied research carried out by research institutes and/or firms including the training of human resources, development of new research techniques and tools, and support for general technologies through the cooperation of businesses to reduce research costs and risks. Diffusion and technology transfer policies cover technical assistance given to firms (financial aid for purchase of new machinery, measures aimed at transferring the knowledge, the promotion of research within the companies, collaboration among companies and with universities, the creation of technology-based firms, support for employing young researchers to companies and the creation of research groups with personnel drawn from industries, universities and research institutes). Infrastructural policies are connected to the creation of technological and scientific infrastructures, educational and research systems including laboratories and equipment, and communication networks (scientific and technology parks, research institutes, incubators, technology transfer centres, technological services and brokerage offering information, consultancy, assistance by themselves and through networks they belong to). (Rolfo, Calabrese 2006: 258–260)

It is also possible to divide policy measures according to a top-down and bottom-up perspective. From a top-down perspective, innovation policy measures are linked with national interest and priorities but they also may be influenced by supra-national institutions and unions. But even in this case policies should take into account the developments and situation inside the country, because policies must be in accordance with its economic environment in order to avoid causing misalignment between designed policy measures and needs of the enterprises. (Howells 2005: 1223–1224) The other perspective is that of bottom-up policies which are actually based on local situations and needs, but these bottom-up policies still have to be held in accordance with national and supra-national development, to fit into the framework of general policy. By doing this it is easier to get finance for designing and implementing these bottom-up policies. (Howells 2005: 1225) The majority of innovation policies are top-down policies though (Howells 2005: 1227). Top-down policies may cause innovation policies to fail, because policy makers may not be well informed about local situation and needs.

The most commonly used grouping of innovation policy measures is to divide them into demand-side and supply-side measures. This grouping also has links with earlier innovation process models. Linear innovation process models advocate supply-side measures or demand-side measures; system-oriented models take into consideration both of them. (Edquist, Hommen 1999: 63–64) Taxonomy developed by Edler and Georghiou (2007) is presented below (see Figure 16). Several innovation policy measures have been divided between supply-side measures and demand-side measures (Edler, Georghiou 2007: 953).

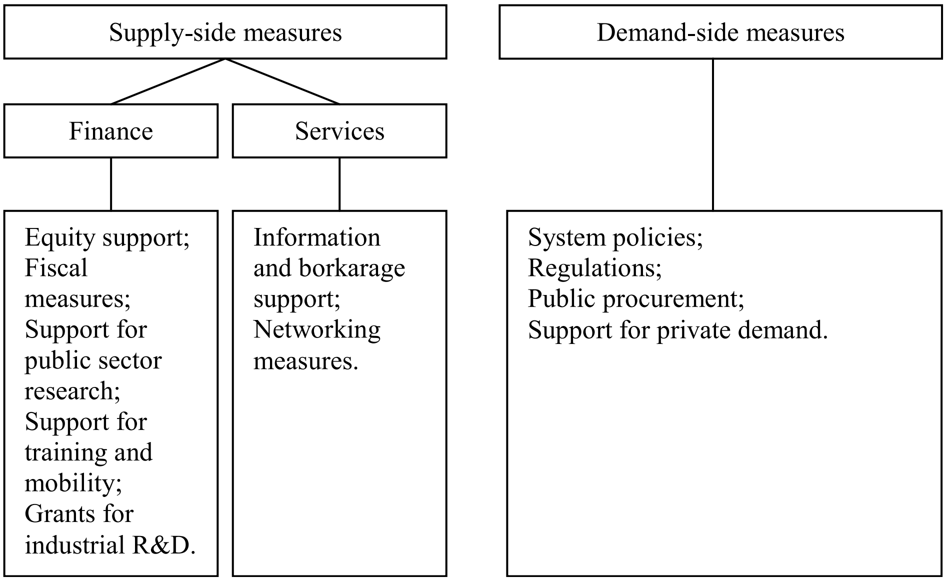



**Figure 16.** Taxonomy of innovation policy tools (Edler, Georghiou 2007: 953)

There are more supply-side measures implemented by governments of different countries than demand-side measures. At the same time, supply side policy measures cannot eliminate and/or create enough incentives to facilitate the innovation process of companies. Demand-side policies are defined as being measures linked to the increase and/or creation of demand for innovations; determining new requirements for new products, services; and a better articulation of demand (Edler, Georghiou 2007: 952). One of these kinds of policy measures consists of the tools implemented with the aim to shift the culture towards the celebration of innovation. Measures such as harmonised regulatory environment, the use of standards and public procurement can be used to achieve this. (Aho *et al* 2006: 6–7) Demand-side policies also encompass systematic policies, because these policy measures are designed to bring together users and providers of innovations (Edler, Georghiou 2007: 953). Demand-side policies can therefore be divided into four groups (Georghiou 2006: 12, Edler, Georghiou 2007: 953):

- systematic policies providing an environment for actors involved in innovation process (e.g. cluster policies),
- regulations for markets,
- public procurement,
- support of private demand.

The third group of demand-side policies, namely public procurement, is currently starting to gain in popularity amongst policy makers. Public procurement is defined as being procurement inside which innovation is an important condition. Through public procurement, private R&D activities can be increased, demand subsidies introduced, public services and infrastructure improved, and cooperation supported. (Edler, Georghiou 2007: 950, 952–953, 956) The precise effect of public procurement depends on the composition of the call. Public procurement usually has a broader influence on region than a direct influence on the tender-winning companies. First, it forms an important part of local demand. Second, it may remove the market and system failures linked to problems in the translation of needs into marked demand. Third, it also creates the possibility of upgrading the public infrastructure and/or public services. (Edler, Georghiou 2007: 954) But public procurement can also introduce additional failures into the system. For example, it can "pick-the-winners" through preferring one solution to another without letting markets and private demand to decide. Public procurement measures can also undermine the principles of free market and trade if the conditions of procurement are favourable only to local companies. All these problems can be removed through the skilful and impartial drafting of the procurement call. (Edler, Georghiou 2007: 961) The latter is very difficult to achieve under political pressure from different interest groups.

Although demand-side policies are not yet widely used, the political pressure to design and implement them is rather high. But the implementation of demand-side policies may bring with it many problems. Implementation of demand-side policy measures frequently requires setting targets and determining the direction of technology development via public sector bodies. At the same time, these bodies only possess secondary information about technology and market trends. (Watanabe, Tokumasu 2003: 70) But even so, the recent trend in the EU is to move away from public funding of enterprises towards increasing demand for innovations (European Innovation… 2008: 9).

A similar problem is also linked to supply-side policies. Innovation policy measures are often designed to focus only on high-tech enterprises and industries. Modena and Shefer (1998) bring out two reasons for this trend. First, high-tech industry is seen as a sector producing products with a high value-added component, which have positive externalities influencing the rest of the economy. Second, high-tech industry is usually very export-oriented. (Modena, Shefer 1998: 2) At the same time Keith Smith has argued that high-tech industry (according to OECD classification) quite often forms only a small part of the country's GDP, and therefore it is hard to understand how this small part of the national economy can have such an effect on overall economic growth. (Smith 2000b: 9) Therefore it is important to focus on broad areas like technology platforms, problem solving without determining the precise technology for solution, and/or linkages between high-tech industries/technologies and traditional industries rather than supporting high-tech sectors *per se*.

In Table 8, connections between the innovation process stages discussed in 1.1.1 and the grouping of innovation policy measures are presented. The table summarizes four different innovation policy groupings as described above.

**Table 8.** Linkages between innovation policy groupings and the stages of the innovation process

| | | Generation of ideas (1st stage) | Problem solving (2nd stage) | Application of the idea (3rd stage) | Stage 1 and 2 | Stage 1 and 3 | Stage 2 and 3 | All three stages |
|---|---|---|---|---|---|---|---|---|
| Oslo Manual | Innovation dynamo | √ | √ | √ | √ | √ | √ | √ |
| | Science and engineering base | √ | √ | | √ | | | |
| | Transfer factors | √ | √ | √ | √ | √ | √ | √ |
| | Framework conditions | | | | | | | √ |
| Rolfo, Calabrese 2006 | Mission policies | √ | √ | √ | √ | √ | √ | √ |
| | Diffusion and technology transfer policies | √ | √ | √ | √ | √ | √ | √ |
| | Infrastructural policies | √ | √ | √ | | | | √ |
| | Territorial policies | √ | √ | √ | √ | √ | √ | √ |
| Howells 2005 | Top-down policies | √ | √ | √ | √ | √ | √ | √ |
| | Bottom-up policies | √ | √ | √ | √ | √ | √ | √ |
| Edler, Georghiou 2007 | Demand-side policies | | | √ | | | | √ |
| | Supply-side policies | √ | √ | | √ | √ | √ | √ |

Sources: Composed by the author on the basis of Oslo Manual 1997; Howells 2005; Rolfo, Calabrese 2006; Edler, Georghiou 2007

All the groups of policy measures can influence all stages of the innovation process, through the different innovation policy measures they include, but in Table 8, dominating innovation policy measures of that group are linked to innovation process stages. Even then the majority of those policy groups cover all seven stages of the innovation process. For example, measures designed to influence any of the innovation process stages may be both top-down and bottom-up policies, but some of the categorizations allow differentiation across innovation process stages, thereby allowing the bringing-out of linkages between innovation policy measures' groups and seven areas in Figure 7. It also has to be remembered that not all aspects of enterprises' innovation process could and should be covered by policy measures. Policy measures should be implemented when one particular kind of system failure exists and intervention from the public sector is the best solution for mitigating the failure.

Policies designed to support the first stage of the innovation process – idea generation – are linked to the 'technology-push' type of policies; if we are to define this group more narrowly than Edler and Georghiou 2007 have done, i.e. if we define it along the lines of science and engineering-base policies according to the Oslo Manual. One example of this kind of policy measure is the creation and support of basic science and technology institutions. This measure does not support innovative activities inside the firm directly, but it increases the creation of potentially beneficial research results and therefore influences enterprises indirectly through knowledge spillovers and network/cooperation activities.

The second stage of the innovation process deals essentially with problems and solutions linked to the possible implementation of new ideas. Therefore policies supporting this stage should focus on capabilities rising within companies. During this stage, enterprises have to be able to evaluate the viability of the idea, the opportunities for new products, and know-how, or they need to know where to find the available solutions for producing the product and use those sources or connections accordingly. All these require high capabilities and knowledge from the firm's employees and managers. Several policy groups mentioned in Table 8 include training related and capability increasing measures. That is why in this thesis the policies linked to second stage of the innovation process are defined as "capability-raising policies".

Policies supporting the third stage of the innovation process are closely linked to demand-pull/demand-side policies. Demand-side policies (mainly market formation policies) have been a rather important factor behind Singapore's innovation system design and success (Hommen, Edquist 2008: 447).

The policies covering two out of three stages of the innovation process simultaneously have to be focused on increasing interactive capabilities inside the enterprise, and between it and external organisations. In this way the diffusion and technology transfer policies can describe these policies in the best way. In addition to diffusion and technology transfer policies common to all overlapping areas between two stages in Figure 7, there are some additional specific policies for some of the overlapping areas. Policies for supporting second and third stage can focus on creation of testing centres where enterprises can test their innovative product before starting to produce it on a large scale, or the facilitation of access to technologies. Policies supporting the first and second stages can include fiscal tools (tax incentives for R&D) creating the incentives for private R&D investments and a well-established IPR (*Intellectual Property Rights*) system. At the same time, the direction of influence of the IPR system is still under discussion. For example it is thought that weak intellectual property rights may ease the transfer of technological knowledge but this also decreases the possibilities of appropriation of benefits coming from innovations which decrease the enterprises' willingness to invest in R&D activities (Singh 2004: 224).

Finally, measures created to support all the three stages simultaneously are linked to business and transfer conditions existing in society (Watanabe, Tokumasu 2003: 74–82, Oslo Manual 1997: 18–20). So, framework conditions mentioned in Oslo Manual describe these policies in the optimum way.

At the same time, the lines between different policy groupings are rather fuzzy, and several policy tools can be defined as being a part of several groups. Therefore it is important to analyse each policy measure separately, while implementing the alignment framework developed in 1.3.2 and not groups of innovation policy measures.

It can be said that innovation policy measures are going through the same kind of development as the innovation process models presented in 1.1.1, but that the transfer from one type to another is somewhat slower. This means that innovation policy measures are moving from supply-oriented measures (the use of supply oriented measures started after World War II and has continued more or less up until today) towards supporting supply and demand side interaction while starting to focus on demand-side and more systematic approaches to innovation activities. (Kuhlmann 2001: 962; Smits, Kuhlmann 2004: 14) For example, investments into R&D do not have any significant influence if there is not enough trained scientists and/or engineers (Hall, Rosenberg 2010: 5).

Taking a systematic approach to innovation activities means that innovation policy measures will move from those designed for one specific innovation process stage as presented in Figure 6 or from demand- and supply-side policies towards measures designed to support all three stages at the same time and making links between demand- and supply-side. So the importance of all the stages of innovation processes and interlinks between firm and its external environment is being recognised more and more, and the importance of innovation system approach being validated.

The importance of systems is also recognised by Isaksen, Remøe (2001) who bring out six characteristics of good innovation policy. Innovation policy has to (Isaksen, Remøe 2001: 290):

- take into consideration the specific context into which the policy is designed,
- be future-oriented (proactive) and take into account wishes of the receiver,
- be oriented towards increasing capabilities of firms including managerial and technical skills,
- be system-oriented rather than solely firm-oriented,
- should include possibilities for policy learning,
- include measures for all stages of innovation process and the external environment.

Another aspect linked to innovation policy measures is the ongoing discussion between the neutrality and selectiveness of policy measures. Many economists think that innovation policy measures should be neutral and not discriminate across all firms. At the same time, there are no measures, which are totally neutral because every policy measure is designed to tackle a specific failure and/or economic problem. That makes all policy measures more or less explicitly or implicitly selective. (Hommen, Edquist 2008: 463)

While developing innovation policy measures, several aspects have to be considered. First, the source of investments is important. Investments in science and technology can originate from public and/or private financiers. It has been considered that public investments should support basic science, because basic science could be considered to be the public good, and the applied science financed by private investments. The basic question here is whether the relationship between public and private R&D is complementary or substitutional. (Howells 2005: 1227–1230) To encourage private investments in innovative activities, several policy tools can be employed, such as tax reductions covering direct investments from private individuals, investment funds, and companies (e.g. tax-free R&D investments, no social tax payment for R&D personnel, no corporation tax, no local taxes, and/or no capital gain tax for shareholders) (Angelino, Collier 2004: 63–68).

The second aspect is linked to the discussion between "Best practice" policy measures and locally-developed policy measures. "Best practice" policy measures may not be transferable to or adaptable by other regions/countries outside the so-called "best-practice-region", but locally-developed policies are not tested in other regions, and may fail because of lack of experience. (Howells 2005: 1228–1230) At the same time locally-developed policies do consider the specificities of the region/country better. When the policy measures do not take into account the conditions of the specific region/country, the resulting measures may be so general that they have no or little effect on the economy and innovative activities. (Smith 2000a: 98)

The third important aspect is that of the duration of the program. Usually the results of any policy measure are expected shortly after the measure has been implemented. At the same time, policy measures are often linked to institutional changes and designed to influence complex economic processes. Therefore these policy measures require longer time spans in order to be evaluated correctly. (Howells 2005: 1230–1231)

Additional reasons and areas which have to be considered while developing innovation policy measures to decrease the possibility of ineffeiciency are held by Singh 2004: 216; Rametsteiner, Weiss 2006: 567; Teubal 2002: 240; Edler, Georghiou 2007: 949 and state that:

- in many countries innovation policy has remained a top-down approach based on linear innovation process models, but even then the local conditions have to be taken into account;
- many policy measures have been concerned only with the supply side of the innovation process and the demand side as a driver for innovations, and creation of demand for new products, processes etc. has been neglected by governments;
- public sector bodies often do not have enough information to choose, design and implement the right measure for a country's existing conditions,

therefore the competencies and capabilities of public sector have to be constantly increased;

- the process of designing a policy measure cannot be superficial, i.e. representatives of beneficiaries of the measures have to be involved in the process and outcomes of measures have to be explicitly defined;
- interventions from public sector have to be grounded, i.e. if public sector intervention is not the best solution for removing existing failure, the public sector should not intervene, but often intervention is called into existence because of the pressure from different interest groups.

Many opinions exist regarding defining innovation policy, but the majority of them emphasize the importance of supporting innovation activities. Innovation policy measures can be divided into different groups to evaluate their correspondence to the aims of policy makers, and assess their coverage across IS functions and innovation process stages. In this thesis seven groups of innovation process factors presented in 1.1.1. and 1.1.2. are linked to different groups of innovation policy measures. Some of the factors important for the first stage of the innovation process are influenced by technology-push measures; factors linked to the second stage of innovation process require predominantly capability-raising measures; and factors of the third stage are predominantly influenced by demand-side policies. Overlapping areas are connected to measures designed to increase networking, interlinkages, and general framework conditions, i.e. focused on systemic side of the measures. But in many cases innovation policies are not as efficient as they should be due to several reasons. In this thesis a new methodology has been developed to evaluate the efficiency of innovation-support measures. This methodology links together the factors of innovation process with implemented policy measures. It will be introduced more thoroughly in 1.3.2.

### 1.3.2. Framework for analysing the alignment between the factors influencing the innovation process and public sector innovation support measures

The need for alignment in innovation support measures is emphasized in different policy papers and analysis. Alignment is something that policy design and implementation should aim for. At the same time, the concept of alignment is almost never defined in published studies and evaluations. Here the alignment is defined taking into account the aim of this thesis, and the framework for analyzing the alignment between factors influencing innovation process in enterprises and implemented innovation support measures is developed.

To innovate, enterprises need a constant exchange of information and knowledge with the external environment. It helps them to notice and use arising opportunities and/or gain the knowledge how to respond to opportunities arising if this is not possible by relying on internal capabilities solely. To help enterprises, several policy measures are designed to support the dissemination of information and knowledge, and support innovations taking place in enterprises. To do this, policy-makers have to find out the objectives and needs of different actors and design policy measures aligning with those objectives and needs. Alignment between policy design and objectives, and the needs of different actors, bring with it the success of policy measures. (Freitas, Tunzelmann 2008: 1447–1448) Therefore the analysis on alignment is very important.

The previous chapters of the thesis have given an overview of factors influencing the innovation process regarding firms and possible policy measures designed and implemented by the public sector to support enterprises in the innovation process. The factors and measures were divided into seven different groups according to their linkages to and importance on the basis of innovation process stages (see Figure 7): factors/measures important for the first stage of the innovation process (idea generation), the second stage (problem solving), the third stage (idea applications), the first and second stages (with mutual feedbacks), the second and third stages, the first and third stages (e.g. 'user-led innovation'), and finally, at the centre, factors and measures important for all three stages of the innovation process with a full set of feedback loops.

The grouping presented in Figure 7 enables the analysis of three different issues: the analysis of innovation process factors, the analysis of innovation support measures, and the alignment between innovation process factors and innovation support measures. This alignment is defined as being related to commonalities between factors targeted by innovation policy measures and innovation process factors causing problems for enterprises. Analysis of alignment can bring out different degrees of alignment – total alignment, partial alignment and total misalignment depending on the degree of overlap. The results of alignment analysis should be considered as describing one moment in time rather than a dynamic process. Dynamics can be introduced by implementing the framework over some kind of time line.

A similar approach was used in Teder *et al* (2007) while analysing the alignment of innovation and development policies for the forest sector in Estonia. The authors used inter-textual analysis, following the COST guidelines, and compared different policy and strategy documents with the aim of reaching conclusions about alignment between innovation-orientation and forest sector-orientation in these documents. Alignment in this study was defined based on the types of orientation under analysis, e.g. if both orientations existed in documents, alignment also existed. (Teder *et al* 2007: 106)

To conduct the alignment analysis, the analysis of innovation process factors and innovation policy measures need to be performed. First, the analysis of innovation process factors has to be conducted. During this analysis, factors influencing the innovation process according to previous empirical studies (see 1.1.2) and factors influencing the innovation processes of enterprises on the basis of the data from the specific country, region and/or sector are compared. Enterprises of a particular country in general will not struggle with, or will not get support from, all the factors presented in 1.1.2, but only some of them.

Importance of the factors mentioned in 1.1.2 differs across countries, regions or sectors. When representatives of enterprises have to name the factors of the innovation process they only mention the most important of them taking into account country- and enterprise-specific aspects. In different countries, different factors will play the key role in the innovation process of enterprises. Therefore, factors mentioned by the country's entrepreneurs can be considered as causing the biggest problems during the innovation process or as facilitating the innovation process the most. Analysis of innovation process factors helps the analyst to find out the most important factors of the innovation process and stages they are linked to. The majority of important innovation process factors could, for example, fall into one or more specific groups out of seven sub-groups of factors mentioned above. So, to analyse the innovation process factors two sets of factors is compared and most problematic areas are found.

Second, analysis of innovation policy measures has to be performed. In 1.3.1, policy measures are grouped according to seven areas of innovation process stages. The implementation and coverage of the seven areas by innovation support measures depends on the policy makers and existence of system failures. At policy level, some countries may not implement policies covering all the seven areas of Figure 7, and focus only on some of the stages of the innovation process and/or their overlapping areas. There may be different reasons for doing so. First, the innovation policy of the country in question is influenced by the trends in transnational organisations, unions, etc. and therefore policies of those countries are also influenced by those international organisations. Second, policy-makers of the country have set themselves objectives linked to only some of the stages of the innovation process. Third, policy measures take into account the local situation and there is no need for policy measures covering all seven areas. Usually combinations of all these reasons exist. As a result, policy measures of one specific country designed to support the innovation process of enterprises do not overlap with all the seven groups of innovation process factors. Therefore, to analyse policy measures they have to be divided into different groups based on factors they influence. The outcome of the analysis could be similar to situation depicted in Figure 17.

Figure 17 describes some of the potential outcomes of innovation policy measures analysis taking into account data from a specific country, region or sector. One of the outcomes of the analysis may be that innovation support measures focus on three separate innovation process stages and their factors and do not cover the factors of overlapping areas (Figure 17a), or most innovation support measures are focused on problems linked to factors influencing all the three stages simultaneously (Figure 17b) or something in between (Figure 17c).

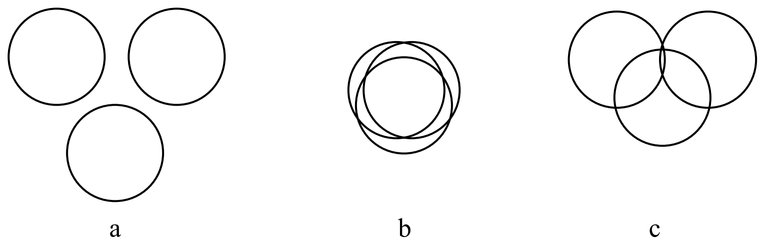



**Figure 17.** Alternative outcomes of the analysis of innovation policy measures based on data from a specific country (composed by the author)

After conducting the analysis of innovation process factors and innovation policy measures, the alignment between innovation policy measures and innovation process factors of a specific country can be conducted. Alignment describes the commonalities between factors influencing the innovation process at enterprises and factors influenced by innovation support measures in one specific country, region or sector; in other words alignment analysis answers the question of whether the design of policy measures considers the local conditions and needs of enterprises. In an ideal case, problems and issues linked to the most important factors of the innovation process in a specific country are covered by the innovation support measures (Figure 18a), but ideal alignment is never achievable because of the time lag and the reaction time of the public sector to new needs and existing system failures. As a result some level of misalignment usually exists. There may be total misalignment between policy measures and factors important for the innovation process of enterprises (Figure 18b), or partial misalignment (Figure 18c). An example of misalignment may be a situation where the capabilities of enterprises to absorb the knowledge coming from research institutes are very low, and they thus prefer to develop relations with their customers instead of with research institutes, but all the policy measures are nevertheless designed to increase collaboration activities between universities and enterprises.

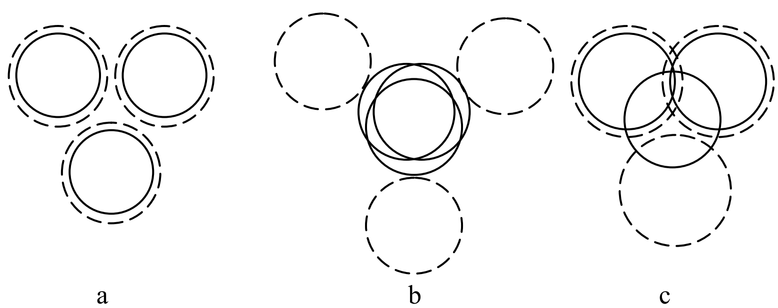



**Figure 18.** (Mis)alignment between policy and enterprises' level (composed by the author)

The evaluation of alignment and misalignment according to Figures 17 and 18 is complicated, so tables aimed at assessing the issues linked to alignment have been developed and presented in the empirical part of the thesis. Figures 17 and 18 can be used to present and summarize graphically the outcomes of the analysis based on the results of the comparison according to different tables.

Depending on which kinds of factors prevail (factors influencing the first, second, third, etc. stages of the innovation process) in society and which of them can be influenced by public sector policy measures, suitable solutions and combinations should be chosen. The importance of factors and corresponding measures may also be linked to the economic development of the country. Changes in importance of factors and/or policy measures may describe the dynamics of the innovation system.

The framework presented above has some limitations. One of these is linked with the definition of innovation policy. It may be said that innovation policy covers all measures that help enterprises to increase their innovativeness. In this sense, innovation policy encompasses education policy, monetary policy, foreign policy, science policy, technology policy, etc. Therefore, before employing this framework the list of policies and measures has to be delimited.

Second, innovation policy should not just take into account enterprises' interactions with research institutes. It should also focus on all kinds of interactions a firm has or may have with different types of organizations and institutions, including regional, national, and international organisations. It also covers different types of knowledge transferred through previously mentioned interactions (Isaksen, Remøe 2001: 286). This means not only that the delimitation of policies is difficult, but also that the institutional and organizational framework has to be defined and described before implementing this framework.

Furthermore, several policy measures have been designed to cover multiple innovation process factors. Measures include different activities, which may be focused on one, two or three stages of the innovation process at the same time. Therefore it is difficult to add a financial dimension to the analysis without inspecting all project applications submitted under this particular measure. Often this is not only time-consuming analysis, but also impossible because of the data-protection regulations of the country in question.

At the same time, the elaborated analytical framework enables the analysis of different areas of innovation policy, different interest groups, different situations in one specific country/region/sector and different types of innovations. This framework allows the analysis of innovation process factors, innovation policy measures, and the evaluation of alignment between factors and measures, which helps to increase the effectiveness of innovation support measures.

The framework presented in this chapter has been developed by the author of this thesis based on theory and earlier empirical studies. In the next part of the thesis, the framework developed will be used to evaluate the alignment in Estonia on the basis of data from dairy processors and biotech enterprises, and public sector organisations.

# 2. RESEARCH INTO THE ALIGNMENT BETWEEN THE FACTORS INFLUENCING THE INNOVATION PROCESS AND INNOVATION SUPPORT MEASURES IN ESTONIAN DAIRY PROCESSORS AND BIOTECHNOLOGY ACTIVITY

## 2.1. Overview of Estonian dairy processors and biotechnology activity, and description of propositions and methodology

### 2.1.1. Importance of dairy processors and biotechnology enterprises in the Estonian economy

After regaining its independence, the Estonian economy started a transformation process. Since then convergence with western countries has taken place. The main competitive advantage contributing to economic growth then was based on cost advantage coming from a previous distorted price structure and the devaluation of the kroon. (Tamm 2004) Also, the value added for manufacturing products was low and the activities were mainly linked to subcontracting. Focusing on how to decrease costs resulted in investments in machines and equipment, but not in high value added product development. This behaviour was possible in the environment of low production costs and high economic growth, but as a result Estonian enterprises do not now have sufficient experience with product innovations and cooperation activities. (Kalvet 2006: 6–7)

During the last decade, the cost advantage eroded rapidly in Estonia. This forced enterprises and the public sector to look for new ways of competing on world markets. One way to do this is to use innovations to increase the production of products with high value-added (e.g. functional products in the food industry).

In this thesis, the innovation process according to the model developed in 1.1.1. is analysed in two sets of activities – dairy processors and biotechnology enterprises. In the case of the dairy industry, only the processors will be analysed and not the whole value chain.

There are several reasons for choosing those two sets of activities. The importance of dairy processors is based on the following. First, milk production and processing have been traditional sectors of Estonian agriculture for a long time. Second, Estonia has had a competitive advantage in dairy products for almost a century. Third, there have been large changes in the milk sector starting with the disappearance of the Soviet market and consequent decrease in milk production from 1 208 thousand tons in 1991 to 676 thousand tons in 2009. (data for 1991 from Hein 2006: 50; data for 2009 from Püvi 2009: 5) Although some recovery of production volumes can be seen, the 1991 level of production has still not been achieved. That level is also impossible to achieve under the production quotas set by the EU (discussion of quotas is presented below). Fourth, besides being a sector with long traditions, the milk processing sector also represents an interesting case for the analysis of the innovation process and innovativeness. The dairy industry is considered to be a traditional sector, but in Estonia dairy processors are rather innovative and many of the processors are closely linked to high-tech activities, mainly biotech. The food processing industry in general is considered to be a customer for many new technologies like biotechnology, ICT and nanotechnology (Yoruk, von Tunzelmann 2002: 6).

Biotechnology is included in the analysis as an example of a high-tech activity. Biotechnology, ICT and nanotechnology are considered to be enabling technologies in the economy and therefore special conditions for the creation and support of those technologies have been developed in several countries. From among these three, ICT is already rather widely used by Estonian public and private organizations, but biotechnology and nanotechnology are not yet linked to the Estonian economy as much as they could be.

In Estonia there are rather few biotechnology enterprises. At the same time, the existence of strong traditional sectors like the food and wood sectors creates opportunities for using biotechnology research outcomes to link high-tech and low-tech industries with the aim of producing high value-added products. For example, the use of biotechnology in agriculture has been one of the oldest applications for biotechnology (Kask 2005: 26). Unfortunately, linking those two sides together has not yet reached its full potential in Estonia, although Estonian dairy processors already cooperate with universities and competence centres through R&D, and have started to implement biotechnological advances in their products.

Table 9 presents a general overview of the **dairy processing industry**. The dairy processing industry is the largest sector manufacturing food products and beverages in Estonia, although it has lost some of its dominance to beverages and meat products (Industrial Production by Economic Activity at Current Prices 2009). The number of dairy producing units has decreased from 42 in 2004 to 40 in 2009. Although the decrease in number of units has not been significant, several of those enterprises actually belong to the same concern. (Püvi 2010: 1) For example, AS Maag Piimatööstus owns factories in Jõhvi, Rakvere and Annikvere (MAAG Piimatööstusest 2009). If information about ownership is taken into account, the number of units decreases to 31 (Püvi 2010: 1). Therefore, we can see that dairy processors are becoming increasingly concentrated on the Estonian market.

The production of raw milk has increased constantly since 2004 with 2009 being the only exception. At the same time, there is still room for larger increases because Estonia has not yet filled the milk quota enforced by the EU. In 2007 and 2008 the difference between raw milk production and the quota was approximately 45 thousand tons. (Saron 09.06.2009) The share of purchases of raw milk by the five largest raw milk processing enterprises has also increased. This shows the trend towards the higher concentration of the dairy processors in Estonia. At the same time, the concentration could even be higher. Neeme Jõgi, CEO of one of the largest dairy enterprises in Latvia is sure that a pan-Baltic dairy concern should be created. This would be more competitive on the internal EU market. (Lättemäe 2009) In Estonia in 2006 there were 4 large and 10 medium-sized dairy processors active on the market. This is similar to Finland and Denmark (respectively 2/9 and 3/8). (Niinepuu 2009: 15)

**Table 9.** Overview of dairy processing industry in Estonia in 2004–2009

| | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|
| Share of dairy processing industry in total production of manufacturing industry (%) | 6,2 | 5,4 | 4,9 | 4,7 | 4,8 | 5,5 |
| Share of dairy processing industry in total production of food industry (%) | 32,0 | 30,3 | 28,2 | 28,4 | 27,3 | 30,5 |
| Share of milk products in food exports (%) | 40,0 | 35,8 | 29,9 | 34,9 | 31,3 | 29,7 |
| Number of dairy processing production units | 42 | 40 | 38 | 37 | 39 | 40 |
| Share of five largest raw milk processing enterprises in purchase of raw milk | N/A | 59 | 62 | 58 | 83 | 85 |
| Raw milk production in thousand tons | 652 | 670 | 692 | 692 | 702 | 676 |
| Raw milk purchase in thousand tons | 536 | 571 | 606 | 593 | 606 | 612 |
| Average raw milk purchase price (EEK) | 3,83 | 3,98 | 3,80 | 4,20 | 4,64 | 3,29 |
| Net turnover per employee in thousand kroons | 1779 | 1828 | 1954 | 2364 | 2625 | 2238 |
| Value added per employee in thousand kroons | 140 | 181 | 254 | 358 | 305 | 307 |

* preliminary data

Source: Püvi 2010: 2, 3, 5, 6; Niinepuu 2009: 2, 3, 4, 10, 12; Niinepuu 2008: 5; Niinepuu 2007: 4; Niinepuu 2006: 5, Saron 09.06.2009, Saron 2010, Purchase of milk 2010

For 2004–2008, the share of the total raw milk production sold to the dairy processing industry has increased from 82% to 88% (Niinepuu 2009: 2). The reason for this can be found in the decrease in the number of small farms because smaller farms have not been able to comply with EU standards (Hein 2006: 51, Hein 2009: 3). Although the number of dairy farms and cows has decreased, the production per cow has increased. For example, milk production per cow increased from 5 140 kg/cow in 2002 to 6 765 kg/cow in 2008, or by approximately 30%. This is influenced by developments in breeding, feeding and technology. (Niinepuu 2009: 2, 3)

Table 10 presents an overview of the production of different milk products in Estonia. As a positive trend, production volumes for butter have decreased during the last 6 years, although they increased again in 2009. Also, the volume of powders has simultaneously decreased with the increase in cheese production. Production volumes for those three products are interlinked – if powder has a higher price, its production increases and the production of cheese and butter decreases and *vice versa* (Saron 2008). At the same time, these three product groups are considered to be bulk products with low value added, although cheese may actually be both – a low and high value added product.

**Table 10.** Production of milk products in Estonia 2004–2009 in thousand tons

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| Milk | 73,4 | 79,9 | 84,6 | 88,3 | 86,6 | 90,3 |
| Fresh cream | 11,1 | 12,6 | 9,7 | 18,1 | 15,6 | 11,7 |
| Butter | 10,7 | 8,3 | 7,3 | 7,7 | 6,7 | 8,0 |
| Sour cream | 16,8 | 14,2 | 15,1 | 15,7 | 15,5 | 16,4 |
| Sour milk products | 16,3 | 17,5 | 18,2 | 17,0 | 16,1 | 16,0 |
| Yoghurt | 15,8 | 18,3 | 19,9 | 20,6 | 19,0 | 20,8 |
| Products from curd | 13,8 | 15,9 | 17,6 | 17,8 | 18,0 | 19,2 |
| Powders | 33,6 | 34,7 | 17,9 | 20,5 | 18,9 | 18,8 |
| Cheese | 12,8 | 15,6 | 20,5 | 17,3 | 19,8 | 21,7 |
| Ice cream | 9,5 | 9,9 | 11,2 | 10,5 | 10,0 | 9,9 |

Source: Production of Food products 2010

Competition in the area of bulk products is very difficult for the Estonian dairy processing industry. The sales of these products are very price sensitive and competition from developing countries with lower labour and production costs is intense. It is important to be less oriented towards bulk goods and to find different options for developing products belonging to the high-value added group for milk processors. In this case, competitiveness would be based on the quality and uniqueness of the product instead of costs and price. (Toming 2006/2007: 23)

The volumes of products like curd and yoghurt have increased. Usually those products have higher value added and are primarily sold on the internal market in Estonia (Saron 2008). That is the reason why in monetary terms the domestic market is larger than the export market. Although, considering the volumes, the situation is the opposite. (Kivine 2008)

There is pressure from consumers for processors to produce more high value added products. This is closely linked to the increased awareness of consumers to eat healthy and demand functional food. This has also motivated processors to develop and introduce new higher value added products with specific functionality. (Hein 2009: 5) As seen in Table 9, productivity and value added per employee in the dairy processing industry has increased in recent years with the exception of 2008 and 2009 when the global economic crisis started and influenced almost all enterprises. It also resulted in a sequential decrease in prices and in demand for dairy products, and there was a scarcity of available resources for investing in innovations. (Niinepuu 2009: 11, 14)

The export of milk and milk products has been higher than imports in the period 2004–2009 (see the period 2004–2009 in Figure 20). Milk and milk products have been one of the few agricultural commodity chapters with positive net exports. (Exports and Imports by Commodity Chapter 2009, Püvi 2010: 9)

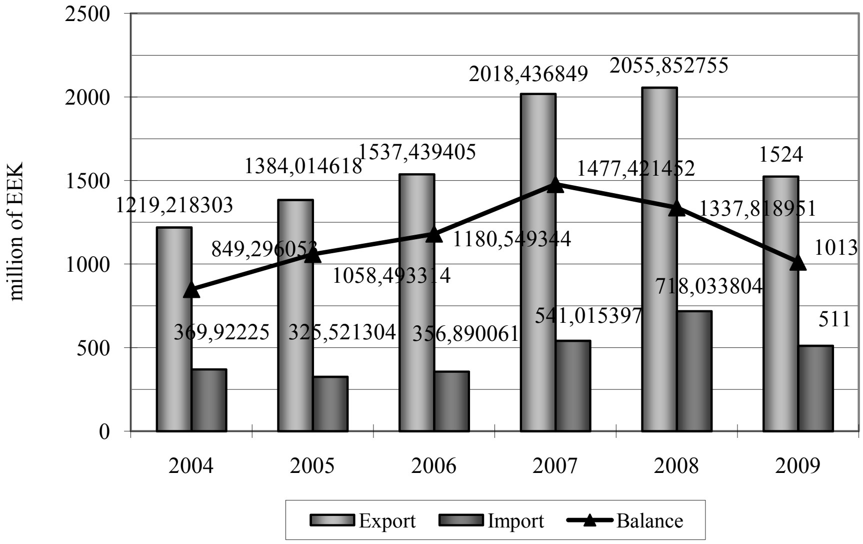



**Figure 20.** Overview of foreign trade in milk products in 2004–2009 (author's calculations on the basis of Exports and Imports by Commodity Chapter 2009, Püvi 2010: 9)

The main export goods for the dairy processors have been powders, butter and cheese. These are low value added products and they are mainly used as inputs for other food processing enterprises (Hein 2009: 3). These three product groups formed 76% of dairy exports in 2009 (Püvi 2010: 10). Therefore, although the production of bulk products is decreasing, their importance in exports is still high. The export of high-value added products is limited by expiry dates on the one hand, and by the fact that the European market has very strong and well-known brands and Estonian processors are not able to compete with those large industries on the other.

In the export of cheese, a positive trend can be observed. Estonian processors are exporting more and more sliced cheese in small packages instead of blocks of cheeses; in other words, the value added of exported cheese is increasing (Saron 2008).

In 2009, the main export countries for Estonian dairy products were Russia (21%), Finland (18%), Latvia (14%), Germany (11%) and Lithuania (8%) (Püvi 2010: 10). Compared to 2008, the importance of Russia has increased significantly from 12.6% to 21% (Niinepuu 2009: 8, Püvi 2010: 10). Before the Russian economic crisis in 1998, Russia was one of the main export markets for the Estonian dairy processors. By 2000, the Russian share of milk product exports had decreased to 7%. (Hein 2002: 24) At the same time, the Russian market has remained an important challenge and target market for Estonian dairy processors. Russia is especially important for the export of products with higher value added because it is easier to compete with those products on the Russian market than on the EU market. (Saron 2008) Therefore, it is positive that exports to Russia have increased in 2009 compared to 2008.

On the European market, Estonian processors do not have any remarkable competitive advantage. On the one hand, Estonian processors no longer enjoy a price advantage in the production of bulk products or other low value added products. On the other hand, the market for high-value added and functional products is dominated by large well-established enterprises with strong brand names that create limitations for Estonian companies. But still, Estonian dairy processors want to focus more on R&D activities, increase the awareness of consumers and increase the production of healthy and functional products; in other words, compete on markets with high-value added products. (Saron 09.06.2009) The trend towards functional food is also supported by the development of the technology platform "Food for Life" elaborated by European Commission. The aim of this platform is to increase the awareness of food and its influence on health in Europe. (Saron 2008)

Starting from the 1990s after Estonia regained its independence, the Estonian food processing industry has had to adapt to changing and sometimes conflicting economic and social conditions. Before joining the EU in 2004, Estonian food sector exports were hampered by import tariffs and import quotas implemented by its trade partners. On the domestic market, Estonian food processing firms had to compete with imported food products, which had lower prices due to different subsidies. Also, the domestic market was not protected by any import tariffs before 2000, which would have decreased the influence of subsidies on prices of imported goods. (Toming 2006: 5, Toming 2006/2007: 5)

This also describes the situation in the dairy industry. The dairy industry had to compete on an unprotected domestic market and a protected global market until 2004 when Estonia joined the EU. Although Estonia introduced import tariffs in 2000, they were applied only towards third countries with a low positive influence. (Hein 2009: 6) On the dairy market, this affected trade in milk products with Russia, but because the volumes at that time were small the influence was not very significant.

Before 2004, only some types of support measures like decreased fuel excise, subsidies for loans and investment support were introduced to help producers and processors of agricultural products. As a result, food prices were low and that influenced the agricultural sector severely. The share of agriculture in Estonian economy decreased significantly. (Hein 2006: 44–45)

After joining the EU, milk production and processing has been influenced by the introduction of milk quotas (in Estonia milk quotas were already introduced on 1 April 2003), export subsidies, intervention and common external tariffs (i.e. measures of Common Agricultural Policy (CAP)) (Hein 2006: 50, Hein 2009: 2). At the same time, CAP is being reformed with the aim of softening or removing some measures and interventions. For example, export subsidies will be abandoned in 2015 and production quotas in 2013. (Saron 09.06.2009) The removal of raw milk production quotas could initiate two alternative development scenarios. Estonian dairy processors could increase their production in existing markets. Or alternatively, the removal of production quotas could change the whole European milk market and the influence of these changes has to be analysed more thoroughly. (Saron Nov 2009) The removal of export subsidies also influences industry because it changes the prices of the products exported to third countries, and therefore, influences the competitiveness of Estonian producers. This may motivate processors to innovate and produce more high value added products because processors will not be able to compete on prices alone.

Before the implementation of the previously mentioned Common Agricultural Policy measures, dairy processors were also influenced by the SAPARD programme (2001–2004). Production facilities received investments of 7,6 million Euros to meet EU standards of which the most important was the Food Act. (Hein 2002: 26, Hein 2009: 5–6) Enterprises not meeting the requirements of the Food Act by 1 January 2003 had to close down (Hein 2002: 26). Therefore, it can be said that demand-driven process innovation took place. Demand-driven innovation may be initiated both by the customers of the enterprise and the public sector through regulations and standards. The latter was the case for Estonia for 2001–2004.

Standardization resulted in increases in production capacities in Estonia. As a result in 2007, none of the dairy processors used their full production capacities and only four enterprises used over 80% of their capacity (Saron 09.06.2009). Some excess capacity is necessary because of the high seasonality of milk production (Hein 2006: 58).

A special feature of Estonia was that all processing facilities met EU standards without any transition period. The same was also true for Cyprus. So, Estonia fulfilled the requirements for joining the EU without any transitional period. (Tiina Saron 2009) This created problems for enterprises because they had to meet standards fast and had to invest all available funds in that process. This also had a positive side. Now the survivors from that transition period are able to use modern production technologies and have full access to the single market (Toming 2006: 5, Toming 2006/2007: 5). They are also able to focus more on innovations and cooperation activities because the preconditions for modern production conditions have been met. The bottleneck in production and competitiveness has moved from problems in production equipment to aspects linked to product development.

On the basis of the previously presented data and earlier research the following aspects characterizing the Estonian dairy processors can be brought out (Kivine 2008, Tammsaar 2008, Kalvet 2006):

- production of dairy products is influenced by European Union through Common Agricultural Policy;
- estonian domestic market is small, therefore it is necessary to find export markets, but exports to EU is limited because of existing large well-established enterprises with strong brands;
- the consolidation process is taking place, most of the raw milk produced in Estonia is bought by 5 companies;
- low level of R&D activities in SMEs;
- in recent years most innovations in the dairy processors have been linked to incremental changes in products, and implementing new packaging and new technology;
- lately, there is more focus on functional and healthy dairy products, and the share of bulk products in production has decreased;
- it is hard to get a patent on food products which may hamper the development of functional food;
- the life cycle of the products is short and therefore investments in product innovation must make a return quickly.

The second group of enterprises under analysis is rather different from the previously described traditional dairy processors. **Biotechnology** is considered to be enabling technology resulting in an increase in value added and productivity in traditional sectors and consequently in GDP for the whole country. Performance and R&D in the field of biotechnology cannot develop without synergy between the different areas of its implementation. (Biotehnoloogia tutvustus 2010) Therefore, several countries focus on biotechnology in their innovation policy. In Estonia, biotechnology has also been declared one of the key technologies by the Estonian R&D and innovation strategy document "Knowledge based Estonia 2007–2013" (KBE II). To support this activity fully and take into account its distinctive characteristics, a technology programme for biotechnology is being developed in Estonia. (Teadmistepõhine Eesti… 2007: 5)

Estonian biotech enterprises are rather young, and therefore, it is said that Estonian biotechnology is in its incubation phase. It takes approximately 20 years to emerge from the incubation stage. (Kukk, Truve 2008: 14) The first biotech companies were founded in the 1990s, and most of them had strong ties with research institutions and universities (Mets 2006b: 754). Even now biotech companies are linked to universities, but these links are mainly informal based on personal contacts (Kask 2008, Mölder 2008). In many cases people belonging to the board of the private company are also employed by the university. This makes it more difficult to evaluate R&D costs in private enterprises because the research results of universities can be transferred to enterprises and *vice versa* through people working in both organisations. (Talpsep 2005: 51)

Some Estonian biotech companies are based on foreign capital (in 2006 approximately 10%). These companies are either focused on mediation or provide R&D and/or production services for the mother company. Therefore, those companies are not strongly linked to Estonian biotechnology activities, nor its R&D and national innovation system. (Mets 2006b: 760)

There are four competence centres active in the field of biotechnology – the Bio-Competence Centre of Healthy Dairy Products, the Competence Centre for Cancer Research, the Competence Centre for Food and Fermentation Technologies and the most recently established Competence Centre for Reproductive Medicine and Biology. The first of these three is the most important competence centre for this study, linking together dairy processors and researchers active in biotechnology. A short overview of that competence centre is presented in 2.2.1.

There are approximately 50 small companies active in biotech in Estonia, and they are mainly located in Tallinn and Tartu (Merirand 2009). Statistics about biotechnology enterprises are difficult to obtain because biotech companies are not explicitly separable from other companies on the basis of NACE codes. Almost half of all Estonian biotech enterprises have declared themselves under code 73.10 "Research and experimental development in natural sciences and engineering" up until 2008 and under 72.11 "Research and experimental development in biotechnology" from 2008. But biotech companies can also be declared under other codes, such as 86 "Human health activities", 20 "Manufacture of chemicals and chemical products" etc. (NACE Revision 1.1. 2009, NACE Rev. 2 2008: 81) Therefore statistics about Estonian biotechnology enterprises are hard to put together, and they are not as representative as the statistics presented above about the Estonian dairy sector.

Some indicators describing Estonian biotechnology enterprises are presented in Table 11. Most of the indicators presented in Table 11 are calculated on the basis of the Estonian Central Commercial Register database and have to be considered as estimations because of the problems exiting in the database. The list of biotech enterprises included in the calculations is formed on the basis of two sources – "Biotechnology in Estonia: Overview, Companies & Research" and the "Estonian Biotechnology Strategy 2008–2013". Although the number of companies in Table 11 is 82, there are approximately 50 active companies or companies with a turnover in 2007.

Turnover per employee in Estonian biotechnology enterprises is comparable to the same indicators characterizing Estonian dairy processors. Turnover per employee in the latter was even higher in 2007 than turnover per employee in Estonian biotechnology enterprises. On the basis of value added per employee, the difference is higher. In 2007, value added per employee in biotech enterprises was almost 4 times higher than in dairy enterprises.

**Table 11.** Indicators describing Estonian biotechnology enterprises in 2007

| Indicator | Value of the indicator | | |
|---|---|---|---|
| | **With Biotech Competence Centres** | **Without Biotech Competence Centres**[1] | **Biotech enterprises with 73.1. NACE code** |
| Number of companies | 82 | 79 | 51 |
| Number of employees | 496 | 445 | 221 |
| Turnover of Estonian biotechnology enterprises in million kroons | 953 | 943 | 124 |
| Share of companies with turnover over 1 million kroons | 38 | 36 | 22 |
| Turnover per employee in thousand kroons | 1921 | 2119 | 561 |
| Value added per employee in thousand kroons[2] | 1334 | 1465 | 621 |

Source: Biotechnology in Estonia: Overview, Companies & Research 2008: 3, Database of Estonian Central Commercial Register

It has to be kept in mind that the biotech enterprises included in the first and second column of Table 11 are very different. Some of them are mediators, some of them provide services, some of them are active in R&D and so on. Therefore, a separate group of enterprises is presented in the third column of Table 11 – enterprises active in "Research and experimental development in natural sciences and engineering".

The indicators of that group are lower than in biotech enterprises on average. Low turnover and low value added is rather usual for biotechnology enterprises because of the high initial investments and the fact that it takes time to achieve profitability (Biotehnoloogia tutvustus 2010). In Estonia many biotechnology companies are not yet selling their products or the sales of the products are insignificant. The innovation process taking place in those companies is rather similar to technology push models; that is, innovation is mainly initiated by the research outcomes. But often in these enterprises the product is still rather far from customers and markets. This may be one of the reasons why many enterprises under the NACE 73.1 code are without any turnover.

Almost half of the active biotechnology companies in Estonia can be considered research-intensive or research based. These companies primarily supply laboratory services, diagnostics and/or products for healthcare organi-

[1] Competence Centre for Food and Fermentation Technologies is not presented in the database of the Estonian Central Commercial Register because it is registered as a non-profit organisation.
[2] Does not include data for Werol Tehased Ltd

zations and/or research institutions. (Mets 2006b: 760) The R&D conducted in Estonian research-based biotechnology companies is primarily linked to the development of new technology platforms (Mölder 2008). There are only two biotech companies actively developing drugs, and one of these acts like a money burner – investing in R&D without selling any products and services with the overall aim of selling the license or the entire company in the future (Talpsep 2005: 52).

The majority of Estonian research-based companies are so called gold diggers. They have a technology platform and the development of that platform is influenced by the financial resources they can invest in R&D. The aim of such companies is to engage venture capital (VC) to insure the rapid growth of the company in the future. (Talpsep 2005: 60) Although the number of drug developers is significantly smaller than the remaining R&D-based biotechnology companies, the money invested in developing technology platforms is three times smaller than the money invested in drug development (Kask 2008).

Therefore, most of Estonian biotech companies are active in red biotech – healthcare and biomedicine – because the strong Estonian research base facilitates the development of those areas (Talpsep 2005: 50). Enterprises primarily active in red biotech provide simpler services to the health care sector (Kukk, Truve 2008: 16). There are also few companies active in white biotech – industrial biotechnology – but unfortunately the number of enterprises in green biotech (i.e. agricultural and food technology) is minimal (Biotechnology in Estonia 2008: 5, Talpsep 2005: 50). At the same time, there is potential for creating new companies active in green biotech because the quality of research at the universities is high and internationally recognized. Main research centre in the area of green biotech is the Estonian University of Life Sciences. (Talvik 2008)

As already mentioned, research in biotechnology in Estonia is internationally recognized (Kes on mõjukaimad… 2009). There are approximately 300 researchers working in the field of biotechnology in around 8 different research institutions (Biotechnology in Estonia 2008: 4, Biotehnoloogia tutvustus 2010). The three leading universities in biotechnology are University of Tartu, Tallinn Technical University and Estonian University of Life Sciences. The majority of financial support from the Estonian public sector goes into research institutions financing basic and applied research. Money channelled into product development and marketing is rather limited. (Kukk, Truve 2008: 27) This has created a situation where research institutions are not interested in formal cooperation with private companies because the majority of their finances come from the public sector and their outcomes are evaluated on the basis of published articles. At the same time, private companies do not have enough financial resources to fund research in research institutions on the basis of formal contracts. (Varblane *et al* 2008: 384)

The money invested in basic R&D in private companies is less than 5% of their turnover. Approximately three quarters of all R&D investments by companies are channelled into applied research and/or product development mainly based on the technology platform that the company was created on or technologies linked to it. As a result, Estonian biotechnology enterprises might not be able to be the elaborators of world-class biotechnology inventions. So, a niche for Estonian biotechnology companies in the future could be as knowledgeable users and developers of technology elaborated and introduced elsewhere. (Kukk, Truve 2008: 14, 28–29; Talvik 2008; Biotehnoloogia tutvustus 2010) There is not enough innovation capability in Estonian biotechnology enterprises, but there is enough capability to understand what is going on in the rest of the world, and implement and use the new knowledge. Estonian biotechnology enterprises could import technology, develop it further or find new areas where existing technologies could be used and earn money from doing this. The realisation of this scenario requires support from the public sector and existing problems must also be overcome.

In this thesis, the analysis of biotechnology enterprises primarily takes into account research-based companies (73.1 in NACE) and their specific characteristics. On the basis of the previously presented data and research, the following findings characterizing Estonian research-intense biotechnology companies can be highlighted (Mets 2006a: 76, Kask 2005, Talpsep 2005, Biotehnoloogia tutvustus 2010):

- the share of exports in sales is increasing because the internal market is too small for biotechnology companies;
- Estonian biotechnology enterprises either sell R&D activities, produce on the basis of contracts, provide services to the healthcare system and/or mediate;
- approximately half of the sales of biotechnology companies come from products and other half from services;
- many of the companies are profitable but they are not able to invest enough in the development of the company and its R&D;
- retained earnings are primarily used for investments in R&D because there is not enough seed and venture capital (i.e. the development of biotechnology enterprises is evolutionary);
- companies are more experienced in research (especially in applied research because there is not much basic research taking place in enterprises) than in marketing and entrepreneurship (several companies have sold their products through personal contacts and do not have sales departments, also marketing budgets are very low);
- companies are informally linked to research-focused networks, links with commercially-oriented networks are weak (there is a lot of informal cooperation with research institutions on the basis of basic and applied research);
- the importance of marketing is increasing.

**The two groups of enterprises** described above are rather different. One represents a traditional scale-intensive sector, the other a knowledge-intensive high-tech activity (biotechnology enterprises that are mainly active in mediation and are not R&D intensive are not included in the analysis). But there are areas where those groups overlap. Both find the Estonian market too small, both have problems with a scarcity of resources and both are mainly based on domestic capital.

Though the largest implementer of biotechnology products has traditionally been pharmaceutical companies, traditional sectors like food producers are starting to use biotechnology research results and products more and more (Kukk, Truve 2008: 21). In the food sector, biotechnology helps to satisfy customer demand for healthier and more functional food. This trend also exists in Estonia where the dairy industry is starting to use biotechnological solutions in their products. This provides the author with an opportunity to analyse those two groups of enterprises separately and also analyse linkages between them. The differences and linkages between those two groups help to highlight the positive and negative sides of policy measures designed to support innovation in enterprises in Estonia and to identify aspects of alignment in Estonian public support measures designed to support innovation in different types of enterprises. 2.1.2. introduces the propositions of the analysis, and provides an overview of the research methods and people interviewed. After that the research results and the discussion will be presented.

### 2.1.2. The development of the research propositions and introduction of the research methodology

This chapter will present propositions for analysing aspects linked to the innovation process, public sector innovation support measures and alignment. The propositions are analyzed and tested in sections 2.2 and 2.3 primarily using data gathered through semi-structured interviews and secondary data sources. The propositions put forward are based on the theoretical part of the thesis and take into account the current situation in Estonian dairy processors and enterprises active in biotechnology.

There are several models elaborated to describe the innovation process taking place in enterprises. The first innovation process models showed the process as being linear, starting either from basic science or the market. Later models became more complex taking into account that ideas can come from different sources and there are no one-way links between the stages of the innovation process (see 1.1.1). On the basis of existing innovation process models, a three-stage innovation process was elaborated in 1.1.1 starting with the generation of ideas and ending with the application of the idea (see Figure 6). The option of returning to previous stages, terminating the innovation process when necessary, including knowledge via feedback loops, information, resources and R&D, and linkages with a firm's internal and external factors were taken into account. This model is the basis in this thesis for analysing factors influencing innovation processes in industries, innovation support measures and alignment issues. Therefore, taking all the previous into account it is assumed that:

**Proposition 1.** The innovation process model developed in 1.1.1 describes the innovation process taking place in both dairy processors and biotechnology enterprises; in other words, the model is not activity specific.

All enterprises are influenced by external factors. Estonia can be considered a catch-up economy with a history of a totalitarian planned economy. This influences the national innovation system, economic activities and the development taking place in Estonia. Therefore, many of the factors influencing innovation processes in Estonian enterprises exist because of path-dependency and the country's current developmental stage. (Varblane *et al* 2007: 404) Path-dependency can be defined as the influence of previous developments and history on the current developmental stage (Kingston 2000: 688).

Country-specific factors are influenced by Estonian path-dependency and by the process of catching-up. Also, the development of an Estonian National Innovation System encompasses changes in conditions influencing all enterprises. Therefore, the economic and legislative environment is continuously upgraded and modified to facilitate all these processes. Changes in the external environment also influence all dairy processors and biotech enterprises through different factors. At the same time not all factors influencing the innovation process in enterprises are country-specific and similar across sectors. High-tech enterprises have different problems to tackle and different innovation process factors to consider compared to low-tech enterprises even if both groups are engaged into R&D activities (Veugelers, Cassiman 1999; Bhattacharya, Bloch 2004). Even if high-tech and low-tech enterprises are influenced by different innovation process factors, the author of this thesis expects that country-specific innovation process factors are more important to enterprises than sector-specific factors in Estonia. Therefore, it can be expected that:

**Proposition 2.** Country-specific innovation process factors dominate over activity-specific innovation process factors in Estonian dairy processors and biotechnology enterprises.

In many countries, including Estonia, the efficiency of the innovation system and innovation support measures is evaluated on the basis of knowledge inputs including investments in research and development taking place in the private and public sector. Also, the strategy document "Knowledge Based Estonia 2007–2013" states that by the year 2014 public and private investments in R&D have to form 3% of GDP. It also determines how many scientists and engineers Estonia should have per 1000 employees, how well established the scientific infrastructure has to be, how many patents Estonia should have and so on. (Teadmistepõhine Eesti … 2007: 21) Therefore, the Estonian public sector is focused on achieving those goals by 2013. All the indicators above describe knowledge inputs to the innovation process and usually result in the need to implement supply-oriented innovation policy measures (Lundvall 1988: 358). Based on Edquist and Hommen (2008), the innovation system should have four functions – the provision of knowledge inputs for the innovation process, the implementation of demand side activities, the provision of the constituents of the innovation system, and the introduction of support services for innovating firms. Taking into account the targets of "Knowledge Based Estonia 2007–2013" from one side and the list of innovation system functions from the other side, the following is proposed:

**Proposition 3.** The provision of knowledge inputs is considered to be the primary function of the innovation system by the Estonian public sector.

Since 2000, the Estonian public sector has been increasingly engaged in supporting enterprises in their R&D and innovation activities (Kalvet 2006: 7). During the period 2004–2006, when Structural Funds were available for the first time for new member states, there was an increase in innovation support measures (Reid 2009: 29). For the current period, 2007–2013, Estonia will receive 53 billion EEK through Structural Funds (Sihtasutusest 2009). To use the money coming from the European Union, policymakers have to take into account the restrictions linked to the usage of these funds and design support measures accordingly.

In addition to restrictions coming from the Structural Funds, the European Union and its members also influence Estonian policy design through policy learning processes. The existing policy-mix in Estonia can be considered as a result of this policy learning (Estonian innovation policy 2010: 2). The European Union supports the policy learning process through different tools, one of which is the Open Method of Coordination. This method should facilitate the distribution of knowledge about successful policies and promote the transfer of policy measures between member states. (Kerber, Eckardt 2005:2)

This all supports the statements presented in the theoretical part of the thesis that national policy design may be influenced by international unions. Estonia being a member of the EU and using European Structural Funds is probably influenced in its policy design and implementation process by the EU. Therefore, it can be suggested that:

**Proposition 4.** The design of Estonian innovation support measures is influenced by trends in innovation support measures in the European Union.

In Estonian biotechnology activity one of the weaknesses of the innovation process lies in commercialization of the innovations. The level of competencies in the international marketing of new products is rather low in Estonian biotechnology enterprises (Biotehnoloogia tutvustus 2010). Marketing competencies are considered to be one of the lowest competencies in Estonian biotechnology enterprises (Talpsep 2005: 64). In Estonian biotech enterprises the product is also sometimes not ready for marketing (see 2.1.1).

Problems with marketing are also significant for Estonian dairy processors. On domestic markets the competition is rather high and one method of differentiating oneself from competitors may lie in skilful marketing. Also, international marketing is important for Estonian dairy processors. Their main export markets are either dominated by large well-established European dairy processors, or sales are compounded because of the problems on the Russian market (see 2.1.1). Therefore, good skills in marketing and experience with Russian markets are highly important, although exports to Russia are also influenced by political factors (Eesti kaupmehi… 2010). Therefore, Estonian enterprises may struggle with the marketing of their products.

In 1.1.1, a three-stage innovation process was elaborated based on earlier innovation process models. In 1.1.2, several innovation process factors were discussed. Based on the innovation process presented in Figure 6, all innovation process factors were divided into seven sub-groups: factors influencing the stage 1, factors influencing the stage 2, factors influencing stage 3, factors influencing stage 1 and 2, factors influencing stage 2 and 3, factors influencing stage 1 and 3, and factors influencing all three innovation process stages simultaneously. The factors connected to marketing fell into the group of factors influencing the third stage of the process.

Taking into account the current Estonian economic, political and social environment, and the development of dairy and biotech enterprises, it can be argued that besides country-specific factors, factors influencing the third stage of the innovation process also cause problems for companies. This argument leads to the following proposition:

**Proposition 5.** The majority of factors in the innovation process creating problems for Estonian dairy processors and biotechnology enterprises are linked to the third stage of the innovation process – the application of the idea.

In Proposition 3, the author of the thesis argues that according to public sector representatives the most important function of the innovation system in Estonia is the provision of knowledge inputs. To introduce this function into the system, greater emphasis must be placed on support for basic and applied research taking place in public and private research centres, and in enterprises. On the basis of the innovation process model presented in Figure 6, policy measures should therefore primarily focus on the 1st stage, 2nd stage and the overlapping area between the 1st and 2nd stage; in other words, be focused on supporting the generation of ides from the supply side. This is closely linked to the 1st generation innovation process models – technology push innovation process models where the main sources of ideas are new technologies and scientific discoveries. Therefore, following this discussion:

**Proposition 6.** In Estonia innovation support measures are primarily focused on the first stages of the innovation process.

As already stated above, Estonian dairy processors and biotechnology enterprises are influenced by factors of the innovation process several of which are similar to both of these groups – country specific factors and factors linked to the marketing of their products. But there are also differences between those groups of enterprises. The main differences come from characteristics specific to biotechnology (2.1.1. and Biotehnoloogia tutvustus 2010):

- biotechnology activity is research intensive,
- a successful innovation process needs high initial investments and may take a long time to reach profitability,
- the development of biotechnology activity needs the convergence of different scientific areas,
- biotechnology cannot develop without synergy with its areas of application,
- cooperation in the biotechnology area is usually international.

This makes biotechnology different from dairy processors. These differences are not taken into account in public sector innovation support measures because those measures are not explicitly sector specific (Ülevaade EAS-i… 2010). The sector-specific component of innovation support measures exists implicitly though because measures supporting the provision of knowledge inputs are more beneficial to research-intensive enterprises including biotechnology companies. In 2008–2009, over 40% of science and development grants went to biotechnology companies (Biotehnoloogia tutvustus 2010). Therefore, the following is proposed:

**Proposition 7a.** The alignment between innovation process factors and innovation policy measures is sector specific.
**Proposition 7b.** The misalignment is greater in the dairy sector than in biotech activities.

The propositions can be divided into three groups (Table 12). The first group focuses on the innovation process in Estonian dairy and biotech companies. The second group is linked to the public sector policy side of innovation support. The third group focuses on alignment.

**Table 12.** The general logic of the research propositions

<table>
<tr><td colspan="6">**INNOVATION PROCESS AND ITS FACTORS**<br>*PROPOSITIONS 1–2*</td></tr>
<tr><td colspan="3">Suitability of innovation process model developed in thesis<br>*P1*</td><td colspan="3">Dominance of country specific factors in innovation process<br>*P2*</td></tr>
<tr><td colspan="6">**INNOVATION SYSTEM AND DESIGN OF POLICY MEASURES**<br>*PROPOSITIONS 3–4*</td></tr>
<tr><td colspan="3">Prioritized function of innovation system<br>*P3*</td><td colspan="3">EU as an influence on Estonian innovation support measures' design<br>*P4*</td></tr>
<tr><td colspan="6">**ALIGNMENT BETWEEN INNOVATION PROCESS FACTORS AND INNOVATION POLICY MEASURES**<br>*PROPOSITIONS 5–7*</td></tr>
<tr><td colspan="2">Factors of innovation process<br>*P5*</td><td colspan="2">Innovation policy measures<br>*P6*</td><td colspan="2">Alignment between factors and measures<br>*P7a, P7b*</td></tr>
</table>

Source: Composed by the author

The presentation and analysis of propositions can be based either on the theoretical or empirical part of the thesis. The above-discussed propositions are presented following the structure of the theoretical part. That is the reason why Proposition 2 is analysed below after Proposition 3 and 4. Proposition 2 is linked to innovation process factors, and therefore, it is necessary to analyse it just before analysing the alignment. Table 13 presents links between propositions and specific parts of the thesis. Propositions from one to four are mainly discussed in section 2.2. The propositions linked to alignment issues are analysed in section 2.3.

**Table 13.** Coverage of research propositions in the following parts of the dissertation

| **Part of the dissertation** | **Propositions** | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Chapter 2.2.1 | X | | | | | | |
| Chapter 2.2.2 | | | X | X | | | |
| Chapter 2.3.1 | | X | | | X | X | |
| Chapter 2.3.2 | | | | | | | X |

Source: Composed by the author

To analyse the propositions, industry case studies are used because case studies are often used to analyse processes taking place within the social context from which the processes are inseparable (Cutler 2004: 367). In the innovation system approach, case studies are the main instrument in developing the approach towards theory. On the basis of the results of the case studies, similarities and common traits are found to draw new contextual statements about the IS approach (Hommen, Edquist 2008: 443). Case studies are also used to conduct research on innovations. There are many studies conducted using the case study method to analyse issues linked to innovation systems and innovation abroad and in Estonia. Usually, the cases used are either industry or country level case studies (see for example Nelson 1993, Doloreux 2004, Varblane *et al* 2008).

There are some limitations the researcher has to be aware of while using the case study method. For example, the case study method is very time consuming. The whole process has to be prepared and executed carefully to avoid any biases and to find the right number of cases/interviewees to include in the analysis. Also, it is considered that the results of case studies are not easy to generalize. Additional limitations and importance of the case study method are presented in Table 14.

The author of this thesis was aware of the limitation of the case study method during collection and analysis of the data. To tackle the limitations of the case study method several precautions were implemented during the research. First, the propositions were developed before the data collection to better focus the analysis. Second, to avoid subjectivity several sources of information were used. Public sector representatives were asked to comment on the innovation process taking place in enterprises in addition to enterprises itself and vice versa – the activities of the public sector were evaluated by enterprises. Also, representatives from industry associations and the third sector were included in the list of interviewees to increase the objectivity and decrease the subjectivity of the research. Third, the interviews were all recorded to decrease the bias of the observer.

**Table 14.** Importance and limitations of the case study method

| **Importance** | **Limitations** |
|---|---|
| • Used in many scientific disciplines with high response rates.<br>• Useful as a tool for developing approach to theory, generate new theory or criticize researched topics.<br>• Suitable for developing context-specific decisions.<br>• Able to capture and explain new, complex and/or dynamic issues. Not limited by the scope of questionnaires and models.<br>• Suitable for asking "what", "how" and "why" questions.<br>• Takes a holistic perspective on real-life events and the processes leading to certain results.<br>• Data can and should be collected from a variety of qualitative and quantitative sources. | • Unappreciated and underutilized research method.<br>• Time-consuming. Is not useful with large data sets.<br>• Limited potential for generalizing results.<br>• Increase in number of cases might result in greater breadth but less depth.<br>• Difficult to access confidential data. Interviewee bias might appear.<br>• Potential researcher bias starting with choosing data sources and finishing with subjectivity in interpreting results.<br>• The right questions have to be asked at the right time. |

Source: Vissak 2003: 74; Cutler 2004: 368, 370; Runyan 1982: 442–443; Voss *et al* 2002: 195–196

Because the number of enterprises in each group under analysis is small, the use of the case study method facilitates obtaining a relatively comprehensive overview of activities. For example, three dairy processors interviewed by the author purchase 53% of the raw milk sold to processors in 2008 (Niinepuu 2009: 4). Those enterprises and their production units are established and active in different regions of Estonia. The representatives of the three dairy processors can also reveal different aspects of this sector, as the enterprises are somewhat different. Tere Ltd is the owner of the first trademark in the Estonian dairy industry and has had long-term cooperation experience with researchers at the University of Tartu (General information 2010, ME-3 2010). MAAG Piimatööstus has the broadest product portfolio in Estonia and is the only dairy processor in Estonia that also owns a bottling production line (MAAG Dairy Industry 2010). E-Piim is a dairy cooperative with 260 members (The History of E-Piim 2010). All of these enterprises are also members of the Estonian Dairy Association.

Two people representing biotech companies were linked to six biotech companies at the time of the interview. Both of them have also been active in the management of the Estonian Biotechnology Association. In addition to people directly linked to private companies, representatives of associations and organizations connected to those two activities were interviewed. Besides biotechnology enterprises and the dairy sector, people from public sector organizations were interviewed to obtain a comprehensive overview of innovation support measures designed and implemented to help enterprises. This helps to estimate the alignment between factors of the innovation process and public sector policy measures. An overview of interviewees is presented in Table 15.

**Table 15.** Overview of interviewee occupation, organization and time of interview

| Name | Occupation | Organization | Time of the interview |
|---|---|---|---|
| *Biotechnology activity* | | | |
| Indrek Kask | Head of Business Development | Asper Biotech | 26th of October 2008 |
| Piret Kukk | Author of Estonian Biotechnology Strategy | Estonian Biotechnology Association | 24th of Nov 2008 |
| Tõnis Mets | Professor of Entrepreneurship | University of Tartu | 16th of Oct 2008 |
| Erki Mölder | Chairman of the Board | Quattromed HTI Laborid | 20th of Oct 2008 |
| Rait Talvik | Head of Innovation Centre | Tartu Biotechnology Park | 22nd of Oct 2008 |
| *Dairy processors* | | | |
| Ülo Kivine | Chairman of the Board | Tere Ltd | 7th of Oct 2008 |
| Jaanus Murakas | Chairman of the Management Board | E-Piim | 14th of Jan 2009 |
| Valdis Noppel | CEO, Member of the Board | Maag Piimatööstus | 27th of Jan 2009 |

| Name | Occupation | Organization | Time of the interview |
|---|---|---|---|
| Urmas Sannik | Member of Executive Board | CC of Food and Fermentation Technology | 14th of Oct 2008 |
| Tiina Saron | CEO | Estonian Dairy Association | 21st of Oct 2008 |
| Ene Tammsaar | CEO | Bio-CC of Healthy Dairy Products | 22nd of Oct 2008 |
| *Public sector organizations* | | | |
| Harry Faiman | Coordinator of Technological Development Centre Support Programme | Enterprise Estonia | 14th of October 2008 |
| Allar Korjas | Director of Export Division | Enterprise Estonia | 13th of Jan 2009 |
| Kitty Kubo | Head of Foresight Division | Estonian Development Fund | 10th of Oct 2008 |
| Ilmar Pralla | Director of Innovation Division | Enterprise Estonia | 8th of Oct 2008 |
| Mihkel Randrüüt | Head of Technology and Innovation Division | Ministry of Economic Affairs and Communications (MEA&C) | 8th of Oct 2008 |
| Lauri Tammiste | Head of Economic Development Dept | MEA&C | 15th of Oct 2008 |
| Marek Tiits | Chief Analyst of Monitoring and Analysis Group | Estonian Academy of Sciences | 14th of Oct 2008 |
| Piret Treiberg | Head of Enterprise Division | MEA&C | 21st of Oct 2008 |
| Oliver Väärtnõu | Adviser of the Strategy Office | State Chancellery | 10th of Oct 2008 |

Source: Composed by the author

The people presented in Table 15 were chosen because of their knowledge of Estonian dairy processors and biotechnology enterprises, or the design and implementation of innovation support measures in Estonia. From the industry perspective, all interviewees know the problems of enterprises either through associations, their own experience or links to the enterprises. From the public sector perspective, all the most important organisations responsible for designing or implementing innovation support measures in Estonia or linked to these were included. Interviewees from those organisations are heads of departments and/or divisions or deal with issues linked to innovation policy on a daily basis. An overview of public sector organisations and their place in the Estonian innovation system is presented in section 2.2.

Primary data was collected for the case studies through semi-structured interviews. The author of the thesis had a list of questions on the basis of which the interview was conducted. Across the interviews, questions varied a little and often some questions were not asked, and some questions were added to the interview plan. These kinds of changes are acceptable during data collection using semi-structured interviews. (Saunders *et al* 2009: 320)

Two interview plans were prepared, one of them for activity, and the other for public sector representatives (see Appendices 4 and 5). After the first two interviews, the wording of some of the questions was slightly changed to allow interviewees to answer the questions without leading them too much or to make answering easier for them. The most important change to the interview plan was linked to the question about the function of the innovation system, which was presented to public sector representatives. In the original version of the interview plan, the functions of the innovation system were named and interviewees were asked to assess their importance on a scale from one to six, one being "not important" and six being "very important". This wording of the question turned out to be awkward and too restrictive, and therefore, it was changed.

All interviews were face-to-face interviews (except one) lasting from one hour to an hour and a half. Face-to-face interviews may create a situation where the interviewee expresses his/her opinions more openly and freely and is more talkative because there is no need for them to write anything down as in questionnaires. (Saunders *et al* 2009: 324) One of the interviewees answered in writing because she was not in Estonia during the period of the data collection.

To decrease the problems linked to an interviewee bias, all the information gathered through interviews was considered in light of the promise of the anonymity of the interviewees. Therefore, in the following chapters interviewees are indicated using a capital letter staring with A until U in random order. Because the thesis includes industry case studies, it is not necessary to reveal the names of the interviewees when their opinions are cited.

The interviewees received an e-mail introducing the topics that would be covered during the interview in advance. A full interview plan was not sent to avoid pre-prepared answers to questions. The e-mail also introduced the purpose of the interview and a short overview of the interviewer. All the people included in the original sample agreed to be interviewed. Some additional contacts and interviewees were suggested by the interviewees and they were added to the sample later.

The interviews were conducted in Estonian. The conversations were recorded (except one interviewee who did not agree to being recorded) and some handwritten notes taken. After the interviews, transcripts were made and sent to the interviewees for them to correct and amend. To increase the validity and reliability of the research results, some additional sources of data were also used; for example, the database of the Community Innovation Survey 2004–2006 (CIS2006), the database of the Estonian Central Commercial register, existing reports and newspaper articles. Also, one additional questionnaire was put together by the author of the thesis and sent to biotechnology enterprises.

The questionnaire included 3 questions about factors influencing the innovation process and the support measures of the public sector. All questions were taken from CIS2006. CIS2006 does not include biotech companies and therefore a separate additional survey was conducted.

A short overview of the stages of the research is presented in Figure 21. The process started with the development of the propositions and finished with analysis of the data and presentation of the research results.

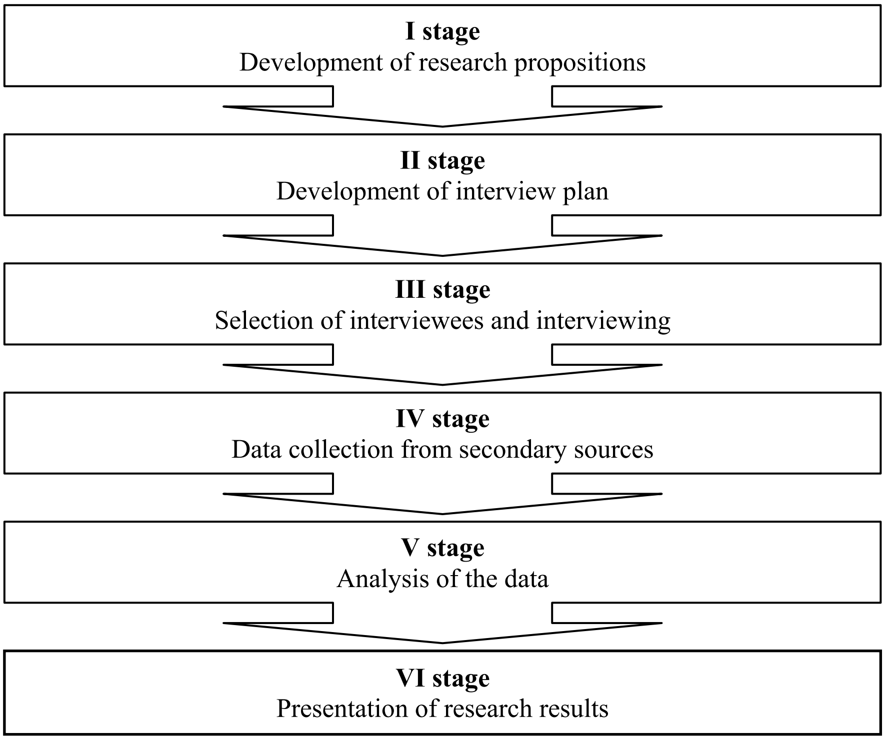



**Figure 21.** Stages of empirical research (composed by the author)

In the next parts of the thesis an overview of the research results is presented. The propositions presented above are analysed and tested, and alignment is identified. Also, suggestions for increasing the alignment and efficiency of innovation support measures are elaborated.

## 2.2. Innovation activities in Estonian dairy processors and biotechnology activities and the Estonian innovation system

### 2.2.1. Analysis of the innovativeness of dairy processors and biotechnology enterprises and the innovation process

2.2.1. will present a discussion of the innovativeness of dairy processors and biotechnology enterprises. Innovativeness is looked at from the viewpoint of the innovation process presented in 1.1.1. Figure 6. That presentation of the innovation process includes three stages starting with idea generation and ending with the application of the idea encompassing feedback loops, and the entire process is influenced by the internal and external factors of the enterprise. The section concludes with a discussion of the suitability of this three-stage innovation process, and so Proposition 1 is tested.

**Dairy processors** are rather innovative in Estonia. According to CIS2006 the share of innovators among the respondents from dairy processors was 91.7%. The share of innovators in the manufacturing sector was 72.8%. (author's calculations on the basis of database CIS2006). Dairy processors might be more innovative than average manufacturing firms because of severe competition for market share (interviewee A). Although the share of innovators is high amongst dairy processors, innovations introduced have been and still are mainly incremental innovations.

> *For a long time innovations in the dairy industry were mainly linked to changes to the jam used or the taste of the products. /…/ So, 90% of innovations are incremental innovations – the product does not change; only the appearance and taste changes.*
>
> **Interviewee B**

At the same time there are positive trends apparent in innovation activities. Movements towards producing higher value added products and the diversification of products by Estonian dairy processors can be observed. For example, there are no dairy enterprises producing only powders anymore (Interviewee C). Also, innovations in the packaging of products are visible. Estonian processors have started to pack dairy products in handy plastic bottles similar to their European competitors. In addition, a movement towards healthy and functional food is also taking place, and so a trend towards radical innovation exists.

Opportunities for Estonian dairy processors lie in radical product innovations (functional dairy products) produced from natural milk. Functional dairy products are niche products with high value added and the demand for them is increasing on global markets. Therefore, radical innovations are triggered by markets and thus, radical innovations in dairy processing are more demand driven than supply driven. Besides innovations in products and processes, marketing and organizational innovations are also being introduced by dairy processors (Database of CIS2006).

To be able to innovate and invest in innovation processes, Estonian dairy processors need financial resources. Table 16 presents the turnover and net profit of dairy processors in current prices. Before 2006, net profit was either rather small or even negative. Starting from 2006, net profit increased significantly. Turnover started to increase in 2005, but the increase was caused by price increases occurring during those years. Therefore, before the global financial crises started, Estonian dairy processors had two years when profits were significant and this enabled investments in innovation processes. These two years refer to the period of high economic growth.

Also, Interviewee D mentioned that starting in 2000, losses for dairy processors have alternated with profits without any long-term stable period during which the industry could have saved money and invested in innovation processes and R&D (Interviewee D). As one other interviewee said:

> *If you are drowning, your only concern is how to get oxygen into your lungs. You are not thinking about long-term strategies and whether my enterprise will produce anything innovative in 15 years.*
>
> **Interviewee B**

**Table 16.** Turnover and net profit of dairy processors in 2000–2007

| Year | Turnover in million EEK | Net profit in million EEK |
|---|---|---|
| 2000 | 3381 | 13 |
| 2001 | 3382 | –77 |
| 2002 | 2377 | 75 |
| 2003 | 3288 | 80 |
| 2004 | 3655 | 23 |
| 2005 | 4403 | –35 |
| 2006 | 4738 | 329 |
| 2007 | 4604 | 166 |

Source: Database of Estonian Central Commercial Register

Even during this volatile period, some larger Estonian dairy processors have still been able to invest in innovation processes and R&D. Dairy enterprises have also cooperated with scientists and some of them are partners in the Bio-Competence Centre of Healthy Dairy Production (Bio-Competence Centre). The latter was established under the programme of competence centres. The programme was implemented by Enterprise Estonia at the beginning of 2000. The first competence centres, including the Bio-Competence Centre, were established in 2004. (Riik toetab… 2009)

The Bio-Competence Centre was created in 2004 as a private company. The main activities taking place at the centre are linked to research connecting biotechnology with milk production and dairy products; in other words, the development of healthy dairy products. To be able to develop healthy dairy products, the Bio-Competence Centre focuses on research starting with the breeding of cows and ending with functional dairy products. (Bio-Competence Centre… 2009) The strength of the Bio-Competence Centre is its focus on the whole value chain – from animal to final customer.

The activities of the Bio-Competence Centre are closely linked to the European Union technology platform, "Food for Life". According to interviewee D, Estonian researchers and dairy processors have recognised this technology platform and are focusing on one of its subtopics, "Food and health".

The Bio-Competence Centre is mainly financed by the public sector. In 2009, the Bio-Competence Centre received additional financing amounting to 114 million EEK from the EE competence centre programme for the next six years (Riik toetab tehnoloogia arenduskeskusi… 2009). Before that, the competence centre has been supported by approximately 21 million EEK starting since 2004 (Toetatud projektid… 2009). According to interviewee E, in addition to support from the public sector, approximately 25% of the Bio-Competence Centre budget comes from its partners, including private enterprises. Therefore, the establishment of the Bio-Competence Centre has motivated some dairy processors to invest in innovations including R&D activities, and work side-by-side with Estonian scientists. It has also increased the interest of scientists to work with industry and think about the how to use the research results in the development of new healthy dairy products. But investments in innovations including R&D are linked to risks, which enterprises have to be ready to take.

> *We went to that CC (Bio-Competence Centre – author's comment) like we would go into the casino. If you are going to the casino you have to take into consideration that you may loose all your money. This is the case also with the CC /…/ No-one can give us any guarantees.*
>
> **Interviewee B**

As a result of the cooperation between enterprises and universities and/or the competence centre, some functional dairy products have already been introduced to the Estonian market. The most known and the first radical innovation was the introduction of probiotic ME3 bacteria into the "Hellus" range of products in 2003 (Kalvet 2006: 86–87). In addition to the "Hellus" range, other functional dairy products have also been launched by Estonian dairy processors, some of them due to cooperation with the Bio-Competence Centre.

Therefore, it can be said that the trend towards healthy and functional food has been recognized and embraced by some of the larger Estonian dairy enterprises. For this trend to be sustainable and continuous strong links with other Estonian biotechnology organisations are also needed. Unfortunately, the links between Estonian biotech organisations and dairy processors are not effective; although this kind of cooperation may create more opportunities for both sides.

> *In Estonia, biotech is considered a sector independent from other sectors, areas. At the same time, it should be linked to other sectors e.g. food and dairy sector.*
>
> **Interviewee D**

To increase interest in cooperation from the traditional sectors and biotech enterprises, besides existing consultancy firms, the public sector could also intervene. These links may not emerge without some kind of support from the public sector. One way to initiate cooperation activities is through awareness raising activities. These help increase knowledge about competencies of Estonian biotechnology activity among traditional sectors. The first step has already been made by Tartu Biotechnology Park (TBP). In cooperation with EE, TBP has published brief introductory materials to show the traditional sectors how biotechnology can be beneficial. (Tartu Biotechnology Park 2009)

The majority of Estonian **biotechnology companies** are SMEs that were established rather recently. While dairy processing is considered to be sector with long traditions in Estonia, biotech is still at the incubatory stage (see 2.1.1.). The size of the companies in those two groups of enterprises also differs. Among dairy processors a trend towards larger companies through a consolidation process is observable. This is not common in biotechnology; although several people own more than one biotech enterprise.

The main activity in biotechnology enterprises is the provision of services to health care, medical companies and/or laboratories. Also, the main innovations and investments in R&D are linked to developing technology platforms, diagnostic or synthesis methods for customers. (Interviewees R, S and U) Therefore, the majority of Estonian biotechnology enterprises can be categorized as specialized suppliers.

In addition to red biotech, there is potential to use biotech in Estonian traditional sectors. There is a strong research base to support this trend, but currently, as already mentioned above, links and cooperation are rather weak.

> *In Estonia today, the role of biotechnology should be for traditional sectors. /…/ Public sector should /…/ plan some of its activities for traditional sectors, so that they (traditional sectors – author's comment) could educate and prepare themselves to exploit the results of biotechnology. It is not a short-term process. I think it would last at least 3–5 years.*
>
> **Interviewee R**

Estonian biotechnology enterprises often finance their R&D through the sales of products and/or services. In some cases enterprises sell products which are indirectly linked to their core competences with the aim of earning money for R&D. (Talpsep 2005: 52–53) This model of financing has worked so far, but development in Estonian biotechnology enterprises has therefore been rather slow and inefficient. The main focus of enterprises has been on making money and/or providing services instead of R&D. At the same time, this kind of financing has been the only way for enterprises to find resources for R&D investments. There have not been strong seed or venture capital funds available for biotechnology enterprises, and the majority of public financial support has been directed to basic science. Many Estonian biotech enterprises are constantly looking for venture capitalists or some foreign investors to help them finance R&D.

The classical biotech enterprises active in drug development and requiring huge investments almost do not exist in Estonia (Interviewees R, S and U). Enterprises active in drug development need very large investments before the results of R&D are ready to be sold or franchised. In drug development, Estonian enterprises are capable of testing the influence of particular molecules in laboratory conditions, but they are not able to conduct clinical testing because of the lack of resources. Therefore, after the tests in the laboratory are conducted, enterprises should sell the results to the highest bidder or license them out. (Interviewee R) The common model of Estonian biotechnology companies where R&D is financed through sales and/or financial support from the public sector would not work for drug development because these sources are not sufficient to finance the necessary R&D.

The scarcity of resources also limits the creation of the Estonian biotechnology industry through the mass production of biotechnology products. Problems lie in the scarcity of both human and financial resources.

> *Let's say that we will discover something very interesting in one area of biotechnology. The reality is that we do not have enough people to produce it in large quantities. If we gather all the Estonian specialists active in one particular area, let's say biosynthesis, the number of those people would be around 10. This is not enough to form even a subgroup in the biotechnology industry.*
>
> **Interviewee U**

If we also add research institutions to enterprises, the main source for innovation expenditures is the public sector. From research done by Tõnis Mets and published in 2006, it can be seen that approximately 80% of innovation expenditures are covered by public funding. One has to keep in mind that the majority of public funding goes to universities or research institutions to fund basic research. The ratio of the funding structure divided between basic research, applied research and products/service development in Estonia including public and private expenditures is 11:5:1. (Mets 2006b: 764) This ratio is in accordance with the first generation of innovation models, technology push models (Mets 2006a: 74).

There are two main organizations funding Estonian science through the budget of the Estonian Ministry of Education and Research. These organizations are the Scientific Competency Council and the Estonian Science Foundation. Out of the budget distributed by the Scientific Competency Council approximately 30% of the budget was given annually to areas linked to biotechnology for the period 2003–2006. The same indicator for the Estonian Science Foundation in 2005 was approximately 25%. The rest of the budget was divided between six research areas dominated by medical and exact sciences and techniques. (Teaduskompetentsi Nõukogu… 2009: 11–12) All this has made the academic side of biotechnology stronger than the commercial side.

The 11:5:1 ratio also highlights the modest role of private R&D. Enterprises are not very active in basic research in Estonia. Applied research and product/ service development primarily takes place in private companies. (Kask 2005: 59) Therefore, private companies do not contribute very much to the first number in the ratio. Investments are mainly linked to the second and third part of the ratio.

At the same time, the public sector does not only support basic research; some support for applied research and the development of private companies is also given. During the last programming period of 2002–2006, Estonian biotechnology firms were rather successful in applying for money from Enterprise Estonia. For example, Quattromed Cell Factory received approximately 10 million EEK from Enterprise Estonia for applied research in 2005, and Asper Biotech received 1.5 million EEK for the development of DNA tests (Toetuste saajate andmebaas 2009). Table 17 presents the general division of financial resources given by EE to companies and research institutions across sectors.

**Table 17.** Distribution of funding from Enterprise Estonia across sectors and groups of organizations for 2002–2006, %

| Sector/activity | Companies | Research institutions |
|---|---|---|
| Biotechnologies | 31 | 39 |
| Energy and environment technology | 16 | 9 |
| ICT | 15 | 1 |
| Product and material technology | 13 | 27 |
| Chemistry | 7 | 0 |
| Oil shale | 6 | 4 |
| Construction and wood | 3 | 5 |
| Electronics and automation | 3 | 2 |
| Production technology and logistics | 3 | 0 |
| Food technology and agriculture | 2 | 13 |
| Other | 1 | 0 |
| Total | 100 | 100 |

Source: Kukk, Truve 2008: 37

Public sector support measures are considered to be very important by biotechnology organizations. As some of the interviewees said, without public sector support some biotech companies would not exist today and/or some activities and development projects would not have been conducted. Through public sector support measures companies' own capital has been amplified and that has allowed them to innovate on a scale that would not have been possible on the basis of private resources.

To change the ratio of funding and increase the input from the private sector, Interviewee S suggested the use of mergers and acquisitions (M&A) in biotechnology activity. M&A between biotechnology enterprises have increased recently in the world. In 2005 compared to 1999 the number of M&A doubled. (Biotehnoloogia tutvustus 2010) In Estonia, M&A could take place either between Estonian companies or between Estonian and foreign companies, and this would increase the resources companies could use for R&D and/or production and/or increasing marketing capabilities.

The next part discusses the validity of Proposition 1. The proposition is tested based on information gathered from the interviews.

**Proposition 1.** The innovation process model developed in 1.1.1 describes the innovation process taking place in both dairy processors and biotechnology enterprises; in other words, the model is not activity specific.

The innovation process shown in Figure 6 consists of three stages: generation of ideas, problem solving and application of ideas. The process seems to be linear, but all stages are interlinked through feedback loops. Feedback loops cover exchanges of knowledge, information, human and financial resources and R&D results between different stages of the innovation process. All three stages are influenced by internal and external factors of the firm. The internal factors include, for example, management style, control over employee activities, the firm's structure, communication and coordination issues etc. The firm's external factors include the economic and legal environment, characteristics of markets, the level and quality of education and research in the country, public policy measures and regulations. A more thorough description of innovation process stages is presented in 1.1.1.

While describing the innovation process in biotechnology enterprises or dairy processors, interviewees did not volunteer any significant differences across the groups of enterprises based on the innovation process in Figure 6. Some interviewees described the process in a more detailed way, but the general idea of the process was similar across all interviewees.

To develop new products every larger dairy processor in Estonia has a development team or at least one employee working daily on how to introduce new products, how to be innovative. But those development teams inside enterprises mainly work on incremental product innovations.

In one of the dairy companies, the innovation process was rather formalized. First, ideas have to go to the development team, which evaluates them in cooperation with the marketing department. Then, the chosen ideas go to a product development commission that selects ideas for a cost-benefit analysis. After the cost-benefit analysis, the product development commission decides whether the ideas will be implemented, rejected or put aside. (interviewee C)

All these stages fall under the second stage of the innovation process shown in Figure 6.

It can be said that the innovation process described by interviewee C is useful for incremental innovation linked to changes in taste and/or minor changes in packaging. More significant changes like process, organizational, marketing and/or radical product innovations need additional input from different actors.

To develop products with high added value Estonian dairy enterprises do not yet have sufficient internal competence, and therefore it requires cooperation with research institutions. Currently, research on healthy and functional food is taking place at the Estonian University of Life Sciences, University of Tartu and at the Bio-Competence Centre of Healthy Dairy Products. (Interviewee A and D)

When comparing the innovation process in dairy enterprises with those taking place in biotech enterprises, the following differences can be brought out. First, the main sources of ideas differ between the two groups of enterprises. Markets as a source of ideas are more important for dairy processors. Ideas for new dairy products may arise even while doing everyday shopping for groceries. Universities as a source of ideas are more important for biotechnology companies. But disregarding the differences, the main sources of ideas are similar. The most important ideas for biotechnology come from internal potential and knowledge followed by information coming from customers and competitors. (Kask 2005: 48) This is also the case for dairy processors. Dairy processors also evaluate suppliers as the source of ideas. ((author's calculations on the bases of database CIS2006)

Second, according to interviewee M, biotechnology companies are relatively close to science. When an idea comes from a research institution or university it may be rather far from being a sellable product. Therefore, internal product development and applied research; that is, formal R&D, is more significant for biotechnology companies than for dairy processors. Thus, in biotechnology the emphasis is on basic research and formal R&D. Enterprises are small and deal with the introduction of the product to the market. Markets are taken into consideration, but the general trend is still similar to the technology push innovation process model.

The third difference between the two groups of enterprises lies in cooperation activities. Products in biotech are rather complicated, specific and knowledge intensive. This creates the need to cooperate with organisations from the external environment to increase internal capabilities. Therefore, throughout the innovation process biotechnology companies are more open to cooperation than dairy processors. Basic and applied research, and product testing are usually conducted in cooperation with research partners. For marketing and sales, several biotechnology companies use the help of consultants and experts. (Kask 2005: 57) This may also be the result of a lack of internal marketing capabilities in biotechnology enterprises. Dairy processors usually do not cooperate (except in the case of radical innovations when cooperation does take place).

The fourth difference is based on patents and licensing. Biotechnology enterprises can not only sell products, technology platforms and/or services, but also licenses, and can earn income from patents. This is more widespread in high-tech sectors than in traditional sectors. In Estonia, biotechnology enterprises submit patents even more than research institutions (Biotehnoloogia tutvustues 2010). In the food industry, patents are hard to get and licensing is not yet used by Estonian dairy processors.

In conclusion, despite the differences, the innovation processes described by dairy industry representatives are in accordance with the innovation process presented in Figure 6. This is also in harmony with the innovation processes in biotechnology companies.

*For biotechnology this model is a widely used approach, but the model has to be put into the specific environment and analyzed in the framework of that specific context.*

**Interviewee P**

There are differences in innovation processes across companies and industries, but the innovation process presented in Figure 6 subsumes those differences. ***Therefore, on the basis of the description of innovation processes presented by the interviewees and discussions presented above Proposition 1 (The innovation process model developed in 1.1.1 describes the innovation process taking place in both dairy processors and biotechnology enterprises; in other words, the model is not activity specific) can be accepted.***

It may be stated that Estonian dairy and biotech industries are rather innovative. In dairy processors, the majority of innovations were until recently linked to either process innovations or incremental product innovations. Now Estonian dairy processing is starting to focus its innovation activities towards developing healthy and functional food in cooperation with research institutes and the Bio-Competence Centre of Healthy Dairy Products. In biotechnology, the major innovations are linked to developments of technology platforms, diagnostics and/or synthesis methods. Unfortunately, there are not yet many links between those two groups of organizations, but both sides are willing to find ways to cooperate. This however, should be supported by the public sector.

### 2.2.2. Estonian national innovation system and the design of innovation support measures

The Estonian National Innovation System (NIS) has been developed systematically since 2000 (Annual Innovation Policy… 2009: 12). Figure 22 presents the Estonian National Innovation System according to the webpage of the Ministry of Economic Affairs and Communication. This figure shows the governance side of the Estonian NIS.

Based of Figure 22, on the highest level of the Estonian Innovation System's governance is the Estonian Parliament and Government. The former has the highest legislative power and the latter the highest executive power in Estonia (Annual Innovation Policy… 2009: 12).

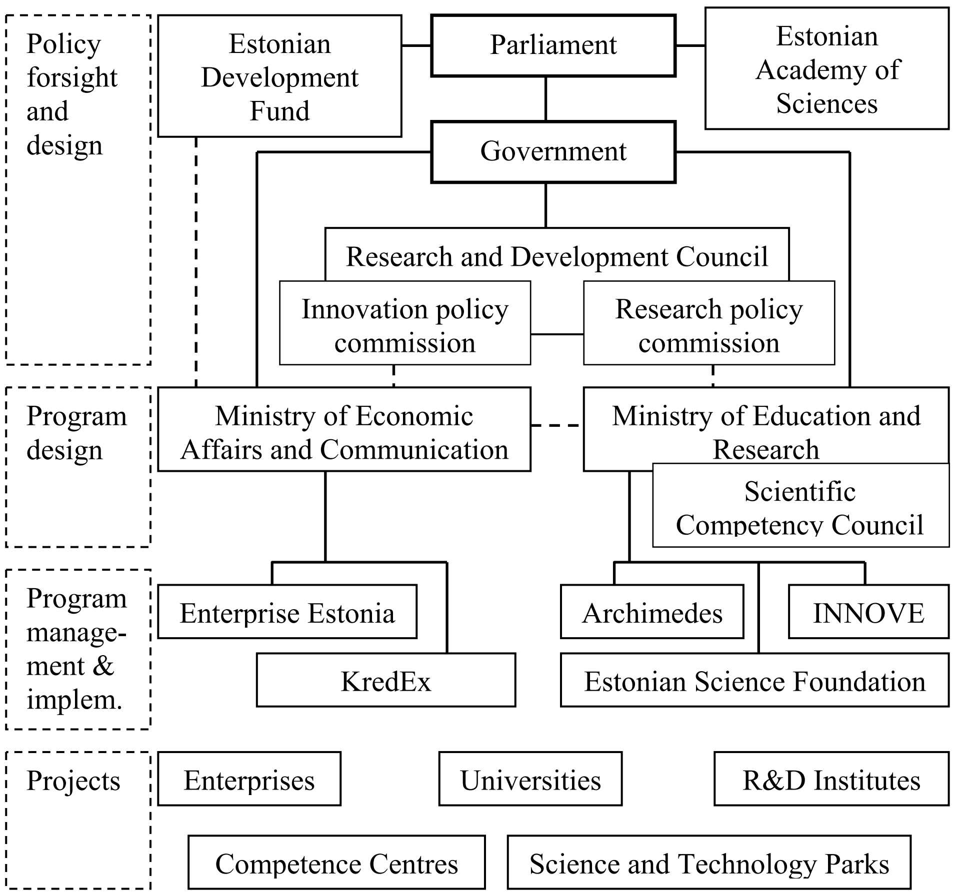



**Figure 22.** Estonian Innovation System (Eesti innovatsioonisüsteem 2009)

The Estonian Government is directly linked to three important institutions in the innovation system: the Ministry of Education and Research (MER) responsible for education and science policies in Estonia, the Ministry of Economic Affairs and Communication (MEAC) responsible for economic policy including innovation and technology policy, and communications, and the Research and Development Council (RDC). Both ministries have sub-units for the implementation and management of programmes developed at ministerial level. The MEAC's sub-units are Enterprise Estonia and KredEx, and MER's Archimedes, INNOVE and the Estonian Science Fund.

The division of responsibilities between the two ministries may create problems coming from the duplication of functions, barriers existing in information exchange, the lack of harmonization of activities etc. Therefore, intensive cooperation between those two ministries is essential to increase the effectiveness of the Estonian National Innovation System.

The RDC is a strategic advisory body for the government and is subordinate to the Prime Minister of Estonia. The RDC embodies two commissions dealing respectively with innovation policy and research policy. (Annual Innovation Policy… 2009: 12–13)

Figure 22 presents enterprises and research institutes at the lowest level of the national innovation system. Following the logic of the figure, their position at the bottom may be grounded, but it also might reflect the thinking of the policy makers about the Estonian National Innovation System. Policy makers look at the innovation system from the top-down perspective, and not from the perspective of enterprises and research institutes.

According to Lundvall (2007), at the core of the innovation system there should be two groups of organizations – enterprises and organizations of knowledge infrastructure. Enterprises can develop, absorb and use new knowledge and technology, and organizations of knowledge infrastructure are responsible for creating new knowledge, and educating and training employees for enterprises (Lundvall 2007: 29). Therefore, these organizations should not be at the bottom of the figure, but in the centre of it.

> *It is done relatively often that the structure of the innovation system is put together from the viewpoint of the state's hierarchy. /…/ In the Estonian case enterprises are placed in the bottom left corner. From this picture it can be concluded that enterprises have a relatively small role in the innovation system.*
>
> **Interviewee M**

Figure 22 also indirectly reflects the abandonment of the demand side of innovation processes because markets and customers are not taken into consideration. Again, according to Lundvall, the core of the innovation system should be planted in the wider setting of the innovation system consisting of four separate groups (Lundvall 2007: 29):

- family patterns, education system, career patterns, inequality and social welfare systems;
- economic context;
- final demand from households and public sector;
- government and public policy.

In Figure 22, only the latter is taken into account and the rest of the wider setting is disregarded. Although some of the aspects of the wider setting are difficult to take into account, the majority of them should still be considered. Right now only the government and public policy side is brought out, emphasising its domination over other aspects of national innovation system even more. Even if the figure shows the governance side of the system, aspects like the importance of enterprises, organizations of knowledge infrastructure, and the existence of demand should have been taken into account.

In the current thesis, the author focuses mainly on the left side of Figure 22 starting from enterprises and their needs. In addition to enterprises, other organisations of the innovation system under analysis are the Ministry of Economic Affairs and Communication, Enterprise Estonia and KredEx. Innovation support measures linked to and/or implemented by those institutions are covered by the thesis. Also, some measures linked to the Ministry of Agriculture and Estonian Agricultural Registers and Information Boards will be discussed below. The fact that the latter two institutions are not included in the Estonian innovation system shows that Estonian policy makers define innovation and innovation policy rather narrowly. Those organizations and their measures are chosen because of their direct link to enterprises. Measures of MES influence enterprises more indirectly through organizations of knowledge infrastructure. Measures analysed in this thesis are presented in Appendices 6–8.

The Ministry of Economic Affairs and Communications, with its divisions, departments and subsidiary units designs, implements and evaluates Estonian economic policy (Ministeeriumi eesmärgid… 2009). The main administrative units active in the area of innovation inside the MEAC are the Economic Development Department with its technology and innovation division and the enterprise division. As one interviewee said:

> *The Economic Development Department (EDD) is one of the central creators of opportunities. The EDD is responsible for the creation of a favourable environment for enterprise development and economic development through innovation.*
>
> **Interviewee L**

The EDD with its two divisions develops strategies and policies in the area of entrepreneurship, R&D activities and innovation. It also puts together action plans and designs programs for implementing those policies and strategies. The cooperation with subunits of MEAC, mainly with Enterprise Estonia and KredEx is also a task of the Economic Development Department. (Majandusarengu osakonna… 2009: 2) According to one of the interviewees, the EDD is also the main organization creating links between different public sector organizations active in the Estonian innovation system.

There are strong links between enterprise, and technology and innovation division. Technology and innovation division is more active in R&D and innovation areas; enterprise division focuses more on supporting enterprises (Majandusarengu osakonna… 2009: 2–3). But the activities and aims of both divisions are rather similar.

*Technology and innovation division is engaged in bringing new solutions to the market, increasing the awareness of enterprises and solving financial problems. This is all done also by enterprise division. Just the measures and support schemes are somewhat different.*

**Interviewee H**

The execution of innovation policy is primarily the task of Enterprise Estonia. Enterprise Estonia was founded in 2000 and provides finances, training and advice to, and creates partnership opportunities for Estonian enterprises, research and development institutions, the public and third sector. The tasks of Enterprise Estonia are (Sihtasutusest 2009):

- increase the sustainability and accelerate the growth of new enterprises,
- increase export and product development capabilities of Estonian enterprises,
- bring foreign direct investments into the Estonian economy,
- increase the export of tourism and develop internal tourism,
- promote regional development and civic society.

Enterprise Estonia is one of the institutions responsible for the distribution of EU structural funds. During the period 2007–2013 Enterprise Estonia is responsible for managing 13 billion EEK coming from structural funds. (Sihtasutusest 2009)

Besides Enterprise Estonia in 2001 the Ministry of Economic Affairs and Communication founded KredEx with the aim of increasing opportunities for enterprises to access financial resources and decrease the risks linked to the export of goods. KredEx provides guarantees to banks to back up enterprise loans. It also provides export, production and investment guarantees to enterprises. (Tutvustus 2009)

In addition to the institutions presented in Figure 22, enterprises active in the countryside and/or are agricultural producers can also apply for (financial) support from the Estonian Agricultural Registers and Information Board (PRIAst 2009). These support measures are financed by the Estonian Government or by the EU under the umbrella of CAP. Many of the support measures provided by EARIB are linked to the innovation process and its factors, and therefore are analysed in this thesis.

For the innovation system to be effective it has to be active and fulfil its functions. So, besides the components discussed briefly above, system functions are also important. According to Edquist and Hommen (2008: 7), the main function of the innovation system is "to develop and diffuse innovations". To fulfil this main function, the following sub-functions and/or actions have to exist within the system (Edquist, Hommen, 2008: 10):

- provision of knowledge inputs for the innovation process:
  - provision of R&D and through that create new knowledge,
  - competence building in innovation and R&D activities through teaching the labour force,

- functions focused on the demand-side:
  - formation of new markets,
  - development of demand side quality requirements,
- provision of the components of the innovation system:
  - creation and change of organizations important for innovations,
  - creation and change to the rules of the game linked to innovative organizations and innovation processes,
  - creation and effective networks,
- creation and implementation of innovation support measures:
  - provision of facilities and administrative support for innovations,
  - provision of finances facilitating the commercialization of knowledge,
  - provision of consultancy.

Edquist and Hommen did not focus so much on basic research in their list of sub-functions. They focused more on R&D and competencies as necessary for the innovation process to be beneficial, and the demand side of innovation. Also, not all functions of the innovation system have to be established by the public sector. Some of the sub-functions mentioned above can be provided by private sector organisations. But even if they are provided by private sector organisations, the public sector has to create the conditions for the private sector to participate (e.g. special legislative and economic environment, and/or conditions needed for venture capital associations to exist etc.).

The activities presented in the list above are all equally important and have to exist simultaneously for the system to fulfil its main function. At the same time in Estonia it seems that more attention has been paid to the first sub-function, provision of knowledge inputs through financing the basic research taking place at research institutions and universities (see 2.2.1.). This brings us to Proposition 3.

**Proposition 3.** The provision of knowledge inputs is considered to be the primary function of the innovation system by the Estonian public sector.

To investigate what functions of the innovation system are considered important by Estonian public sector representatives and policy makers, a question about that was included in the interview. The question was not focused on functions existing inside the Estonian National Innovation System, but on a hypothetical system; that is, what functions an innovation system should have. Six interviewees from the public sector answered this question. Table 18 presents important functions of the IS mentioned by the interviewees. The table only presents the thematic categories of the sub-functions brought out by Edquist and Hommen.

The interviewees most frequently mentioned the existence of innovation support measures and services designed for enterprises as a function that the innovation system should have. Two of the interviewees stated that this function is the most important, and four interviewees mentioned support measures as being one of several important innovation system functions. Therefore, no interviewee questioned the need to support innovations taking place in enterprises. But many interviewees emphasised that the innovation system and its functions including innovation support measures have to be flexible and able to adapt to the changing environment conditions. As one of the interviewees said:

> *The innovation system cannot exfoliate from the economy and changes in society. It cannot start to live an independent life. The innovation system has to be embedded in its surroundings.*
>
> **Interviewee N**

**Table 18.** Important functions of the innovation system

| | Provision of knowledge inputs | Functions focused on demand-side | Provision of innovation system's components | Innovation support measures |
|---|---|---|---|---|
| Interviewee H | | | ✓ | ✓ |
| Interviewee J | ✓ | | | ✓ |
| Interviewee K | | | | ✓ |
| Interviewee M | | | ✓ | ✓ |
| Interviewee N | | | ✓ | ✓ |
| Interviewee O | ✓ | | ✓ | ✓ |

Source: Composed by the author

This explains why the interviewees consider the creation of the components of the innovation system and changes to them almost as important as the innovation support measures themselves. It is important that the system is flexible and able to adjust to changes in the environment. If necessary, changes have to take place in all components of the innovation system. Otherwise the system can lock-in on its successes or failures – a lock-in failure may emerge. The system also has to be able to look to the future.

> *Structural changes taking place in the economy are important. /.../ It is important to have an idea about what you have (in terms of the structure of industry – author's comment) today. /.../ You also have to know where you want to go.*
>
> **Interviewee M**

Changes also have to be introduced to the complex of innovation support measures in response to changes taking place in the environment and/or when organisations foresee such changes. As interviewee H stated about innovation support measures, that it is important for the government to address failures in the environment, it is also important to move out when the failure does not exist anymore. Direct innovation support measures should transform into indirect measures and then into consultation services or disappear all together when conditions make this possible.

The provision of knowledge inputs is the third most important function of an IS according to the interviewees. Knowledge inputs have been considered an important part of the innovation process since the beginning of 2000. This had been taken into account from the start of the process of designing the innovation policy measures. Currently, during the new programming period new measures are being elaborated in addition to or replacing the existing measures. Those changes cover other factors of the innovation process and not only R&D and knowledge input measures. ***Therefore, one can say that the provision of knowledge inputs cannot be considered the primary function of the innovation system by the Estonian public sector, and so Proposition 3 (The provision of knowledge inputs is considered to be the primary function of the innovation system by the Estonian public sector) cannot be accepted***.

From Table 18, one can see that no interviewee mentioned demand side activities as being an important function of the innovation system. There may be three explanations. First, demand side policy measures are not yet very widely used by policy makers in Europe and in Estonia. Second, the Estonian public sector does not have enough knowledge and experience to implement demand side measures. Third, the quality requirements and standards linked to demand side policies are put in place at the European level, and therefore, Estonia cannot introduce different requirements and/or standards alone.

**Proposition 4.** The design of Estonian innovation support measures is influenced by trends in innovation support measures in the European Union.

Being a European Union member state could influence Estonia through different channels. The sources of potential influence from the EU can be divided into two – influences through financial resources provided by the EU and through the policy learning process. Those two sources of influence were also discussed during the interviews with public sector representatives and the results are presented below.

*Influence through financial resources coming from the EU*

To support innovation, the Estonian Government has mainly used resources from European Structural Funds. Funds from the Estonian Government are only used for investments not eligible for Structural Funds. But if we compare the financial resources from the EU with those from Estonia, the EU resources prevail.

The first period when Structural Funds were available for new member states was 2004–2006. This period can be linked to when the systematic approach to innovation policy and its measures in new member states began. (Reid 2009: 29) The use of Structural Funds to support innovativeness in new member states also continues in the period 2007–2013. Estonia will receive 53 billion EEK from European Structural Funds in 2007–2013, from which 13 billion EEK will be given to EE to implement innovation support measures (Sihtasutusest 2009).

The Ministry of Finance of the Republic of Estonia compiled the strategy for using Structural Funds for 2007–2013. While writing this strategy, the ministry had to take into account several documents and regulations from the EU, the most important of which was the European Council Decree for using Structural Funds (Nõukogu määrus (EÜ) nr 1083/2006 2009). On the basis of "The National Strategic Reference Framework 2007–2013" composed by the Ministry of Finance of the Republic of Estonia, three operational programmes were developed: the operational programme for human resource development, for the living environment and for the economic environment. These operational programmes include activities financed by Structural Funds and the respective financial plans. (Riiklik struktuurivahendite … 2009: 108–109)

In addition to the general framework regulating the use of Structural Funds, precise rules for state aid are also presented by the European Union. A short overview of these rules is presented in "Vademecum – Community Law on State Aid" published by the EU Directorate-General for Competition. For example, these rules determine what kinds of industries are allowed support from Structural Fund resources, how to define small and medium sized enterprises, maximum aid intensities across activities, enterprises and R&D projects and so on. (Vademecum. … 2009)

The previously described regulations and restrictions have to be taken into account while designing innovation support measures in Estonia. The regulations governing Structural Funds and the Community Law on State Aid constitute the framework within which policy makers have to act.

> *Estonia is free in distributing financial resources coming from Structural Funds. But we have to take into consideration the conditions and restrictions set by the European Commission. /.../ We are free to decide how to use that money to achieve the living standards and level of infrastructure of European Union member states as soon as possible.*
>
> **Interviewee G**

Interviewee N stated that money from the Structural Funds is given to countries so countries can implement their own strategies. In the case of Estonia, the main strategy document in the area of innovation support designed for private companies and R&D activities is "Knowledge Based Estonia 2007–2013". This is closely linked to the Estonian Entrepreneurship Policy 2007–2013 including activities linked to innovation process factors.

"Knowledge Based Estonia 2007–2013" focuses on society's sustainable development through R&D and innovation. The objectives of "KBE II" are to increase the quality and quantity of competitive R&D, existence of innovative enterprises creating value in the global economy and the existence of an innovation friendly society focused on long-term development. There are also key technologies defined in that document. These technologies should be used to achieve the objectives set by the strategy. Key technologies within the framework of KBE II are user-friendly ICT, biotechnology and materials technology. (Teadmistepõhine Eesti… 2007: 5–6). The objectives of KBE II shall be achieved through four measures. Namely, the development of human resources, increased efficiency in public sector RD&I, increased innovation capacity in enterprises, and the design of policies aimed at the long-term development of Estonia (Teadmistepõhine Eesti… 2007: 25).

The Estonian Entrepreneurship Policy 2007–2013 focuses on four key areas: support for the development of knowledge and skills, investments, internationalisation, and the development of and improvements in the legal environment (Eesti ettevõtluspoliitika 2007–2013 2007: 18). To fulfil the aims in those areas, the following measures should be implemented (Eesti ettevõtluspoliitika 2007–2013):

- support the development of knowledge and skills – development of the knowledge and skills of entrepreneurs, managers and employees through training and life long education; consultancy for starting, growing and/or internationalizing companies; raising awareness in the area of entrepreneurship and innovations;
- support for investments – improve access to capital for SMEs; support investments; develop the business angel network;
- support for internationalization – development of the export capabilities of Estonian enterprises; supply of services supporting the internationalization of enterprises; public sector activities supporting internationalization;
- improvements in the legal environment – evaluation of the influence of current and future legal acts on entrepreneurship; involvement of key stakeholders into the development of legal acts and strategies; improvements in the international competitiveness of the legal environment for entrepreneurship.

*Influence through policy learning*

Within the framework created through European Union regulations and on the basis of Estonian strategy documents, innovation support measures are developed. According to Interviewee G, policy design takes place in two steps. First, the problems in the economic environment are analysed; and second, best practices to solve the problems are sought from Europe and the rest of the world. One reason it is reasonable to copy innovation support measures is because Estonian innovation policy is so young. Our policy makers do not have much experience in designing policy measures. Therefore, policy makers look for policies that have already been implemented, which can also solve the problems existing in Estonia. A second reason is linked to the changes taking place in the EU. Namely, policy learning is encouraged by the European Union. Several countries experience the same or similar innovation process problems. Through policy learning and cooperation we can increase the effectiveness of innovation support measures. As one of the interviewees said:

*European countries are all dealing with the same kinds of questions and problems like questions linked to venture capital, cluster initiatives, product development projects and the development of human capital. /…/ But we also adjust policy measures to suit Estonian conditions before implementing them.*

**Interviewee J**

Thus, while implementing policy measures copied from European countries it is important to understand that particular measure fully and thoroughly. This helps when modifying and adjusting the measure to local conditions. If this is not done correctly the measure will not have the desired effect.

*The trend of copying policies in reality shows that even if at first glance the policy measures and objectives are relatively similar across member states, countries that copy measures are not able to implement them as well as the countries from which they are copied. /…/ Each country must have the capabilities to implement the policy measures in the most effective way.*

**Interviewee N**

Similarities between European innovation support measures can also be found when comparing the sectors and technologies favoured by innovation support measures in different countries. High-tech activities like ICT, biotechnology and nanotechnology are very popular in almost all European countries according to interviewee K because they are considered to be enabling technologies of the future. Innovation support measures are also indirectly biased towards those technologies in Estonia. This bias is more thoroughly discussed below.

The principle of equal treatment is another reason why Estonian policy makers follow the policies implemented in other European countries. Interviewee H stated that policy makers have to keep an eye on the support measures of other countries because otherwise unfavourable conditions for Estonian enterprises might be created.

Therefore, it may be stated that the design of innovation support measures is influenced both by the finances and regulations from the EU, and the innovation support measures implemented in other member states because the European innovation system covers part of the Estonian innovation system. ***So, Proposition 4 (The design of Estonian innovation support measures is influenced by trends in innovation support measures in the European Union) can be accepted.***

2.2.2. provided an overview of the Estonian National Innovation System and policy design. Only those organizations more closely link to innovation support measures designed to support enterprises were discussed more thoroughly. For the innovation system to be effective not only is the structure of the system important, but so are its functions. The outcome of the interviews shows that two of the most important functions of the innovation system should be the provision of innovation support measures and innovation system components. The provision of knowledge inputs was also considered rather important. At the same time, demand side policy measures as one of the functions of the innovation system were not mentioned by any of the interviewees. This could be considered a weakness of the Estonian National Innovation System and innovation policy design.

The following parts of the thesis will analyse innovation process factors and innovation support measures more thoroughly. While concentrating on innovation support measures, the measures implemented by the Ministry of Economic Affairs and Communication through its sub-units Enterprise Estonian and KredEx and by the Ministry of Agriculture implemented through the Estonian Agricultural Registers and Information Board will be included. The alignment between innovation process factors and innovation policy measures will also be covered in 2.3.1. and 2.3.2.

## 2.3. Identification of alignment on the basis of Estonian dairy processors and biotechnology enterprises

### 2.3.1. Innovation process factors and innovation support measures important for Estonian dairy processors and biotechnology enterprises

Here the author will analyse innovation process factors and innovation policy measures. Innovation process factors will be analysed based on a comparison between factors influencing the innovation process according to the theoretical framework developed in 1.1.2. and factors influencing the innovation process in Estonian dairy processors and biotech enterprises. This will help us identify the factors causing problems for Estonian biotech enterprises and dairy processors. The analysis of innovation policy measures helps us identify which factors influencing the innovation process according to the theory are covered by Estonian innovation support measures. Innovation process factors mentioned by representatives of dairy processors and biotech enterprises, and innovation support measures implemented by Enterprise Estonia, KredEx and the Estonian Agricultural Registry and Information Board are grouped according to the theoretical framework developed in the first part of the thesis. In other words, all the factors and measures are divided into seven subgroups on the basis of the stages of the innovation process and the overlapping areas they are linked with.

Tables 19–20 and 22–23 show the results of the analysis of innovation process factors. Those tables present the factors influencing the stages of the innovation process in Estonian dairy and biotech enterprises. To facilitate the comparison of factors highlighted by representatives of dairy processors and biotech enterprises, and factors named in the theoretical framework the same wording of factors is used and only factors mentioned in interviews and the questionnaires are presented. Tables 19–20 and 22–23 also include additional factors not brought out by earlier studies. These factors are underlined.

To introduce and emphasize the differences between the theory and the results of the case studies plus, minus and plus/minus signs are used. A plus sign shows that a factor mentioned by industry representatives influences the innovation process positively (+). A minus sign means that opposite to the factor presented in the table is true and therefore the factor causes problems for Estonian enterprises. A plus/minus sign means that the factor is considered important by the interviewees, but enterprises cannot pay as much attention to it as necessary.

Table 19 highlights factors influencing three stages of the innovation process in Estonian dairy processors. Dairy representatives highlight one additional and very important external factor of the innovation process. Namely, they say that the quality of the basic research conducted in Estonian universities is good and can be used as a source of ideas for new products. Therefore, this factor should be analysed more thoroughly in future research.

At the same time main source of ideas for dairy processors is still their employees who get ideas through scanning the business environment and following the latest research outcomes. Visits to the grocery store in Estonia or abroad primarily trigger innovative ideas. This may be the reason why mainly incremental innovations have been introduced in the dairy industry so far.

Factors influencing the second stage of the innovation process in dairy processors are more or less linked to prevailing market conditions. The competition for markets between dairy processors is fierce because the domestic market is rather small and the EU market is dominated by large and well-established enterprises. There are a lot of competing products, and introducing a new innovative product does not provide any monopolistic advantage to the enterprise. It just makes it possible to protect existing market share and not to loose out to competitors.

To survive and obtain competitive advantage on the market, larger Estonian dairy processors have gone along with the recent trend towards healthy and functional food. The development of products responding to that prevailing trend usually provide only temporary competitive advantage on the domestic market. To be successful with functional food products, a feasibility assessment of the ideas has to be conducted with the utmost care and on a high level taking into account all the related costs and potential revenues.

The fierce competition and increasing demand for healthy food products increases the necessity for high-quality feasibility studies. Therefore, the person conducting the feasibility study has to have competence and thorough knowledge. Feasibility evaluation in the area of functional food has to link together knowledge of production processes, research results, biotechnology and so on. The knowledge and experience for conducting this kind of evaluation is currently almost completely missing among dairy processors.

**Table 19.** Factors influencing the three stages of the innovation process among dairy processors

| | Idea generation stage | Problem solving stage | Idea application stage |
|---|---|---|---|
| External context | • The quality and development stage of basic research (+) | • Market has few competing products (-)<br>• Large market (-) | • The adaptability/ acceptance of innovation by users (+/-) |
| Internal context | • Recognition of employees as source of innovative ideas (+)<br>• Scanning of business and research environment (+) | • High-quality of technical and market-directed feasibility assessment of the ideas (-)<br>• New products related to market needs/trends (+) | • Emphasis on marketing (+/-)<br>• Proficient marketing and commitment of resources (-)<br>• Existence of necessary production volumes (-)<br>• Product testing (+/-) |

Source: composed by the author on the basis of interviews with representatives of dairy processors

Linked to the third stage of the innovation process, factors like acceptance of innovation by users, importance of marketing, limits on production volumes (additional factor), and product testing are recognized as being important in a successful innovation process by the interviewees. Two of these hamper the innovation process more than the other three.

Dairy processing enterprises do not have enough resources to spend on marketing. This is more relevant when the enterprise wants to enter foreign markets – there is a scarcity of resources to support export activities and win market share outside Estonia. Closely related to this, inadequate size of enterprises and the scale of production can become important innovation and growth barriers. The production volumes demanded by European and/or other larger markets are high, and one Estonian enterprise could not satisfy demand.

Production volumes are limited by market size. Every idea has to be evaluated against the probability of its economic success. The main aspects limiting the implementation of new ideas for Estonian dairy processors are the small size of the domestic market and difficulties linked to entering foreign markets. The volume of the production of a new innovative product may not be sufficient to cover the development costs and create a profit. The existence of insufficient production volumes as a hampering factor is also one factor not brought out by earlier studies.

Table 20 shows the factors influencing two or all of the stages of the innovation process simultaneously in Estonian dairy processors. As seen from the table there are no important factors influencing the first and the third stages of the innovation process simultaneously. The majority of factors highlighted by the interviewees are linked to all three stages. Also, almost half of the factors mentioned by the interviewees have not been analysed thoroughly enough in earlier studies. Many of those factors characterise Estonia's development stage and its enterprises.

From among formal R&D activities (factors linked to the first and second stages of the innovation process) cooperation with universities are acknowledged by dairy processors. At the same time, interviewees did mention that scientists are not ready to work with enterprises. Right now cooperation between universities and dairy enterprises primarily takes place in the Bio-Competence Centre of Healthy Dairy Products due to the competence centre programme implemented by EE. But not only has the low degree of willingness among scientists hampered cooperation activities, the scarcity of resources and therefore the ability to invest in formal R&D must also be taken into consideration. In addition to the scarcity of internal resources, the opportunities for accessing external financing for developing radical innovations is almost missing.

Factors negatively influencing the second and the third stage of the innovation process are linked to export markets and export activities. Enterprises feel that more support from the government is needed to enter foreign markets. Dairy processing enterprises consider the Russian market as a potential market for their products, but entering and selling on that market requires export guarantees from the state. Enterprises are not able to absorb the risks on their own. There are some guarantees in place, but according to the interviewees, exports towards Russia should be targeted using special measures.

Most of the factors mentioned by representatives of dairy processors were linked to all three stages of the innovation process (including many additional factors not analysed by earlier studies). This may be caused by the fact that those factors are mainly country-specific, and therefore, influence the industry in a similar way. So, when interviewees were asked to analyse the factors influencing the industry they mainly focused on those general factors. Also, discussing general factors makes it possible to avoid discussing enterprise-specific problems. Interviewees might have been influenced by the prevailing heavy competition between dairy processors, and the low willingness to cooperate, and therefore, preferred to discuss general problems rather than enterprise-specific problems.

**Table 20.** Factors simultaneously influencing two or three stages of the innovation process in dairy processors

| | Idea generation and problem solving stage | Problem solving and idea application stage | All three stages |
|---|---|---|---|
| External context | • Willingness of R&D institutions to cooperate with enterprises (+/-) | | • Established international relations (+/-)<br>• No contradiction between public and private sector (-)<br>• Country image (+/-)<br>• Structure of the industry (+/-)<br>• Stable economic environment (-)<br>• External financing of innovations (-)<br>• Public sector's innovation support measures (-) |
| Internal context | • Cooperation in R&D (+/-)<br>• High R&D intensity including R&D investments (+/-) | • Ability to absorb risks coming from export markets (-)<br>• Product's performance to cost ratio (-) | • No resistance to change and development (+/-)<br>• Risk-taking behaviour (+/-)<br>• Willingness to cooperate (-)<br>• Identification of suitable partners for cooperation (+/-)<br>• Existence and harmony btw different strategies (-)<br>• Existence of long-term innovation strategy (-)<br>• Allocation of resources (-)<br>• Manager's characteristics (+/-)<br>• (Intrinsic) motivation of employees (+/-)<br>• Competent and skilled employees (-)<br>• Existence of formal NPD process (+/-) |

Source: composed by the author on the basis of interviews with representatives of dairy processors

Concerning factors influencing the whole innovation process, representatives of dairy processors appreciated the opening up of EU markets, but they feel that international relations between Russia and Estonia severely hamper export possibilities. Also, from the side of policy design, processors want to be more included in the development process of strategies and/or policy measures. Their opinions are sought from time to time, but usually the process is not well prepared and takes place in haste. Consequently, industry representatives think their opinions are not appreciated and taken into account. So, there exists a contradiction between the public and private sector. Other problems linked to public sector innovation support measures and their implementation will be discussed more thoroughly in 2.3.2.

To be able to solve some of the problems mentioned above, cooperation between enterprises could be beneficial. Unfortunately, there is a lack of willingness to cooperate in Estonian dairy processors. Many of the interviewees recognized the potential of cooperation and its positive influence on the innovation process, but no one believed it was possible. This is probably caused by the severe competition between enterprises on the Estonian dairy market and a lack of trust.

Table 21 summarizes the results of CIS2006 concerning factors hampering the innovation process in dairy processors. Those results are rather similar to the results from the interviews. Among factors hampering the innovation process, factors linked to financial resources dominate. Information does not cause problems for enterprises. Also, factors linked to demand are not so important for enterprises.

**Table 21.** Factors hampering the innovation process in dairy processors

| **Factor hampering the innovation process** | **Share of enterprises** | | |
|---|---|---|---|
| | **Degree of importance is high and medium** | **Degree of importance is low** | **The factor is not relevant** |
| Lack of appropriate sources of finance inside enterprise or concern | 67 | 0 | 33 |
| Lack of appropriate sources of finance outside of enterprise or concern | 33 | 17 | 50 |
| Innovation costs too high | 50 | 9 | 42 |
| Lack of qualified personnel | 42 | 8 | 50 |
| Lack of information on technology | 17 | 16 | 67 |
| Lack of information on markets | 25 | 25 | 50 |
| Difficulties in finding cooperation partners for innovative activities | 8 | 42 | 50 |
| Dominance of enterprises already existing on markets | 17 | 50 | 33 |

| Factor hampering the innovation process | Share of enterprises | | |
|---|---|---|---|
| | **Degree of importance is high and medium** | **Degree of importance is low** | **The factor is not relevant** |
| Uncertain demand for innovative products and services | 42 | 8 | 50 |
| No need for innovations because of the existence of innovative products | 25 | 25 | 50 |
| No demand for innovations | 33 | 17 | 50 |

Source: composed by the author on the bases of CIS2006

Table 21 also shows that the limited list of innovation process factors does not allow those who answer to add additional and maybe more important factors. For example, the interviewees could explain which areas the scarcity of financial resources causes problems for them instead of just mentioning the lack of financial resources as a hampering factor in the innovation process. Also, during the interviewes interviewees did not mention problems with information, but in CIS2006 25% of enterprises highlighted the lack of information as a problem. This may be linked to the situation were the idea to mention a lack of information as a hampering factor was suggested to the person by the questionnaire. So, in this thesis the results of CIS2006 are not used as a dominant source of information, but only as a controlling instrument to validate the interview results.

Table 22 presents factors influencing three separate stages of the innovation process in Estonian biotech enterprises. The factors mentioned by representatives of biotech are almost similar to those mentioned by the representatives of dairy processors, but some differences can be outlined. One of the differences is linked to the evaluation of the importance of basic science and research institutions. Universities are more important to biotech companies than to dairy processors because many of them use some principle and/or research result coming from research institutions as a basis for their product. Therefore, scientific grants and money invested in basic research at universities influence the innovation process taking place in biotech enterprises more than in dairy processors.

**Table 22.** Factors influencing three stages of the innovation process in biotech enterprises

| | Idea generation stage | Problem solving stage | Idea application stage |
|---|---|---|---|
| External context | • Support for basic research by the public sector (+)<br>• The quality and development stage of basic research (+)<br>• The availability of basic principles helping assembling of invention (+) | • Market has few competing products (-)<br>• Large market (-) | |
| Internal context | • Recognition of employees as source of innovative ideas (+)<br>• Existence of internal tacit knowledge (+)<br>• Scanning of business and research environment (+)<br>• Use of lead-user ideas generation model and involvement of clients (+) | • Unique advantage of the product (+/-) | • Emphasis on marketing (+/-)<br>• Proficient marketing and commitment of resources (-)<br>• Existence of necessary production volumes (-) |

Source: composed by the author on the basis of interviews with biotechnology industry representatives

But only a few biotech enterprises have been capable of developing the ideas coming from research institutions further and turning them into successful products for the market. Thus, biotechnology enterprises should not focus only on the technology side, but also introduce the market side into the process as soon as possible. The role of universities is more important for biotechnology companies also because of the informal cooperation taking place between universities and biotech enterprises. Informal cooperation is mainly based on people working in both the private sector and research institutions at the same time.

As one can see, all the factors mentioned under external factors influencing the idea generation stage are not covered by earlier research. At the same time cooperation and the transfer of knowledge between enterprises and research institutes are important aspects of the innovativeness of enterprises. Those aspects are primarily covered by triple helix literature and not by articles analysing the innovation process in enterprises. Therefore, this shows the need to incorporate those two approaches more thoroughly.

The small size of the Estonian market is also a problem for biotechnology companies. The Estonian market is not representative for testing biotechnology products, and it is not sufficient to be the main market for Estonian biotechnology companies. It is not possible to generate enough income from the domestic market to be successful in the biotechnology area and grow. So, enterprises active in this area consider export markets as their main markets. The competition between suppliers on foreign markets is fierce, forcing Estonian enterprises to focus more on finding some unique advantages.

Factors of the third stage are linked to marketing and production volumes. As with dairy processors, Estonian biotech companies also recognize the importance of marketing, but financial resources invested are still rather modest and limited (Interviewee S).

Estonian biotech enterprises are rather small and they are not able to produce in large quantities. So, small-scale production may create problems for both dairy processors and biotech enterprises in the future if fast growth is set as a primary goal for the enterprises. If this is the case, enterprises have to consider how to overcome the small size or how to turn size into an opportunity – exploit the flexibility of the small enterprises.

Table 23 shows factors simultaneously influencing two or three stages of the innovation process in Estonian biotechnology companies. Similar to dairy processors, no one from the biotech side mentioned factors simultaneously influencing the idea generation and idea application stage. There are also other similarities between those two groups of enterprises. For example, both groups feel that the willingness of R&D institutions to cooperate with enterprises is low. Also, there is a scarcity of resources available for investments in R&D in both groups of enterprises and both consider cooperation in R&D to be important. Investments in R&D are linked to high risks, but without investments no innovations will be introduced. So, both industries need financial resources for R&D. Investments in the innovation process in biotechnology enterprises are usually several times larger and linked to higher risks than in dairy processors. This is caused by the longer pay off period and higher R&D costs in biotechnology.

Two groups of enterprises differ on the basis of the importance they give to the patenting system and the use of patenting. Patenting is more important for biotech enterprises, although the number of patents in Estonian biotech enterprises is not very high. The reason for that is mainly linked to the scarcity of human and financial resources. (Mets *et al* 2007: 19) There are not enough finances to keep patents active. The knowledge necessary to start the patenting process and the funds for obtaining the patent do not create as many problems as keeping the patent running. (Kask 2005: 47)

**Table 23.** Factors simultaneously influencing two or three stages of the innovation process in biotech enterprises.

| | Idea generation and problem solving stage | Problem solving and idea application stage | All three stages |
|---|---|---|---|
| External context | • Willingness of R&D institutions to cooperate with enterprises (+/-)<br>• Patent regulation system of the country (+) | | • Legislations and regulations introduced by government (+/-)<br>• Influence of regulations on duration of innovation process (-)<br>• Favourable tax system (-)<br>• Country image (-)<br>• Structure of the industry (-)<br>• External financing of innovations (-)<br>• ***Public and private sector's innovation support measures (-)*** |
| Internal context | • Cooperation in R&D (+/-)<br>• Existing R&D activities (+/-)<br>• High R&D intensity including R&D investments (+/-)<br>• Knowledge, ability and willingness to use patenting (-) | • Knowing (potential) markets (+/-)<br>• Ability to absorb risks coming from export markets (-) | • Size of the company (-)<br>• Age of the company (+/-)<br>• Innovation capability (-)<br>• Risk-taking behaviour (+/-)<br>• Big ambitions (-)<br>• Identification of suitable partners for cooperation (+/-)<br>• Being part of international networks (-)<br>• Previous NPD experiences (+)<br>• Allocation of resources (-)<br>• Manager's characteristics (+/-)<br>• Competent and skilled employees (-)<br>• In-depth understanding of customers and market place (-) |

Source: composed by the author on the basis of interviews with biotechnology industry representatives

Therefore, the decision to patent or not has to be considered with utmost caution. Two aspects have to be weighed against each other: the value of the intellectual property (IP) and the enforceability of the patent. If the value of the IP and the enforceability are high, the enterprise should use patenting, in other cases protection through trade secrets or publishing could be alternatives. So, the patenting strategy has to be closely connected to the enterprise's business strategy and its vision. (Mets *et al* 2007: 39–40)

On the basis of factors influencing all three stages of the innovation process, regulations play an important role in biotech. Although, regulations in Estonia are in harmony with EU regulations and do not hamper the innovation process or entering European markets, regulations are not in accordance with the US market. But the latter is considered to be the most important market for Estonian biotech companies. (Interviewee R)

Compared to dairy processing, enterprises active in biotech are more willing to cooperate. Throughout the innovation process biotechnology companies are more open to cooperation with different organizations than dairy processors. Basic and applied research and product testing are often conducted in co-operation with different research partners. For marketing and sales, several companies use the help of consultants and experts. (Kask 2005: 57)

The problem lays in the fact that Estonian biotech companies do not belong to international networks. In his master thesis, Tiit Talpsep highlighted two sets of networks important for biotech companies. One of them includes suppliers and clients for mediation activities, and the other, R&D institutions including research institutes and suppliers/buyers for products coming out of those institutions. (Talpsep 2005: 44) It may be said that Estonian biotech companies have a well established network with R&D institutions, but what is missing is a network enabling to market their products better (Talpsep 2005: 54) (i.e. network including suppliers and customers).

Not being part of international networks is also linked to the scarcity of competent employees, especially people with international experience in biotech activity (interviewee R). In biotechnology, the preparation of employees able to work in research and laboratories is good. There are three main universities educating people useful for biotechnology companies: the University of Tartu, Tallinn Technical University and Estonian University of Life Sciences. In a single year approximately 135 students graduate and enter the labour market. (Biotechnology in Estonia 2008: 4) However, biotech enterprises need employees from other areas; for example, marketing, processing and intellectual property management and so on. Also, international experience in biotechnology is lacking. This does not mean that those people must have worked in international biotechnology enterprises as researchers. Experience in all areas is necessary for Estonian biotechnology enterprises trying to enter and establish themselves on foreign markets. It would help to link Estonian enterprises to international industry networks, and facilitate the marketing and sales of local goods.

There is one innovation support measure introduced into the Estonian innovation system, which may help enterprises alleviate this problem. Support for the involvement of R&D employees covers the costs of finding the employee, and his/her employment, travelling and housing costs. An R&D employee is defined as a person with higher education and international experience working as a researcher, engineer, designer and/or marketing manager. (Homepage of Enterprise Estonia 2009) Implemented innovation support measures are discussed more thoroughly below.

In June and July 2010, an additional questionnaire was sent out to biotechnology enterprises to obtain additional information about factors hampering the innovation process. The question about innovation process factors had the same wording as the similar question in CIS2006. This helps compare the results with the results from dairy processors. The results are presented in Table 24.

As seen from Table 24, the most important factors hampering the innovation process in Estonian biotechnology enterprises are the lack of qualified personnel, the lack of information on markets, and uncertainties in demand. The lack of qualified personnel was thoroughly covered above. Factors like the lack of information on markets and uncertainties in demand may be linked to problems with regulations and with the ability to absorb risks also presented above. The lack of information on technology and lack of the need for innovations are not hampering factors for Estonian biotechnology enterprises. Enterprises do have knowledge about the technology and there is high demand for innovations both inside and outside the enterprise.

**Table 24.** Factors hampering the innovation process in biotech enterprises

| **Factor hampering the innovation process** | **Share of enterprises** | | |
|---|---|---|---|
| | **Degree of importance is high and medium** | **Degree of importance is low** | **The factor is not relevant** |
| Lack of appropriate sources of finance inside enterprise or concern | 40 | 30 | 30 |
| Lack of appropriate sources of finance outside of enterprise or concern | 30 | 30 | 40 |
| Innovation costs too high | 50 | 10 | 40 |
| Lack of qualified personnel | 60 | 20 | 20 |
| Lack of information on technology | 30 | 10 | 60 |
| Lack of information on markets | 60 | 30 | 10 |
| Difficulties in finding cooperation partners for innovative activities | 40 | 20 | 40 |
| Dominance of enterprises already existing on markets | 30 | 20 | 50 |
| Uncertain demand for innovative products and services | 60 | 20 | 20 |
| No need for innovations because of the existence of innovative products | 10 | 30 | 60 |
| No demand for innovations | 30 | 20 | 50 |

Source: composed by the author on the basis of the questionnaire

**Proposition 2.** Country-specific innovation process factors dominate over activity-specific innovation process factors in Estonian dairy processors and biotechnology enterprises.
**Proposition 5.** The majority of factors in the innovation process creating problems for Estonian dairy processors and biotechnology enterprises are linked to the third stage of the innovation process – the application of the idea.

Figure 23 and 24 summarise the results of the previous analysis graphically and are used to test the propositions mentioned above. Seven areas of the figure indicate the three stages of the innovation process and overlapping areas between them (see Figure 7). Areas are shaded based on the degree of overlap between innovation process factors. Dark grey areas show the stages of the innovation process and overlapping areas between the stages where the innovation process factors mentioned by interviewees do not cause problems. Light grey areas show areas where factors mentioned by interviewees are important to enterprises, but the enterprises cannot pay as much attention to them as they think would be necessary (marked with +/- signs in Tables 19, 20, 22 and 23); in other words, those factors are considered important, but they are not always taken into account. White areas show problematic areas for dairy processors and biotech enterprises – factors linked to those stages of the innovation process cause problems for the enterprises.

Figure 23 is compiled based on the results of the analysis of the dairy processors. As seen from the figure factors causing problems for dairy processors are linked to the problem solving stage (2nd stage), the problem solving and the idea application stage (overlap between the 2nd and the 3rd stage), and the general external and internal environment (overlap between the 1st, the 2nd and the 3rd stage). Factors causing problems for enterprises during the 2nd stage of the innovation process are linked to the size of the market and fierce competition between dairy processors. Many factors cause problems also for activities linked to the 2nd and 3rd stage simultaneously, enterprises have low ability to absorb risks, and product performance to costs ratio could be higher. But the majority of factors causing problems for dairy processing enterprises are linked to all three stages of the innovation process – to country-specific factors.

The previously mentioned factors have to be taken into account during the design of public sector measures. This does not mean that the public sector has to intervene and help enterprises with every factor, but input for further development of public sector support measures can be extracted from this.

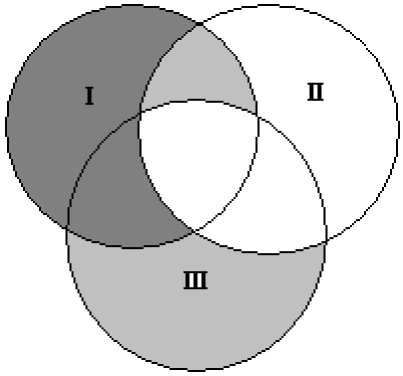



**Figure 23.** Overlap between factors of the innovation process in Estonian dairy processors and innovation process factors based on theory (composed by the author)

The discussion of innovation process factors in Estonian biotech enterprises is graphically depicted in Figure 24. According to the discussion the most problematic factors for biotech enterprises are linked to the 2nd and 3rd stages of the innovation process, and to the overlapping area between all three stages. These areas are marked with white on the figure.

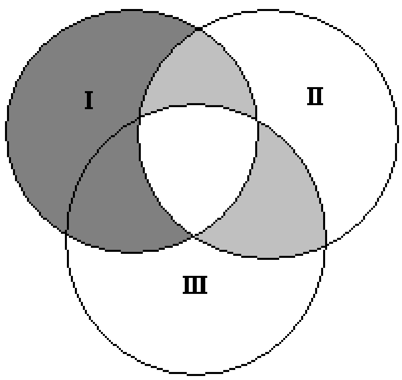



**Figure 24.** Overlap between factors of the innovation process in Estonian biotech enterprises and innovation process factors based on theory (composed by the author)

During the second stage, aspects linked to market size and fierce competition cause problems for Estonian biotechnology enterprises. The most important factors of the third stage hampering the innovation process are the lack of commitment to marketing and the lack of the necessary production volumes. Also, many factors linked to all three stages were mentioned as problematic by the interviewees. Therefore, there is a need to focus on factors of the second and the third stage of the innovation process, and factors covering all stages of the innovation process by both enterprises and the public sector to increase the innovativeness of Estonian biotechnology enterprises.

In conclusion, the innovation process in biotechnology enterprises is influenced by developments in science, the existence of an IP system, the availability of venture capital and the existence of regulations more than in dairy processors. But there are many factors which cause similar problems for both groups of enterprises and the majority of them can be characterized as country-specific factors. This is also supported by the fact that many factors mentioned by the interviewees are linked to the developmental stage of the country and its path-dependency. ***Therefore Proposition 2 (Country-specific innovation process factors dominate over activity-specific innovation process factors in Estonian dairy processors and biotechnology enterprises) can be accepted.***

In Proposition 5, the author assumes that many the factors of the innovation process that create problems for Estonian dairy processors and biotechnology enterprises are linked to the third stage of the innovation process – the application of ideas. Taking into account the results of the analysis of the factors of the innovation process, no certain conclusions about Proposition 5 can be made. Marketing was highlighted by the interviewees as being important and causing problems for the enterprises, but these factors did not dominate over the other factors. ***Therefore Proposition 5 (The majority of factors in the innovation process creating problems for Estonian dairy processors and biotechnology enterprises are linked to the third stage of the innovation process – the application of the idea) cannot be accepted.***

Innovation processes taking place inside the enterprise and company are influenced by the external environment, including the country's public sector and its measures designed to support innovation. Estonian biotechnology activity is mainly supported by three public sector organizations: the Estonian Science Foundation, the Estonian Ministry of Education and Research and the Ministry of Economic Affairs and Communications (including Enterprise Estonia). (Mets 2006b: 759) For the dairy processors, the most important public sector organizations are the Ministry of Economic Affairs and Communications (including Enterprise Estonia), the Estonian Agricultural Ministry (including the Estonian Agricultural Registers and Information Board).

In the current thesis, innovation support measures implemented by Enterprise Estonia, KredEx and EARIB are analysed because those organizations are the most important sources of public sector support for companies. An overview of measures included in the analysis is presented in Appendices 6–8. Although some Estonian companies have received finances directly from the EU through the Sixth Framework Programme (FP6) and the Seventh Framework Programme (FP 7), this will not be covered here because of the low significance of that support. Companies are not interested in applying for support from the EU through FP6 and FP7 due to the very high competition, and therefore, low probability of success. Approximately 20% of all projects obtain financing from the EU. Finance from the EU also sets severe limits on conducting R&D and commercializing research results. (Kukk, Truve 2008: 36)

Tables 25 and 26 present the results of the analysis of innovation policy measures. In those tables innovation support measures implemented by EE, KredEx and EARIB are linked to the seven groups of innovation process areas (see Figure 7) to evaluate the coverage of the innovation process factors by Estonian innovation support measures. Measures offered EE, KredEx and EARIB but not explicitly linked to innovation process factors (e.g. support measures designed to increase tourism) are not taken into account. Also measures designed to improve the general social and economic environment of enterprises (e.g. measures focused on civil society, and visiting and business environment) and first stages of the dairy production chain (support for agriculture) are not analysed. These measures influence innovation activities of analysed enterprises, but their influence is rather indirect.

Innovation support measures in Table 25 and 26 are divided into two groups according to the organization entitled to submit the applications. Direct support measures include measures open to enterprises. Indirect support measures include training, networking events and other activities financed by EE or EARIB, and organized by different intermediaries and/or non-profit organizations. In addition, measures are distinguished in the following way: measures open to SMEs are presented in italics, measures open only to dairy processing enterprises are underlined, and measures open only to biotech enterprises are underlined and in bold. The remaining measures do not present any limitations to the enterprises under analysis.

Table 25 presents an overview of measures linked to factors influencing the three separate stages of the innovation process. The first two stages and factors influencing them are covered by a rather small number of measures; the third stage and its factors are targeted by more measures.

Starting from the first stage of the innovation process – generation of ideas – it can be seen that there are no public policy measures designed directly for enterprises. This may be linked to the particular nature of the first stage. Namely, measures focusing on factors of the external context of the first stage are mainly not implemented by EE, KredEx and/or EARIB and are not open to enterprises. For example, there are monetary resources directed to supporting basic research in research institutions. Those measures are under the jurisdiction of the Estonian Ministry of Education and Research, and therefore, are outside of the scope of this thesis. Other factors of the first stage according to the theoretical framework are more or less linked to the enterprises' own capabilities to organize searches for new ideas. These capabilities may be increased through different trainings, but those measures are grouped as measures influencing all three stages of the innovation process simultaneously and are presented below. Factors influencing the first stage of the innovation process might also be considered as the responsibility of the capable manager and therefore outside the responsibility of the public sector. Therefore, there are not many public sector measures in place.

**Table 25.** Innovation support measures helping enterprises with factors of all three stages of the innovation process

| | Direct support measures[3] | Indirect support measures[4] |
|---|---|---|
| Generation of ideas (1) | | • Base financing of transfer of knowledge and technology<br>• Competence centre grant |
| Problem solving (2) | • Product development grant (preparation of product development or applied research)<br>• *Innovation vouchers*<br>• Cooperation in the development of new products, processes and technologies | • Competence centre grant<br>• Development of knowledge and skills: business mentoring program<br>• **Offset programme for export opportunities** |
| Application of ideas (3) | • Subordinated loan<br>• Investment loan guarantee<br>• Working capital loan guarantee<br>• Business loan guarantee<br>• Long-term loan resource offer in cooperation with banks<br>• Credit insurance of short term transactions<br>• Product development grant (product development)<br>• Foreign trade fair grant<br>• Export marketing grant<br>• EXPO 2010<br>• *Start-up loan*<br>• *Start-up and development grant*<br>• *Innovation vouchers*<br>• *Adding value to agricultural and non-wood forestry products (investment support)*<br>• Technology investment programme for industrial enterprises<br>• Cooperation in the development of new products, processes and technologies<br>• ***Diversification of the rural economy(investment support)*** | • Competence centre grant<br>• Infrastructure investment programme for test and half-industrial laboratories<br>• Cluster development<br>• Development of knowledge and skills: trainings in topics related to export<br>• Joint marketing grant<br>• Market development support<br>• Setting up and development of producer groups |

Source: composed by the author on the bases of Tooted 2010, Ettevõtlus 2010, Toetused. 2010, Ülevaade EAS-i … 2010

[3] Support given directly to enterprises
[4] Trainings, networking events etc organised by intermediaries

There are some measures designed to help enterprises with the first stage of the innovation process – base financing of the transfer of knowledge and technology and the competence centre programme. These two measures are implemented by Enterprise Estonia and they are designed either for associations between enterprises and research institutions or solely for research institutions. Through the competence centre programme, 904 million EEK is given to competence centres (see Appendix 8). The base financing programme supports the transfer of knowledge with 120 million EEK. Both of those programmes will run throughout the period 2007–2013.

For the second stage and factors linked to that stage, the most important measure is the measure of innovation vouchers. Activities covered by this measure are linked to almost all of the factors of the internal context, but this support measure is available only for SMEs and the maximum amount is limited to 50 000 EEK per enterprise. EE defines SMEs based on the number of employees (< 250), annual turnover (≤ 50 million Euros) and balance sheet (≤ 43 million Euros) (The new SME… 2009: 14). Also, links and connections to other enterprises are taken into account. Qualifying as an SME does not create problems for biotech enterprises, but it is restrictive for many dairy processors.

Concerning the third stage of the innovation process and its factors, it appears that factors of the third stage are covered almost fully by different innovation support measures. The factors not covered by public sector innovation support measures are mainly linked to the management role and commitment, and pricing of the product. The public sector can help enterprises with these factors through indirect measures – management training and awareness raising activities. These measures are presented under the group of measures influencing all stages of the innovation process. But these are also factors enterprises themselves should focus on and improve their capabilities and competencies.

Table 26 presents an overview of the policy measures focusing on factors influencing two or three stages of the innovation process at the same time. There are no measures helping enterprises with the factors simultaneously influencing the first and the third stages of the innovation process. At the same time, factors belonging to that subgroup based on the theory can be influenced by skilled managers themselves more than public sector innovation support measures.

**Table 26.** Innovation support measures helping enterprises with factors simultaneously influencing two and three innovation process stages

| | Direct support measures[5] | Indirect support measures[6] |
|---|---|---|
| 1st and 2nd stage | • Product development grant (preparation of product development or applied research , applied research)<br>• Export marketing grant<br>• *Start-up and development grant*<br>• *Innovation vouchers*<br>• <u>Cooperation in the development of new products, processes and technologies</u><br>• <u>***Diversification of the rural economy (investment support)***</u> | • Base financing of transfer of knowledge and technology<br>• Competence centre grant<br>• Development of creative industry (3 programs) |
| 2nd and 3rd stage | • Subordinated loan<br>• Investment loan guarantee<br>• Business loan guarantee<br>• Long-term loan resource offer in cooperation with banks<br>• Short- and long-term credit risk guarantee<br>• Pre-shipment risk guarantee<br>• Product development grant (preparation of product development or applied research, product development)<br>• Information about export provided by EE<br>• Export marketing grant<br>• *Start-up loan*<br>• *Start-up and development grant*<br>• *Innovation vouchers*<br>• <u>*Adding value to agricultural and non-wood forestry products (investment support)*</u><br>• <u>Export licences and support</u><br>• <u>Technology investment programme for industrial enterprises</u><br>• <u>Cooperation in the development of new products, processes and technologies</u><br>• <u>***Diversification of the rural economy(investment support)***</u> | • Programme of entrepreneurship and innovation awareness: export awareness<br>• Infrastructure investment programme for test and half-industrial laboratories<br>• Cluster development<br>• Infrastructure investment programme for test- and half industrial laboratories<br>• Development of knowledge and skills: trainings in topics related to export<br>• Information about export provided by EE<br>• Joint marketing grant<br>• <u>Setting up and development of producer groups</u><br>• <u>Market development support</u> |

[5] Support given directly to enterprises
[6] Training, networking events etc organised by intermediaries

| | Direct support measures | Indirect support measures |
|---|---|---|
| All the stages | • Subordinated loan<br>• Investment loan guarantee<br>• Working capital loan guarantee<br>• Long-term loan resource offer in cooperation with banks<br>• Investment guarantee<br>• Support for development of knowledge and skills<br>• Support for involvement of R&D employees<br>• Foreign trade fair grant<br>• Export marketing grant<br>• EXPO 2010<br>• *Start-up loan*<br>• *Training vouchers*<br>• *Innovation share* | • Programme of entrepreneurship and innovation awareness: innovation, management, export and entrepreneurship awareness<br>• Programme of entrepreneurship and innovation awareness: aktiva.ee<br>• Centrally organised trainings by EE<br>• Competence centre grant<br>• Cluster development<br>• Joint marketing grant<br>• Programme of internationalization<br>• Programme of international cooperation<br>• Joint stands on foreign fairs<br>• EXPO 2010<br>• *Development of knowledge and skills: base training for start-ups*<br>• *Business incubator program*<br>• Training and information activities<br>• Setting up and development of producer groups<br>• Market development support<br>• Development of knowledge and skills: business mentoring program, **training in area of space technology**<br>• **Programme of energy technology** |

Source: composed by the author on the bases of Tooted 2010, Ettevõtlus 2010, Toetused 2010, Ülevaade EAS-i … 2010

The list of measures linked to the factors influencing all stages of the innovation process is rather long, but the measures are mainly focused on increasing the country image, creating networks and/or training activities. The remaining factors of that group are more or less neglected. At the same time, factors simultaneously influencing stages 1 and 2, and 2 and 3 of the innovation process are more or less covered by policy measures.

**Proposition 6.** In Estonia innovation support measures are primarily focused on the first stages of the innovation process.

Figure 25 summarizes the results of analysis of innovation policy measures – coverage of the factors of the innovation process according to the theory by innovation support measures implemented in Estonia. The only area not covered by innovation support measures is linked to factors of the first and third stages of the innovation process. All other factors of the innovation process are more or less targeted by Estonian innovation support measures. Coverage of the factors of the third stage and the measures focused on these may be considered the highest (dark grey area on the figure).

From the tables presented above, the reader can see that only a limited number of innovation support measures are devoted to help enterprises with the first stages of the innovation process. The first, second, and the first and second stages are primarily covered by two indirect support measures such as the competence centre programme and base financing for the transfer of knowledge and technology, and two direct measures – product development grants and innovation vouchers. The number of measures covering the rest of the stages of the innovation process is higher compared to the number of measures covering the first stages, but in monetary terms the latter amount to approximately 20% of all financial resources at the disposal of Enterprise Estonia for the period 2007–2013 (Homepage of Enterprise Estonia 2009).

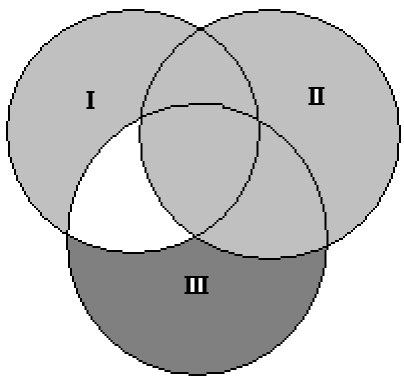



**Figure 25.** Coverage of factors of the innovation process by Estonian innovation policy measures (composed by the author)

Although 20% of the financial resources are channelled to measures helping enterprises with the first stages of the innovation process, it cannot be said that the provision of knowledge inputs is considered to be the primary function of the Estonian innovation system, and that Estonian policy makers support the technology push model of the innovation process. It might have been the case at the beginning of this century, but during the current planning period more focus has been paid on the whole innovation process and its stages, and available financial resources from the EU have helped in realising those trends. So, on the basis of the previously presented analysis ***Proposition 6 (In Estonia innovation support measures are primarily focused on the first stages of the innovation process) cannot be fully accepted.***

From Tables 25 and 26 it can be seen that formally there are almost no sector specific measures in Estonia – the Estonian government supports the horizontal approach in designing innovation support measures. This is also encouraged by the OECD. Horizontal innovation policy has to cover many policy domains beyond ST&I policy and must also be cross-sector. (Governance of innovation… 2005: 22) In Estonia, innovation policy is quite horizontal based on the sectors it covers, but not based on the policy domains involved in the process of the development and implementation of innovation policy.

To some extent sectors are still taken into account in innovation support measures. Sector specificity is introduced to the Estonian innovation system from EARIB and CAP and from EE's offset and technology investment programmes. Two additional sector specific measures (training in the area of space technology and the energy technology programme) are not explicitly linked to either dairy or biotech enterprises, but indirectly these measures are more favourable towards the latter. In addition, the Estonian support system is also implicitly more condescending towards high-technology activities due to the characteristics of innovation support measures. R&D measures have a larger budget than other measures and the extent of R&D activities in high-tech enterprises is higher than in other enterprises. Therefore, high-tech activity benefits from R&D focused measures more than enterprises from traditional sectors. Also, some sector specificity is introduced to the system through biased information distribution. Specific focus groups are chosen by public sector organizations in terms of what information is shared more intensively.

This is not uncommon in Europe. Many CEE countries have focused their activities on high-technologies. By doing this the number of beneficiaries is rather limited because the majority of firms in CEEC are not active in high-technology areas. (Radosevic 2002b: 355, Kalvet 2006: 9) Therefore, it would be more efficient to support the use of high-technology solutions regardless of the sector implementing it. High-technologies are considered to be enabling technologies, so they have to be integrated into the country's economy including the traditional sectors. This may also increase the number of the sources of ideas in traditional sectors.

In conclusion, the factors influencing the innovation process in dairy and biotech enterprises in Estonia are not very different. Both groups of enterprises consider research institutions as being important for the innovation process, perceive that the domestic market is too small, recognize the importance of marketing and struggle with the scarcity of finances available for investments in R&D processes. The main difference between those two groups lies in their attitude towards the patenting system. The latter is more important for biotechnology enterprises. Regarding innovation support measures, factors linked to the first two stages of the innovation process and the overlapping area between those two stages are not very well covered by the public sector. At the same time, almost all the stages of the innovation process are targeted by at least one innovation support measure (except the overlapping area between the first and the third stage of the innovation process).

### 2.3.2. Alignment between innovation process factors and innovation policy measures, and the synthesis of the research results

This chapter will test the alignment between factors influencing the innovation process in two groups of enterprises in Estonia and the Estonian public sector innovation support measures. Two propositions are analysed as well. The propositions focus on the differences between dairy and biotech enterprises.

Previous results reveal a possible mismatch between factors causing problems for enterprises and innovation support measures. If the problem causing factors are not covered by existing innovation support measures there might exist a need for addition innovation support measures. A mismatch may also exist where innovation support measures are in place, but they include limitations that hamper enterprises from benefiting from that measure.

Two figures (Figure 26 and Figure 27) are developed and presented – one for dairy processors and the other for biotechnology enterprises – mapping the alignment between factors mentioned by interviewees and existing innovation support measures. These figures are composed based on the tables presented in 2.3.1. and tables presented in Appendices 9 and 10. The figures presented below are rather general and cannot show the differences in detail. That is why Appendices 9 and 10 were composed. The tables are presented in the appendices and not in the text of the thesis because they are very capacious.

The light grey areas in the figures show that there are measures focused on particular factors of the innovation process, but those measures do not cover all of the factors causing problems for Estonian enterprises, and/or the conditions of the measures introduce serious limitations to the application and support process. Of course not all the factors can nor should be influenced by public sector measures. Some hampering factors can and should be removed from the innovation process by the enterprises itself. The dark grey areas show where either there are no factors that influence the stage(s) of the innovation process negatively brought out by the interviewees, the factors influence the process positively or the factors named are covered by public sector measures.

Figure 26 presents the alignment between factors influencing the innovation process in dairy processors and innovation support measures designed to help enterprises with factors of the innovation process (more detailed info about factors of the innovation process and innovation support measures is presented in Appendix 9). Figure 26 shows that based on dairy processors the alignment between factors and innovation support measures is good. The total alignment between factors and innovation support measures for the first stage comes from the fact that representatives of dairy processors did not mention any factors influencing this stage negatively. All the factors mentioned by them were positively linked to the first stage of the innovation process. One of the named factors, the quality and developmental stage of basic research, can be and is influenced by different policy measures. This could show the effectiveness of those measures and may be the reason why this factor was mentioned as a supportive factor in the innovation process. The total alignment on the basis of the area linking the 1st and the 3rd stage can be explained by the fact that there were no factors mentioned by the industry representatives.

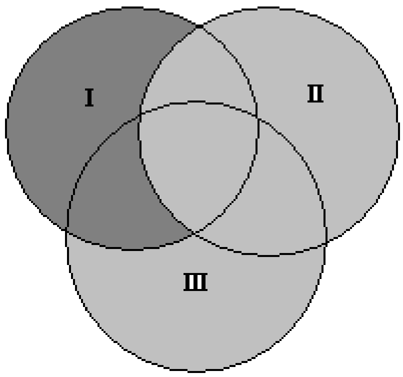



**Figure 26.** Alignment between factors influencing the innovation process in dairy processing and innovation process measures (composed by the author)

In other subgroups, the alignment between innovation process factors and innovation support measures can be improved. Considering the group of factors influencing the second stage of the innovation process, it appears that those factors are either not directly influenced by innovation support measures or should not be influenced by the public sector at all. For example, markets with a high number of competing products can cause problems for enterprises, but not for consumers. Strong competition creates the need to innovate continuously to be able to stay on the market, but there might not be enough resources to finance the innovation process because profit margins are very low.

The problem of the small size of the domestic market, which can hamper the innovation process, can be resolved by attempting to increase the size of the market through increasing purchasing power or extending the internationalisation of enterprises. There is a whole range of internationalisation measures designed and implemented to help enterprises with export activities. Measures focused on exports are discussed more thoroughly below.

Besides innovation process factors, public policy measures can also cause problems for enterprises. For example, innovation vouchers are only given to SMEs and the maximum amount of the support is 50 000 EEK. This support does not allow enterprises to acquire enough professional advice to help them with potential problems of the innovation process. The amount of the support could be greater.

Almost all factors causing problems for dairy processing enterprises in the third, first and second, and second and third stages of the innovation process are covered by innovation support measures. Problems arise from the conditions and characteristics of the measures. For example, the factor "adaptability/acceptance of the innovation by users" is covered by two innovation support measures – a joint marketing grant (up to 1 000 000 EEK per application) and cluster development (preliminary applications up to 400 000 EEK). Both of these measures are not direct support measures. Their influence on the enterprise's production is indirect. The joint marketing grant focuses on increasing export sales and is open to associations of companies or professional associations, business incubators, research and technology parks, county development centres and competence centres. Through the cluster development initiative joint marketing activities are supported, but this means that the enterprise has to belong to the cluster and even then the cluster must focus on a product complex involving all the partners of the cluster and not just the products of one company. (Ülevaade EAS-i … 2010) Also, the conditions of measures linked to high rates of self-finance, the indirect influence of the measure and/or a focus on SMEs (additional information about innovation support measures can be found in Appendices 6–8) may create problems and decrease interest from the enterprise's side.

The majority of factors influencing the innovation process in Estonian dairy processors belong to the seventh subgroup – factors influencing all the innovation process stages simultaneously. There is no possibility to influence many of the factors presented in the theoretical framework and mentioned by the interviewees through innovation support measures. Some of the factors are, for example, favourable international relations between Estonia and Russia and stable economic environment. Aspects linked to those factors require analysis of public sector activities at a more general level than in the narrow sense of innovation support measures. Several other factors mentioned by industry representatives like resistance to change, lack of risk-taking behaviour, low willingness to cooperate, lack of long-term innovation strategy, no harmony between different strategies, motivation of employees and so on, depend on the internal context and capabilities of the enterprise itself. Some of the innovation support measures; for example, the programme focused on entrepreneurship and innovation awareness, do help enterprises indirectly with those issues, but enterprises themselves can and should tackle those problems.

But there are factors influencing all of the innovation process stages covered by different innovation support measures. For example, three measures including introductory activities at foreign fairs focus on increasing the country's image. Also, several direct and indirect measures deal with the possibilities to increase the competencies and skills of employees. One of the measures is a measure designed to help enterprises hire R&D employees from abroad for a period up to three years. R&D employees under that programme include researchers, engineers, designers and international marketing managers. (Homepage of Enterprise Estonia 2009) In addition to the previously described programme, several support measures are designed to help enterprises with training and increasing the competencies of their employees. Problems with the existing contradiction between the public and private sector and issues with public sector innovation measures in general, are discussed more thoroughly below.

Figure 27 presents the alignment between factors influencing the innovation process in biotechnology enterprises and innovation support measures. Figure 27 is similar to the situation prevailing in dairy processors. More detailed analysis brings out some differences between those two groups of enterprises (see also Appendix 10).

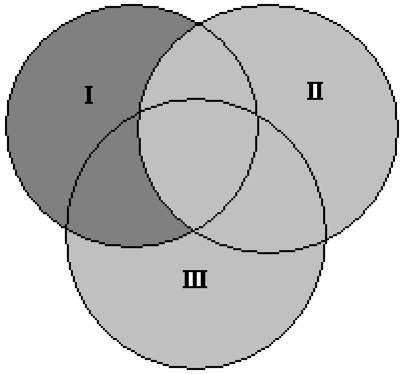



**Figure 27.** Alignment between the factors influencing the innovation process in biotech enterprises and innovation process measures (composed by the author)

Representatives of biotech activity did not mention any factors negatively influencing the first stage of the innovation process. Therefore, it may be concluded that measures are present and working and/or there is no need for innovation support measures because enterprises can cope with these factors on their own, and total alignment exists. Data from interviews supports the first explanation – there are already policy measures in place and they do have an effect on factors influencing the first stage of the innovation process. Total alignment between factors simultaneously influencing the first and the third stage of the innovation process is caused by the fact that no factors were mentioned by the interviewees or in the questionnaires, and no measures exist for this subgroup.

Concerning the subgroup of factors influencing the second stage of the innovation process, representatives of biotech activity mentioned strong competition on international markets, the small domestic market and the low level of uniqueness of products as being the main problems of the innovation process. The main markets for biotech products are Europe and the US, and the competition on those markets is fierce. The domestic market is almost insignificant for biotech enterprises. Therefore, internationalisation is important, but small enterprises often do not have enough resources to establish themselves on international markets.

In Estonia, the government has strongly supported research in academia. Also, biotech enterprises have received support, but the innovation process in biotech enterprises requires more resources and takes more time compared to the innovation processes in traditional sectors. To gain additional resources, enterprises have provided diagnostic services to the domestic market (health care, hospitals, doctors etc), and this has decreased their ability to enter foreign markets. To be competitive on foreign markets, biotech enterprises need FDI and/or to be incorporated into large international networks. Also, the uniqueness of their products is important. Right now those aspects create problems for biotech enterprises.

There are two public policy measures – innovation vouchers and product development grants – that help enterprises develop and introduce innovations with unique advantage. But the innovation voucher programme only provides support up to 50 000 EEK per enterprise, and this is not enough for biotechnology enterprises. Also, enterprises with no previous experience of cooperating with research institutions are preferred. The problem with the product development grant this that the measure arises from the high share of the enterprise's own financing in product development activities. (Ülevaade EAS-i … 2010)

From among factors influencing the third stage of the innovation process, the most problematic factor needing intervention from the public sector may be the lack of necessary production volumes and technology in biotech enterprises. Estonian biotech enterprises are only able to produce in small quantities, but if they receive larger orders, the limited production capabilities will become an obstacle (Talvik 2008). In general, the CEOs of biotech companies are satisfied with the equipment they have, but equipment that is more expensive and would allow quicker production, in larger quantities and at a lower cost is missing. (Kask 2005: 51) EE, EARIB and KredEx do provide some measures to help enterprises with these problems. The most appropriate of them is the start-up and development grant, but it is open only to SMEs not older than 3 years. Also, the maximum amount of the grant is 500 000 EEK, which is not sufficient for purchasing equipment for a biotechnology firm. Therefore, again the criteria of the grant do not favour biotech enterprises.

Considering the factors influencing the first and the second stage, and the second and the third stage of the innovation process simultaneously, the most problematic issue is linked to patent management. The protection of IP might be necessary, but it also may be very expensive for enterprises. Enterprises need specific knowledge about the patenting process and finances. (Mets *et al* 2007: 39) There are measures linked to patenting (e.g. financial support for the initial patent search), but none of the measures help enterprises to maintain patents after the patent has been acquired. This causes problems according to the enterprises. At the same time, patenting has to be thought through and the decision to patent has to be made only when the patent can sustain itself. Therefore, support for patent maintenance may create the wrong signals and result in a wave of patenting solutions with no economic value. (Roolaht 2009)

Linked to this subgroup of factors, the role of universities in the innovation process should also be emphasized more. Universities have different roles in supporting the innovativeness of enterprises. Lately, the technology transfer aspect between universities and enterprises has been one focus through the introduction of cooperation activities and support measures (e.g. base financing of the transfer of knowledge and technologies). In several cases however, policy measures created to support cooperation are not very successful. Enterprises and research institutions are just not ready to cooperate, or they see events focused on encouraging cooperation as being a waste of time rather than a useful place for networking.

Besides the technology transfer aspect, there are also other roles for universities in the national innovation system. One of those roles is the supply of a qualified workforce. Universities could also make the region more attractive by pulling in highly educated people, enterprises and financiers looking for opportunities presented by the university research potential. (Lester 2005: 7–8) These roles are closely linked to factors influencing all stages of the innovation process simultaneously.

As in dairy processors, factors in biotech enterprises influencing all three stages of the innovation process form the largest subgroup. For biotech enterprises, issues linked to regulations and legislation are more important than for dairy processors. These issues are more important when entering the US market. In Europe, legislation and regulations are rather similar across countries. The formation of regulations in this area falls under the jurisdiction of the EU, and therefore, is not covered in this thesis.

One additional problem, similar to regulation, is linked to the unfavourable tax system. Currently, there are no tax-incentives to promote innovations in Estonia, but the Ministry of Economic Affairs and Communication is investigating the possibility of using tax-incentives to boost R&D activities in enterprises (Tammiste 2008). Tax-incentives can be offered in different forms. One possibility is to decrease taxes on activities linked directly to R&D activities, like purchases of research equipment, social taxes for R&D employees and so on.

The size and age of companies may also become hampering factors in the innovation process for biotech enterprises. Enterprises are mostly small and rather young, which can cause several problems. Existing problems linked to low production capacity, missing international connections and industrial experiences, difficulties in identifying suitable partners for cooperation and some additional factors might be explained through the small size and young age of biotech enterprises. But the size and the age are not the only factors contributing to difficulties in the innovation process. In any case, there are not many possibilities for the public sector to help enterprises with those issues. Some support can be provided through awareness raising programmes in the area of entrepreneurship and innovation, but the effectiveness of those measures depends on the characteristics and openness of the enterprises' managers (i.e. whether enterprises are active themselves in using those measures).

**Proposition 7a.** The alignment between innovation process factors and innovation policy measures is sector specific.
**Proposition 7b.** The misalignment is greater in the dairy sector than in biotech activities.

Although the general picture of the alignment is the same when comparing the two groups of enterprises, the public sector measures do suit biotech enterprises more. One of the reasons lies in the conditions applied to the measures, but also in the characteristics of the measures. Almost all biotech enterprises are SMEs, and therefore, there are almost no restrictions for them to apply for public sector measures. That also means that self financing conditions does not cause as many problems for biotech enterprises as for dairy processors because those conditions are more lenient for SMEs. In addition, biotech enterprises have been supported more because they have been more successful in the application process. This is probably linked to the higher ability of biotech enterprises to write suitable applications especially for programs focused on R&D projects.

> *There are no sector specific measures in Enterprise Estonia, but you can say that the positive effect of the measures have been more significant in supporting biotechnology enterprises. Because of the importance of biotechnology as one of the key technologies, a lot of information is directed towards biotechnology enterprises and there is open communication between those enterprises and EE. This is the reason why the influence of public sector measures on biotechnology is larger that on other sectors.*
>
> **Interviewee R**

In addition to differences, there are also similarities between the two groups of enterprises. The similarities are primarily linked to the scarcity of financial resources distributed by the different programmes, and the criteria of those programmes. For example, for dairy processors to enter the EU market requires a lot of financial resources because there are many well-established and well-known producers already on the market (i.e. dairy processing is a mature industry). To compete with those producers and become visible on the market, large investments are needed. There is one programme open to enterprises to help them with these kinds of problems – the export marketing grant. This covers 50% of suitable costs and the maximum support amount is 2.5 million EEK. In 2009, one of the dairy processors, Maag Piimatööstus received 1.3 million EEK from this programme to finance its export marketing. (Ülevaade EAS-i … 2010) Although this support may appear significant, it is equal to less than 100 000 Euros. This is a very small marketing budget for large European dairy industries. So several implemented measures could be more suitable for enterprises and aligned to their needs if the amount of the grant would be higher and/or self-financing rate lower.

Up until now enterprises in dairy processing and biotech have tried to solve the problems financing innovation activities through their own finances, having some kind of cash cows, but this does not support fast growth. As one representative of dairy processors said:

*We are trying to cope based on our own resources, but I feel, a lot of things that should be done are not done today. /…/ And I fear that tomorrow this will influence Estonian competitiveness and backfire on the dairy industry.*

**Interviewee A**

Fortunately this programming period provides some more opportunities for enterprises compared to the previous programming period. Also, the amounts directed towards enterprises have increased, although the rate of own financing is still rather high.

There are some additional problems linked to the criteria of the programmes besides the amount of the grant and conditions set for the enterprises. For example, several representatives of dairy processors mentioned the need to broaden the list of eligible costs under the competence centre grant. Right now this grant does not include the costs of launching products developed within the competence centre programme. The criteria create problems also for biotech enterprises. For them the main problem is linked to their innovation process, where the revenues from the innovation usually appear after a long time – in biotech the pay off period is longer and this should be taken into account by the intermediaries. Also, measures designed to help enterprises with marketing should take into consideration that many biotech enterprises are born global enterprises, and therefore, need specific knowledge, capabilities and support from the public sector.

***On the basis of the previous analysis Proposition 7a (The alignment between innovation process factors and innovation policy measures is sector specific) can be accepted.*** Although at the general level (on the basis of Figures 26 and 27), proposition should be rejected, the differences come out in the detailed analysis of the alignment issues. ***At the same time Proposition 7b (The misalignment is greater in the dairy sector than in biotech activities) cannot be accepted.*** There are differences in misalignment issues between dairy and biotech, but the misalignment is not bigger in dairy processors than in biotech activity.

Table 27 provides an overview of the results of testing the propositions. Half of the propositions are supported by the results of the analysis and therefore can be accepted. But there are propositions, which are not supported and cannot be accepted. It cannot be said that Estonian innovation support measures are biased in favour of the first part of the innovation process and the primary function of IS is the provision of knowledge inputs. All the stages of the innovation process are more or less covered by the innovation support measures. It also cannot be said that misalignment is more important in dairy processing than in biotech enterprises. Although biotech enterprises are supported more by Enterprise Estonia than dairy enterprises, misalignment exists in both groups and the extent of misalignment cannot be compared across the two groups of enterprises.

**Table 27.** Results of proposition testing

| Short description of the proposition | No. of prop. | Result |
|---|---|---|
| Suitability of innovation support model | P1 | Supported |
| Dominance of country-specific innovation process factors | P2 | Supported |
| Knowledge input provision as primary function of IS | P3 | Not supported |
| Influence of EU innovation support measures on Estonian innovation support measures | P4 | Supported |
| Prevailing problems with factors linked to the third stage of innovation process | P5 | Not supported |
| Focus of support measures on the first stages of innovation process | P6 | Partly supported |
| Sector-specific alignment | P7a | Supported |
| Larger misalignment in dairy processing industry | P7b | Not supported |

Source: composed by the author

While addressing the problems existing in the alignment between factors influencing the innovation process and innovation policy measures, policy makers should also take into account some additional bottlenecks existing in implementing innovation support measures in Estonia. Table 28 presents a summary of problems existing in the implementation of public sector innovation support measures. The problems are divided into three separate groups presenting the opinions of the interviewees; that is, the opinions of representatives of the public sector, dairy processors and biotech activity in Estonia. The order of the problems is based on the answers of the interviewees. A higher ranking has been given to problems mentioned more often by the interviewees; for example, the lack of consistency and the focus on policy making was the most frequently, and technical evaluation and administration of innovation support applications was the least frequently mentioned problems by the representatives of dairy processors. The discussion of these problems will follow the same order as the responses from public sector representatives.

The problems mentioned by the three groups of interviewees are rather similar, but they differ in terms of importance and specific content. The main bottleneck in the implementation of innovation policy and innovation support measures is the *lack of coordination and communication between actors of the innovation system*. Biotech and dairy groups identified these respectively as the second and third bottlenecks. The actors of the innovation system already exist, but the division and coordination of tasks should be better organized. For dairy processors, the main problem lies in the division of tasks between EARIB and EE. They belong under different ministries and there has often been confusion about where dairy processors should get their support or how the division of tasks is organised between those organisations.

**Table 28.** Areas of improvement in the implementation of public sector innovation support measures

| Public sector representatives | Dairy industry representatives | Biotechnology activity representatives |
|---|---|---|
| • Lack of coordination and communication between actors in the IS<br>• Restrictions coming from state aid regulations<br>• Technical evaluation and administration of innovation support applications<br>• Low level of experiences and competencies of people working in public sector<br>• Lack of consistency and focus in policy making | • Restrictions coming from state aid regulations<br>• Lack of consistency and focus in policy making<br>• Lack of coordination and communication between actors in the IS<br>• Low level of experience and competencies of people working in public sector<br>• Technical evaluation and administration of innovation support applications | • Lack of consistency and focus in policy making<br>• Lack of coordination and communication between actors in the IS<br>• Low level of experience and competencies of people working in public sector<br>• Technical evaluation and administration of innovation support applications |

Source: composed by the author on the bases of interviews

Dairy and biotech representatives also mentioned additional problems linked to coordination and communication. Problems like involving industry representatives, and opposition between the Ministry of Economic Affairs and Communication and the Estonian Ministry of Education and Research needs to be addressed. Industry representatives are involved in different strategy development commissions, especially representatives of biotechnology activity, but the outcomes are considered to be almost non-existent by the enterprises. Therefore, all actors in the innovation system should evaluate their efficiency on the basis of the objectives and tasks given to them, and look at innovation as a process covering science, R&D, application and marketing. The Estonian innovation system requires a more systematic approach and clear communication to solve existing problems. It is important not to create new organizations, but make the existing ones work more effectively and link all of them into one consistent system moving towards one overall objective.

The second problem is linked to *existing regulations to do with state aid*. This bottleneck was also mentioned several times by representatives of dairy processors. For dairy processors, following the restrictions from state aid regulations to the letter has created a situation of unfair competition. The ministries of agriculture in new member states could file for special conditions, and this was done in Latvia and Lithuania. Therefore, large enterprises in those countries are supported under the Common Agricultural Policy (e.g. investment support). This was not done in Estonia. Therefore, the Estonian dairy industry is in a worse situation compared to its main competitors on the European and Russian market. It was also mentioned that support given to dairy industry enterprises by EE is too small and requires a lot of financing from within the enterprises themselves. EE has to follow state aid regulations stating that the closer to the market the new product is, the greater the share of financing from the enterprise. The high share of self financing has stopped many companies in the dairy industry from apply for support measures at all.

Therefore, regulations are very strict and make the application and support process difficult for many enterprises. It has also resulted in the *technical evaluation of applications* and strict control during the support period, which causes problems for both dairy and biotech enterprises. The regulations have been followed very strictly by Estonian public sector organizations, but it is important to find out the boundaries of regulations through, for example, filing for special conditions. Experience of how to play within the framework established by the regulations needs to be gained. This is closely linked to problems *with the low level of competencies and the lack of experience* among public servants.

While implementing innovation support measures more emphasis should be put on the context of the application submitted by enterprises not only on existing regulations and requirements. Employees in the public sector should be more like consultants than auditors (Interviewee O). To address this problem, a move towards a client-based approach instead of a program-based approach is being taken in Enterprise Estonia. In the client-based approach the problems of the enterprise are analysed and the best measures for those problems are selected from the existing list of support measures. (Interviewee L) This however, requires high-level competencies from the public servant. Therefore, thorough training is needed. The lack of experience and low level of competencies do not exist only at Enterprise Estonia. It is an overall problem in the public sector. Personnel turnover is high in the public sector. More experienced people leave and the vacant positions are often filled with young people who have just graduated from university.

The next important bottleneck is the *lack of consistency and focus in policy making*. This is also closely linked to the lack of coordination and communication between the actors in the innovation system. Policies and support measures are changing too fast according to the representatives of biotech enterprises and dairy processors. There is a need for long-term decision- making and consistency in the support activities. This requires a good overview of the economic structure, following the objectives set in different policy agendas and consistency between strategies and everyday activities from the policy makers' side. For biotech activities, the situation is somewhat better because of the development of the biotechnology national research and development programme. But there is no strategy document for the dairy industry.

Currently, some stability in policy measures is introduced through the use of European Structural Funds, but from 2014 or 2015 financing innovation support measures will change. Estonia might have to find resources to support innovation and economic activities from the state budget, which makes long-term decision-making more difficult. (Interviewee O)

The results of the thesis show that problems and barriers existing in the Estonian innovation system are linked to existing system failures and can be interpreted within the framework of the system failure approach. Several types of system failures exist in the Estonian National Innovation System. Based on Figure 13 and the discussion presented in 1.2.2., the following system failures exist in Estonia: failure of institutional infrastructure, transition failure, market failure, weak network failure and policy failure. The failure of the institutional infrastructure is mainly caused by the lack of the use of regulations and standards by policy makers. The use of regulations and standards helps introduce demand side policy measures to the package of innovation support measures. Also, problems existing in economic relations between Estonia and Russia may be considered an example of a failure of the institutional infrastructure.

Transition failure existing in Estonia is mainly caused by the low level of the capabilities of firms, namely innovation capability linked to the weak knowledge base and skills. But in addition some other problems also mentioned by the interviewees can be linked to aspects of transition failure.

Finally, the group of failures existing in the Estonian innovation system are sub-types of governance failure – market failure, weak network failure and policy failure. In Estonia, market failure appears through a scarcity of financial and human resources – weak venture capital market, lack of people with necessary experience and skills etc. Weak network failure is caused by the lack of interactions between different actors and organizations in the innovation system. Coordination and information exchange between actors in the innovation system should be more efficient and intensive in Estonia to decrease the doubling of activities and increase the efficiency of information exchange and the innovation support system. One way to increase the efficiency is to revisit the mandate of EE. Right now EE is just a sub-unit of the MEAC created to implement and manage different programs and innovation policy measures, and therefore, EE participates in the design of innovation policy measures indirectly. Measures are elaborated in and funds provided by MEAC, but this organisation does not interact with enterprises on an everyday basis. Therefore, how to increase the responsibilities and opportunities for EE to react faster to changes in the needs of enterprises should be discussed due to the fact that EE has first-hand information about that. Such an increase in responsibilities and opportunities has to be accompanied by a qualitative increase in the analytic and strategic competencies of EE employees.

The last types of governance failure existing and causing problems in Estonia are policy failure and weak network failure. These are mainly linked to problems in public sector intervention including the low level of policy-making capability. To increase the capability of policy making it is necessary to involve all the relevant organisations in the policy making process. It is also important that during that process, information exchange has to be free of any barriers. Relevant organisations include all the essential ministries and associations of enterprises for the development of the specific programme/policy measures and information exchange has to take place between all partners. Currently, associations of enterprises are often not even invited to participate in discussions, and the cooperation between ministries is not efficient. It might be said that only biotechnology enterprises are well represented during different policy discussions because they have a strong association and their managers are very active. Therefore, it is important to analyse how the public sector could support associations of enterprises to increase their capabilities and opportunities for being involved in policy discussion; in other words, the public sector has to build strong partners for itself.

The previously described research results lead to the following suggestions and proposals. The suggestions are grouped into five sets: suggestions relevant for using an operationalized method of alignment analysis, for dairy processors and biotech enterprises, relevant for those two groups of enterprises separately, and relevant for public sector organizations.

Suggestions relevant for *using an operationalized method of alignment analysis* are linked to exploiting the developed method in the future. This developed method is universal and it can be implemented in different countries to evaluate the alignment between innovation support measures and the needs of enterprises. In the current thesis, the method was used to evaluate the alignment between innovation support measures implemented by EARIB, EE and KredEx, and the factors influencing the innovation process in biotechnology enterprises and dairy processors in Estonia. At the same time, the method enables us to broaden the list of innovation support measures and sectors or groups of enterprises under analysis. For example, it is possible to also include measures covering the education system without any major modifications. It would only require increasing the sample of interviewees because it has to encompass all the important organisations.

The method can also be implemented in different countries because the toolbox is not country-specific. At the same time the list and the grouping of innovation process factors needs additional research to develop these into more comprehensive sets.

Suggestions relevant for *both groups of enterprises* are linked to alleviating transition, market and policy failure and the failure of the institutional infrastructure. As already mentioned, transition failure is linked to enterprise capabilities and innovation awareness. From the analysis of factors influencing the innovation process several interviewees mentioned factors linked directly to the capabilities and skills of management. For example, representatives of dairy processors highlighted factors like the resistance to change, the lack of risk-taking behaviour, missing willingness to cooperate, lack of long-term innovation strategies, etc. Those factors can be addressed by the CEO’s of enterprises without additional help from the public sector through recognizing the problems and devoting time to lessen their negative effect on the innovation process. At the same time, the public sector can help enterprises with issues arising from the low capability to innovate. Reducing the risk level of innovative activities, and providing training focused on increasing the innovation capabilities of enterprises are very important measures in this respect.

The need for awareness raising events that unite traditional and high-tech enterprises was also mentioned. Companies belonging to traditional sectors including dairy processors are not informed about research conducted in research institutions in the area of enabling technologies. Knowledge about the capabilities of biotechnology enterprises is not wide spread in the traditional sectors either. Therefore, it is hard to find common interests and opportunities for cooperation. A similar problem exists in high-tech enterprises. If there is no dialogue between enterprises, and the awareness of each other's activities is low, there is no chance for cooperation activities to appear. So spreading information about existing competencies in both directions is necessary. One measure supporting the distribution of information could be helping enterprises from traditional sectors to use high-technology solutions in their production. Another possibility is to create positions inside public sector organisations, for example EE, responsible for distributing information among networks of relevant organisations. They are similar to cluster facilitators, but they should facilitate cooperation between high-tech and traditional sectors through identifying areas of common interest and introducing those areas. Currently, a manager exists for the National Biotechnology Programme at EE, so perhaps this manager should also be responsible for facilitating cooperation. It is also possible to increase cooperation between traditional and high-technology enterprises through setting some kinds of standards and/or regulations forcing those two groups to work together to meet the standards.

The second set of problems relevant for both groups of enterprises is linked to policy failure. As discussed above, in Estonia there are several innovation support measures dealing with innovation process factors. At the same time, problems arise not from the lack of innovation support measures, but from the conditions set for those programmes. This decreases the potential positive influence of the designed and implemented measures. For dairy processors the main problem is linked to the extent to which they must add finances from their own resources; for biotech enterprises problems arise from the long pay-off periods in the innovation process typical for this activity. Representatives of both groups also mentioned high levels of bureaucracy and that grants given to enterprises are too small. So, it is necessary to focus more on possibilities to change the conditions of some policy measures/programmes. One way to do that is to apply for special conditions from the EU. This issue will be discussed more thoroughly below.

Tax-incentives should be considered as one possibility to increase the resources invested in the R&D process and facilitate the innovation process in both groups of enterprises. There are several options for decreasing the costs of R&D activities through tax-incentives (e.g. lower social tax rates from the salaries of R&D employees, smaller VAT from buying in research services etc.). Currently, our tax system favours investments in equipment and machines, which is increasing the use of modern technology and meeting different production standards. Right now these aspects are not so relevant anymore and more attention should be paid to how to change the tax-system so it is more supportive of the quality of human resources and the use of knowledge.

Suggestions relevant only for *dairy processors* are mainly linked to the international relationship between Russia and Estonia; that is, the failure of institutional infrastructure. Dairy processing representatives mentioned the need for better economic relations between Estonia and Russia, and a better system of export guarantees covering the risks of exporting to Russia. International relations between Estonia and Russia are rather delicate. Every major dispute at the political level influences Estonian enterprises doing business with Russian partners, including dairy processors. At the same time, Russian market is important for Estonian dairy processors because competitive advantage is easier to use on the Russian market compared to the European market. The European market is dominated by large dairy enterprises making entering that market and competing very difficult for Estonian dairy enterprises.

In addition to the need to improve international relations between Estonia and Russia and/or keeping them stable, a better export guarantee system is also needed to support dairy processors exporting to Russia. Currently, the most suitable export guarantee to fulfil this need is a turnover guarantee offered by KredEx Krediidikindlustus, but the choice of guarantees should be wider and/or some beneficial conditions for dairy enterprises should be introduced. Thus, the existing market failure has to be addressed.

Specific suggestions for *biotech enterprises* are linked to new measures. Some of them are indirect measures and some direct. Indirect measures are linked to market, transition and network failures existing in the Estonian innovation system. Many interviewees linked to biotech activities mentioned the need for a stronger VC market (market failure). The first steps towards solving that problem have already been made. On 26 March 2009, the Estonian Private Equity & Venture Capital Association (EstVCA) was created. The general aim of this association is to develop the industry of private equity and venture capital in Estonia (Eesti riskikapitalistid… 2009). They also want to participate in the process of creating legislative acts, support the cooperation of enterprises active in the private equity and venture capital market, create a strong and active membership list etc (Mittetulundusühingu Eesti… 2009).

At the same time, besides Estonian VC's, it is also important to attract foreign venture capital firms to Estonia. This will require commitment from the public sector. The improvement of the country's image and stable economic development has to be achieved to make Estonia more attractive for foreign VCs.

Through public sector support measures, it is not only important that Estonian biotechnology research results implemented in Estonian biotech companies be supported, but also that enterprises willing to develop and/or upgrade existing biotech products are favoured. There are examples where the first to enter the markets are less successful than the followers. The competence to be a successful follower exists in Estonia because of knowledge accumulated so far, but the majority of enterprises do not recognize this opportunity just yet. So, the public sector should not invest only in basic research and the transfer of knowledge and technology, but also in bringing the market closer to biotech enterprises.

In addition, biotech enterprises also need measures to help them become part of international industrial networks. There are problems with networking measures because their effectiveness is perceived to be low. These measures are successful and efficient only if all the events are well organized and enterprises can see the benefits of participating in networking events. Otherwise enterprises will not be willing to contribute their time and money, and this influences the success of these measures.

Two more measures could be introduced to the innovation support package to help Estonian biotechnology enterprises. Many interviewees related to biotech activity mentioned the high costs linked to patent maintenance. Enterprises are generally able to conduct an initial search for patents and submit a patent application, but after the patent has been granted, the costs of maintaining the patent is rather high for SMEs. The public sector should consider designing measures to help enterprises find partners interested in patents. Also, the enterprises themselves have to recognize the importance of a patenting strategy as part of their business strategy, and the decision to patent has to be weighed against the market value of the patent and its enforceability. It is also important to inform people that patents are not the only way to protect ideas. Sometimes, for example, another model could be more suitable than patents for achieving the strategic aims of the enterprise.

The second measure is linked to the introduction of public procurement measures. Public procurement is used as a demand side policy measure in several European countries. At the same time, efficient implementation of this measure needs a high level of competence from public servants, which may cause problems in Estonia right now. Currently, the first steps towards such a procurement system are being made through orders related to space technology and the offset programme.

Such measures would help increase the resources available for investments in R&D in Estonian biotech enterprises, and therefore, decrease the existing market failure. At the same time, enterprises themselves can also decrease current R&D costs and increase the finances available for investments through cooperation activities. One way to do that is the creation of joint laboratories. This would decrease fixed and variable costs linked to labs, and therefore, free up additional finances, but the issue of how to protect trade secrets in these laboratories has to be addressed.

The final group of suggestions is linked to the *public sector*. Public sector institutions should realise that enterprises and research institutions have to be at the core of the innovation system. All innovation support measures should be directed to those organizations, and they should be the final beneficiaries of the support system. The innovation system is something more than just the task and responsibility of a limited set of public sector actors, and the system should exist for enterprises and research institutions not for public sector organizations.

Up until now, innovation policy has mainly been seen as a task for two Estonian ministries: the Ministry of Economic Affairs and Communication, and the Ministry of Education and Research. In addition to those two ministries the Research and Development Council also contributes to policy design and implementation. Although the circle of ministries and organizations (including representatives of private sector) responsible for innovation support measures should be broader as already mentioned above, information exchange and increasing the analytical capability of ministries should be attended to.

Even when the exchange of information is between just two ministries this is not without barriers. The result of miscommunication can be a decrease in efficiency or doubling activities and a waste of resources. Therefore, regular meetings between two ministries could be organized. Currently, representatives of the two ministries do meet, but those meetings are not regular. Increasing the analytical capability of ministries does not mean that ministries have to create their own analysis departments, just that more intensive cooperation should exist between the Estonian Development Fund and other third parties active in policy analysis, and Estonian ministries. Those organisations can provide useful inputs in the process of policy design.

There are also problems in the design and implementation of innovation support measures, which cause additional policy failures. First, our policy makers are not yet very experienced in communicating with the European Commission and applying for special conditions for Estonian enterprises. The boarders of the EU's regulations are not yet known, and therefore, regulations and requirements are followed very carefully. This has resulted in measures with very detailed requirements for enterprises, and all the risks, which might arise from not following EU regulations are moved from the public sector organisations to the enterprises.

At the same time, it is possible that some kind of exceptions can provide a balance between EU regulations and enterprise needs while implementing innovation and agricultural policy measures, but this requires experience with working in the legal framework of the European Union. Right now this experience is scarce in Estonian public sector organizations. To increase the experience of employees in public sector organizations, it is important to reduce staff turnover, so employees have to be provided with good working conditions, possibilities to further their career and competitive remuneration. This would also increase their motivation to work and make themselves more approachable for enterprises.

This limited experience and the desire to avoid risking the loss of EU funds results in the technical evaluation and surveillance of applications and supported projects. Several representatives of companies mentioned that it is easier for them not to apply for support measures than to fill in all the reports and documents needed if the benefit from such measures is small. The technical evaluation and surveillance of innovation support measures could be decreased through implementing the client-based approach, which has already been introduced at Enterprise Estonia. At EE all the consultants are accredited and they are required to know all the measures provided to enterprises and other organizations through EE. Therefore, the employees at Enterprise Estonia are moving from being administrators of specific programs and/or projects towards being partners and consultants for applicants through helping them to find and apply for those measures most necessary for them. At the same time, this does not solve problems linked to the strict requirements and unfavourable conditions of innovation support programmes and policy measures. In general it may be stated that the stages of the innovation process are more or less covered by different innovation support measures, and no interviewee from the public sector mentioned areas of the process, which should not be covered by public sector measures, but the conditions introduced are not in accordance with the current economic situation and needs of enterprises. The fact that the selection processes on the market, which works in terms of the survival of the fittest, cannot be completely replaced by a system supporting enterprises with the ability to write good applications should also not be forgotten.

Many of the abovementioned problems could be explained through a short history of Estonian innovation policy. It can be stated that Estonia is still building the basis of its innovation policy and national innovation system. Therefore, the tasks of the people behind the innovation system have not yet been drawn out explicitly, and the coordination and communication between them needs to be improved. Also if the system and its participants gather more experience, the new employees of those participants gain experience faster, which also helps solve the existing problems better and faster. At the same time, consistency in decision-making does not come from a lack of experience. It is linked to changes in the politics of the country. Innovation policy design and implementation in Estonia requires greater consistency from the public sector, starting with the development of strategy documents linked to the innovation system and the implementation of innovation support measures, and ending with the surveillance of the achievement of different objectives described in policy documents. The harmonization of strategies and increased effectiveness of designing and implementing innovation support measures would also increase the alignment between innovation process factors and innovation support measures in Estonia.

# CONCLUSION

## The theoretical concepts leading to the formulation of a research framework

The process of innovation has been studied for several decades. To simplify the complicated process taking place in enterprises and facilitate the analysis of it many innovation process models have been elaborated starting with technology push models and ending with the system integration and networking model. To analyse the alignment between factors influencing the innovation process in enterprises and public sector innovation support measures, the author of the thesis developed an innovation process model taking into account the short-comings of existing models. As a result, an innovation process model comprising three stages was elaborated. According to this model, the innovation process starts with an idea generation stage followed by a problem solving stage and the idea application stage. All stages are interlinked through feedback loops including the exchange of different resources (e.g. financial resources, information, knowledge and R&D). Also, the possibility to reverse the innovation process was taken into account. The innovation process may return to the previous stage or to the beginning of the process at every decision point. The developed three-stage innovation process is embedded in the enterprise's internal and external environment and its factors.

The innovation process model developed in this thesis is rather general. It may be used to describe the innovation process taking place in different sectors (i.e. the model is not sector specific). Also, it can be used to analyse different types of innovations either from product to market innovation or from incremental to radical innovations. Therefore, it can be used to analyse the innovation process taking place in different sectors and/or activities and it is not limited to one type of innovation.

Based on this innovation process model, factors influencing the innovation process were grouped and analysed. Innovation process factors were divided into seven separate subgroups: factors influencing the first stage of the innovation process, the second stage of the innovation process, the third stage of the innovation process, and overlapping areas between those stages, including factors influencing the whole process. Inside each of the seven previously described subgroups, innovation process factors were also divided into two: factors of the external and internal context. The first of these includes factors of the enterprise's external environment. These factors cannot be influenced by the firm itself. Internal factors are linked to the enterprise's internal environment, including strategies, regulations and procedures and everyday activities. Enterprises have to consider the external and internal environment and the factors of these constantly because they exist inside a system interacting with different institutions and organisations. Therefore, to study the alignment between factors influencing the innovation process in enterprises and innovation support measures, the author had to analyse the innovation system approach and different reasons for government intervention.

The innovation system approach originates from Friedrich List, who tried to explain the differences between dominant countries in 1841. He discussed the social, cultural and economic factors of countries, and emphasized the importance of government intervention. Although List is considered to be the first to discuss a national innovation system, this approach arose at the end of 1980s in the writings of Freeman and Lundvall.

The innovation systems approach is influenced by interactive learning and evolutionary theory, and the capabilities and path dependency concepts. Although the approach has been developed since the 1980s, there are still a number of innovation system definitions and approaches existing in economic literature; in other words, no common definition and/or approach has been broadly accepted. This has resulted in some inconsistencies between different definitions and approaches but there are still some common features. For example, innovation and learning are at the centre of the different approaches, and evolutionary developments are taken into account. Also, no one argues that there is an optimal innovation system that countries have to move towards.

The innovation system approach has also been criticized, and this has helped to improve the approach. The main criticism relates to the difficulty of limiting the innovation system. The limits of the innovation system are determined through the definition of the innovation system. According to the broad definition of the innovation system, all actors and institutions relevant to the innovation have to be taken into account. Therefore, in some cases the national innovation system could be limited by the world economy. Often the problem linked to limiting the system is solved through limiting the analysis to the most important organizations and institutions relevant for reaching the aims of a specific study.

In addition to definitions of innovation systems, determining the functions of the innovation system also helps to minimise the criticisms of the systems approach. Issues related to innovation systems may be studied from the viewpoint of system functions and efficiency. This helps to limit the system, introduce more quantitative characteristics to the study, and cover important linkages and flows. In the current thesis, functions highlighted by Edquist and Hommen (2008) are taken as the bases of the study. They described four functions of the innovation system: the provision of knowledge inputs for the innovation process, demand-side activities, the provision of the constituents of the innovation system, and support services for innovating firms. To support the existence and efficiency of the functions and/or remove system failures, policy measures can be elaborated and implemented. These should result in the facilitation of the innovation process taking place in enterprises and improve the efficiency of public sector interventions.

## Framework for analysing the alignment and data

The analysis of alignment takes place according to the theoretical framework developed in 1.3.2. The theoretical framework takes into account the innovation process model developed by the author of the thesis, sets of factors covering the stages of the innovation process and innovation support measures. The factors influencing the innovation process in Estonian dairy processors and biotechnology enterprises, and innovation support measures are divided into seven sub-groups linked to the stages of the innovation process: factors/ measures linked to the first stage of the innovation process, factors/measures linked to the second stage of the innovation process, factors/measures linked to the third stage of the innovation process, and factors/measures linked to the overlapping areas of the innovation stages.

Grouping factors and measures into seven sub-sets enables us to analyse the innovation process factors, the innovation policy measures, and the alignment between factors and measures. During the analysis of innovation process factors, factors influencing innovation in one particular set of enterprises are compared with the theoretical set of innovation process factors. The analysis of innovation policy measures evaluates the coverage of the theoretical set of innovation process factors by policy measures implemented in one particular country. The alignment between factors and measures compares the factors influencing the innovation process in enterprises with innovation support measures implemented by the public sector of the country where the enterprises are located.

To study this alignment in Estonia, two groups of enterprises were chosen: dairy processors and biotechnology enterprises. Those groups of enterprises represent a classical traditional sector and enabling high-technology enterprises. Also, the use of biotechnology solutions by dairy processors made it possible to introduce an additional dimension into the analysis covering the use of high-technology solutions by a traditional sector.

The analysis was conducted based on industry/activity case studies. The data used in this thesis was collected through interviews with representatives of the dairy industry, biotechnology enterprises and public sector institutions. The interviewees were chosen based on their linkages and knowledge about the two groups of enterprises or the process of policy design and implementation. Additional data was gathered through public information and previous studies. To describe the innovativeness of dairy processors and biotechnology enterprises, and provide an overview of the two groups of enterprises, the database of Community Innovation Survey for 2004–2006, the Estonian Central Commercial Register and an additional questionnaire distributed amongst Estonian biotechnology enterprises were used.

## Validity of propositions and overview of findings

The author of the thesis set up seven propositions to test the innovation process model and its factors, the design of Estonian innovation support measures and alignment. An overview of the propositions and the results of the study are presented below.

**Proposition 1.** The innovation process model developed in 1.1.1 describes the innovation process taking place in both dairy processors and biotechnology enterprises; in other words, the model is not activity specific.

Discussions of the innovation process model with interviewees validated the proposition. Although the innovation process may differ slightly across sectors/ activities, the innovation process model enables us to study those differences. On the general level, in every situation the innovation process starts with idea generation followed by problem solving and application. How thorough the execution of each stage of the process is depends on the particular situation.

**Proposition 2.** Country-specific innovation process factors dominate over activity-specific innovation process factors in Estonian dairy processors and biotechnology enterprises.

The comparison of innovation factors based on two groups of enterprises highlighted some activity-specific factors of the innovation process. For example, the innovation process in biotechnology enterprises is more influenced by factors like developments in science, the existence of an IP system, the availability of venture capital and the harmonization of regulations than the innovation process in dairy processors. At the same time, the majority of innovation process factors were similar across the analysed enterprises and may be considered to be country-specific. Hence, Proposition 2 was accepted.

**Proposition 3.** The provision of knowledge inputs is considered to be the primary function of the innovation system by the Estonian public sector.

To validate the proposition, representatives of the public sector were asked to name the functions a hypothetical innovation system should have. The most frequently mentioned function was the provision of innovation support measures followed by the provision of constituents of the innovation system. The provision of knowledge inputs was the third most important function of the innovation system. So, the results do not support Proposition 3 and Proposition 3 cannot be accepted.

**Proposition 4.** The design of Estonian innovation support measures is influenced by trends in innovation support measures in the European Union.

The influence of the EU can be divided into two subgroups: influences through financial resources provided by the EU and influences through the policy learning process. Throughout the implementation of innovation support measures, money primarily coming from the EU is used in Estonia. Therefore, Estonian policy makers have to consider the legal framework regulating the use of Structural Funds and state aid. In addition to financial resources and the limitations linked to it, the Estonian policy design process is also influenced by the EU through the policy learning process. The policy design process can be divided into two steps. First, existing problems are analysed and second, best practice for removing the existing problem is sought. The policy learning process is also encouraged by the European Union to lessen the waste of the resources. Hence, Proposition 4 can be accepted.

**Proposition 5.** The majority of factors in the innovation process creating problems for Estonian dairy processors and biotechnology enterprises are linked to the third stage of the innovation process – the application of the idea.

Proposition 5 was rejected. Although the interviewees highlighted several factors supporting the importance of marketing, these factors did not dominate over other factors. Almost every stage of the innovation process and its overlapping areas were linked to one or several problematic factors. The only exception was the overlapping area between the first and third stage of the innovation process. No factors influencing that sub-group were mentioned by the interviewees.

**Proposition 6.** In Estonia innovation support measures are primarily focused on the first stages of the innovation process.

If the number of innovation support measures focusing on the first stages of the innovation process is taken into account, Proposition 6 has to be rejected. Compared to the first and second stage of the innovation process, the list of different innovation support measures dealing with issues linked to the application of ideas is longer. At the same time, in monetary terms, the first stages of the innovation process are better financed. Hence, Proposition 6 can be partly accepted.

**Proposition 7a.** The alignment between innovation process factors and innovation policy measures is sector specific.
**Proposition 7b.** The misalignment is greater in the dairy sector than in biotech activities.

Figures 26 and 27 of the thesis describe the alignment between factors influencing the innovation process in dairy processors and biotech enterprises, and Estonian innovation support measures. These figures are exactly the same. So, according to these figures, Propositions 7a and 7b should both be rejected.

A more detailed analysis reveals existing differences across the two groups of enterprises though. The problems causing the misalignment for dairy processors are linked to issues connected to entering the Russian market and limitations related to enterprise size while applying for support from different innovation support measures. Misalignment for biotechnology enterprises is linked to the regulations implemented in the EU and the weak VC market. There are also similar problems across the groups of enterprises. Therefore, although Proposition 7a can be accepted, Proposition 7b cannot.

The results of the study can also be interpreted on the basis of the system failure concept. Almost all sub-types of system failure exist in the Estonian National Innovation System. The only types of system failure not causing problems in the Estonian National Innovation System are physical infrastructure and lock-in failure.

These findings were used to develop suggestions important for using an operationalized method of alignment analysis, for dairy processors, biotechnology enterprises and Estonian policy makers. It is important to find ways to support Estonian dairy and biotech enterprises. To make the support system more efficient, public sector employees have to gain more experience working within the legal framework put forward by the EU, and find ways to apply for special conditions if needed by Estonian enterprises. It is also important to understand that national innovation system has to exist for enterprises and research institutions not for public sector organizations. This change can be initiated through the introduction of small modifications to the figure of Estonian National Innovation System by moving enterprises and research institutions to the centre of the system. Enterprises should also conduct innovation and develop innovation strategies in a more systematic and formal way. This will help to create some stability into changing internal and external environment.

## Recommendations for future research

Further research can be conducted on the basis of the developed theoretical framework of factors influencing the innovation process in enterprises. The developed framework includes detailed information about the factors relevant to innovation processes allowing studying this aspect more thoroughly. Innovation process factors were just one part of the current study, and so they were not examined as deeply as they could be in a study that focuses only on these factors. The theoretical framework itself could also be improved by adding additional innovation process factors through additional synthesis of previous studies and verifying the factors mentioned by the interviewees.

The developed operationalized method for analysing alignment can be used to elaborate and design new (sector-specific) innovation support measures. The process of analysis can almost be the same, only some modifications have to be introduced to the interview plans. Also, the policy measures incorporated into the analysis do not have to be linked to innovation policies in a narrow sense. It is also possible to add measures implemented by other public sector organizations (e.g. Ministry of Education and research), and also analyse research institutions in addition to enterprises.

The toolbox for analysing alignment can also be supplemented by adding the financial aspect. Currently, the results do not include the financial side of the support measures in as much detail as might be requested by some policy designers. Therefore, additional instruments could be added to the method.

The system failure concept described and developed in 1.2.2. also presents additional research avenues and topics. System failures are not thoroughly analysed based on the Estonian National Innovation System just yet. Therefore, this area includes many new possibilities for research.

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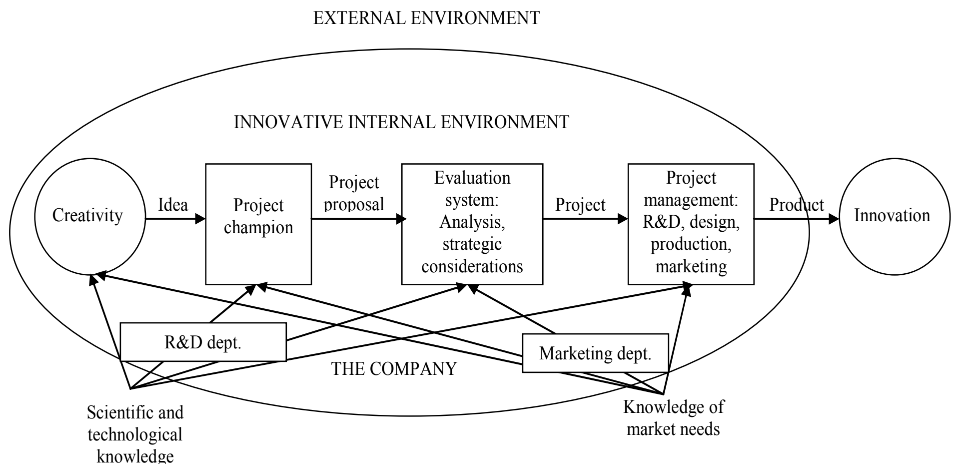
# APPENDICES

## Appendix 1. Twiss's activity stage model




Source: Forrest 1991: 442

# Appendix 2. Overview of studies about factors influencing innovation process

| Author(s) | Short description of the study | Type of innovation |
|---|---|---|
| Abetti, P. A. (2000) | The analysis of 5 radical technological innovations on the bases of critical success factors from earlier studies | Radical technological innovation |
| Achilladelis, B. *et al* (1971) | Study of product success and failure factors in chemicals and scientific instrument industry | Product innovation |
| Avermaete, T. *et al* (2003) | Linkages between innovativeness and determinants of innovativeness in small Belgian food firms | Product, process innovation, HCCP certific., ISO 9000 certific. |
| Avermaete, T. *et al* (2004) | Determinants of product and process innovation on the basis of small food and drink manufacturing. firms | Product and process innovation |
| Axtell, C. M. *et al* (2000) | Factors affecting the suggestions and implementation of ideas by “shopfloor” employees | Small-scale improvements in work processes |
| Balachandra, R., Friar, J. H. (1997) | Overview of over 60 papers studying factors of innovation success | Commercial R&D projects, product innovation |
| Carrier, C. (1998) | Results of the use of suggestion programs in manufacturing firms | Idea generation |
| Chin, A., Sing, I. (2000) | Factors that help to create the innovative culture in SMEs amongst the employees | Product/ service innovation |
| Cooper, R. G. (1984) | Study of elements of successful new product program. Studied 19 new product strategy dimensions. | Product innovation |
| Cooper, R. G. (1994) | Overview of 8 factors driving the success in product innovation | Product innovation |
| Cozijnsen, A. J. *et al* (2000) | Factors that lead to success in innovation projects and factors that bring along failure in Dutch companies | Innovation projects (mainly product innovation) |

| **Author(s)** | **Short description of the study** | **Type of innovation** |
| --- | --- | --- |
| De Brentani, U. (2001) | Study of factors linked to new business service's success | New business services |
| De Jong, J. P. J., Vermuelen, P. A. M. (2006) | Study about the differences in product innovation determinants across industries | Product innovation |
| Dhamvithee, P. *et al* (2005) | The rate of the NPD and success of products introduced to the market on the bases of Thai food-industry | Product innovation |
| Dougherty, D (1992) | Barriers of successful innovation in large firms | Product innovation |
| Ernst, H. (2002) | Review of success factors of NPD on the basis of literature | Product innovation |
| Flint, D. J. (2002) | Development of the process describing activities that ought to exist when generating new product ideas | The idea generation for product and service innovations |
| Freel M. S. (2000) | Barriers of innovation for SMEs | Product innovation |
| Frenkel, A. (2003) | Study of innovation barriers in Israel. | Innovative projects |
| Garrido-Rubio, A., Polo-Redondo, Y. (2005) | Study of tactical launce decision's influence on new product performance | Product innovation |
| Hadjimanolis, A. (1999) | Innovation barriers in SMEs active in small less developed country | Not defined |
| Hultink, E. J. *et al* (2000) | Factors of launch decision related to success of new products | Product innovation |
| Johnson, J. D. (2001) | Study of factors linked to success in innovation implementation based on cases from govm organisations | Innovation is not explicitly defined |
| Jones, O., Stevens, G. (1999) | The role of micro-politics in the new product development (NPD) | Product innovation |
| Kahn, K. B. (2005) | Influence of department status on product development and management performance | Product innovation |
| Kohn, K. (2005) | Links between idea generation and business environment scanning | Generation of new product ideas |

| **Author(s)** | **Short description of the study** | **Type of innovation** |
|---|---|---|
| Lilien G. L. *et al* (2002) | The comparison of results between lead user idea-generation method and traditional methods based on customer inputs | Ideas for product innovation |
| Martin, S., Scott, J. T. (2000) | The analysis of sources of innovation failure across 4 main modes of innovation and corresponding policy measures | Not defined |
| McAdam, R. *et al* (2004) | Barriers of innovation in SMEs located at the peripheral regions of EU (North Ireland) | Innovative activities |
| Nemeth, C. J., Ormiston, M. (2007) | Stable or changing membership of the group and idea generation | Creative idea generation |
| Oldham, G. R., Cummings, A. (1996) | Study of contributions of characteristics of employees and organizational context to creativity | Ideas/inventions produced at the individual level and not implemented |
| Panne, G. *et al* (2003) | Literature review of success and failure factors of innovation | Innovative projects |
| Parthasarthy, R., Hammond, J. (2002) | The connection between innovation input, level of integration and frequency | Product innovation |
| Sowrey, T. (1990) | Study of techniques for idea generation system | Idea generation |
| Stewart-Knox, B., Mitchell, P. (2003) | Study of variables related to success and failure of reduced fat food products | Product innovation |
| Unsworth, K. L. *et al* (2000) | The factors which influence employee innovation | Idea generation |
| Wan, D. *et al* (2005) | Study of relationship between innovation and its determinants | Process of innovation |
| Zirger, B. J., Maidique, M. A. (1990) | Development of the model for product development | High-technology product innovation |

Source: Composed by the author

# Appendix 3. Grouping of factors influencing innovation process across innovation model stages

| GENERATION OF IDEAS | PROBLEM SOLVING | APPLICATION OF THE IDEA |
|---|---|---|
| **EXTERNAL CONTEXT:**<br>***Influence of competitors' activities on idea generation initiative***<br>• Influence of competitors' activities on innovation project and idea generation initiatives | **EXTERNAL CONTEXT:**<br>***Market conditions for new product***<br>• Size of the market<br>• Growth of the market<br>• Number of competing products<br>• Concentration of buyers<br>***Attractiveness of and opportunities for new product***<br>• Attractiveness and durability of the opportunity corresponds to aims | **EXTERNAL CONTEXT:**<br>***Possibility of out-sourcing some parts of production***<br>• The possibility to sub-contract some parts of production<br>***Adaptability of innovation by users***<br>• The adaptability/acceptance of innovation by users |
| **INTERNAL CONTEXT:**<br>***Framework for idea collection***<br>• Creation of organized network for collecting ideas<br>• Knowledge-base and technology from outside the commercial sector<br>***Environment to support employees' innovations/idea generation***<br>• Recognition of employees as source of innovative ideas<br>• Possibility to use the part of working day for development of new ideas<br>• Support for work on unofficial projects<br>• The availability of internal VC for implementation of new ideas<br>***Assessing and interpreting emerging patterns and future trends***<br>• Scanning of business and research environment | **INTERNAL CONTEXT**<br>***Framework for idea screening***<br>• Existence of framework for screening ideas<br>***The alignment between market opportunities and technology***<br>• Links between market orientation and technological prowess<br>• High quality of technical and market-directed feasibility assessment of the ideas<br>***Characteristic of new product***<br>• New products related to market needs/trends<br>• Unique advantage of the product<br>• Degree of product's innovativeness<br>• Degree of technological advancement<br>***Suitability of new product with current business model***<br>• New product related to existing market<br>• Market existence<br>• New products related to other products | **INTERNAL CONTEXT**<br>***Importance of marketing***<br>• Emphasis on marketing<br>• Proficient marketing and commitment of resources<br>• Firm's marketing capabilities<br>***Formal planning***<br>• Existence of formal and planned launch strategy<br>***Production processes***<br>• Modifications in existing manufacturing processes<br>• Lack of resistance of employees to changes in production processes<br>***Product quality***<br>• Product testing<br>• Identification of product defects before product launch and sales<br>• Relative quality of the product |

| GENERATION OF IDEAS | PROBLEM SOLVING | APPLICATION OF THE IDEA |
|---|---|---|
| • Interpretation of emerging patterns and future trends in external environment<br>• Use of lead-user idea generation model and involvement of clients<br>***Organization of creative workshops***<br>• Organization of creative workshops for transferring trends into opportunities<br>• Involvement of front line employees<br>• Involvement of employees with different skills, perspectives, characteristics<br>• Change of the members in idea generation team | • New products related to existing production methods<br>• New products related to existing technologies<br>***Solutions for transforming the idea into innovation***<br>• Transforming the idea into innovation | ***Product price***<br>• Relative price of the product<br>• Skimming price strategy<br>• Undercutting pricing policy<br>***Marketing and distribution***<br>• Launching broader assortment of products<br>• Communication expenditure higher than competitors'<br>• Use of different communication means<br>• Attention to publicity and advertising<br>• Use of intensive distribution channels<br>• Trial selling |

| GENERATION OF IDEAS AND PROBLEM SOLVING | GENERATION OF THE IDEAS AND APPLICATION OF THE IDEA | PROBLEM SOLVING AND APPLICATION OF THE IDEA |
|---|---|---|
| **EXTERNAL CONTEXT:**<br>***IPR system***<br>• The appropriability of returns from innovation | **EXTERNAL CONTEXT:** | **EXTERNAL CONTEXT:**<br>***Availability of new production technology and materials***<br>• The availability of production technology for producing new product<br>• Availability of raw materials and energy |
| **INTERNAL CONTEXT:**<br>***Existing R&D activities***<br>• Existence of R&D activities<br>• Existence of R&D department<br>• High R&D intensity incl. R&D investments<br>***Clearly defined problem***<br>• Sharp and early product definition<br>• Determination of demand<br>• Clarity of problem definition/product concept<br>***Execution of R&D activities***<br>• Planning and execution of the R&D process<br>• Adequate R&D, design and testing within the firm<br>• Efficiency of development process<br>• Transferability of ideas to internal user(s) with skills in production, marketing and distribution<br>• Chief of R&D on board | **INTERNAL CONTEXT:**<br>***Framework for fluent flow of ideas***<br>• Existence of suggestion schemes for new ideas<br>***Employee's work characteristics***<br>• Breadth of self-efficacy<br>• Production ownership<br>• Machine maintenance | **INTERNAL CONTEXT:**<br>***Consistency between existent technology and the production of new products***<br>• Need for new production equipment<br>• Influence on production of other products<br>***Demand for inputs***<br>• Demand for new materials/inputs<br>***Evaluation and testing of invention***<br>• Probability of technological success<br>• Trial production<br>• Customer test of prototype<br>***Revenue aspect of the product***<br>• Product's performance to costs ratio<br>• Product's contribution margin to the firm |

| GENERATION OF IDEAS, PROBLEM SOLVING, and APPLICATION OF THE IDEA |
|---|
| **EXTERNAL CONTEXT:**<br>***Legal environment***<br>• Legislations and regulations introduced by government<br>• Trust<br>• Risks associated with standards for new technology<br>***Economic environment***<br>• Economic performance of the region/country<br>• Competitive environment<br>• Market power<br>• Technical and marketing uncertainty<br>***Conditions of resource markets***<br>• Supply and demand of skilled labour<br>• Financial market's transaction costs<br>• External financing of innovation<br>• Awareness of alternative financial sources<br>• Trends in technology developments<br>***Public and private sector's innovation support measures***<br>• Government assistance<br>• Knowledge about government support measures<br>• Governmental bureaucracy<br>**INTERNAL CONTEXT:**<br>***Firm's characteristics***<br>• Size of the company<br>• Age of the company<br>• Mother or daughter company<br>***Structure of the company***<br>• Flexible structure of organization<br>• Equal status of different departments<br>***Internal innovation culture***<br>• Firm's innovative culture and climate<br>• Strategic long-term focus of new product development projects |

| GENERATION OF IDEAS, PROBLEM SOLVING, and APPLICATION OF THE IDEA |
|---|
| • No resistance to change and development<br>• Entrepreneurial spirit<br>• Risk-taking behaviour<br>• Complex and challenging jobs for employees<br>• Diversity of responsibilities<br>***Tapping into (information) networks***<br>• Existence and use of formal processes for gathering and interpretation the info<br>• Identification of suitable partners for cooperation<br>• Information management<br>• Absorptive capacity<br>• Interactive learning between different actors and using of those sub-groups to overcome the limited resources<br>***Existence of and harmony between different strategies***<br>• Harmony between vision and culture<br>• Technology strategy tied to business strategy<br>• Progressive identification of business and technical goals and matching of these goals<br>• Framing the innovations in term of expectations of key stakeholders<br>***Existence of long-term innovation or new product development (NPD) strategy***<br>• Existence of formal NPD process/program/innovation plan/strategy<br>• Complementarity with core competencies<br>• Previous NPD experiences<br>• Timing of market introduction and returns from investments<br>• Need to lower production costs<br>• Costs linked to innovation process<br>• Allocation of resources<br>***Commitment and role of management***<br>• Management style<br>• Management support<br>• Senior authority of development team leader<br>• No power-struggle<br>• The qualification, background and training of management (incl. team leader)<br>• No resistance to leadership |

| GENERATION OF IDEAS, PROBLEM SOLVING, and APPLICATION OF THE IDEA |
| --- |
| ***Characteristics of employees***<br>• Job competence<br>• (Intrinsic) motivation<br>• Creative personality<br>• Enabling mind-set<br>***Training of employees***<br>• Training and existence of well-educated employees<br>• Competent and skilled employees<br>***Customer/market orientation***<br>• In-depth understanding of customers and market place<br>***Organization of innovation process/NPD project***<br>• Division of the innovation process into multi-stages<br>• Existence of evaluation and decision points<br>• Customer involvement in innovation process<br>• Share of employees engaged in innovation process<br>• Functional integration<br>• Cross-functional teams<br>• Collaboration and communication between different departments<br>• Free communication channels/communication is fluent<br>• Use of available technology<br>• The amount of time team could spend on NPD project<br>• Project team responsible for the entire project<br>• One man is not responsible for many tasks<br>• Technology gatekeepers<br>***Evaluation of innovation process/NPD project***<br>• Commercial evaluation of NPD project<br>• Efficient allocation and utilization of available resources<br>• Quality of execution of innovation process<br>• Commitment and involvement of project stuff |

Source: Composed by the author

# Appendix 4. Interview plan for public sector organizations (pre-prepared questions)

1. What is the role and tasks of your institution and yourself in Estonian innovation system?
2. How would you describe the innovation process which takes place in enterprises? Is this process similar in all manufacturing sectors or are there any differences across the sectors?
3. How appropriate for the dairy and biotech industries is an innovation process model which divides the innovation process into three stages, namely: generation of ideas (incl. idea generation linked to different sources of ideas like markets, business partners, universities, research institutes, employees of the firm, and self-evaluation of the idea), problem solving (incl. screening and feasibility evaluation of ideas, selection of the most feasible idea, and preliminary solutions for problems which may rise in the implementation stage), and application of the ideas (incl. activities linked to the introduction of the idea into practice)?
4. If we divide the innovation process into 3 stages presented in Q3 then which stage of the innovation process and why is most problematic for the dairy and biotech industries according to your knowledge?
5. What factors influence the innovation process in the dairy and biotech industries the most according to your knowledge? Why?
6. How independent is Estonia in designing and implementing its innovation system and innovation support measures (including independency in deciding over the list of innovation support measures, financial resources etc)? Are there influences from different international institutions? If yes, please name some of these institutions.
7. What functions should an effective innovation system of the country have? Are those functions existent and effective in the Estonian innovation system?
8. What kinds of policy measures dominate innovation support today in Estonia? In your view what are the most important innovation support instruments? Please explain.
9. What kind of public sector innovation support measure should be additionally designed and implemented to support enterprises in the dairy and biotech industries in their innovation activities? How would the implementation of these measures influence the innovative activities of the industry?
10. What kind of problems to your knowledge do the dairy and biotech industries have while innovating but which should not be supported by the public sector?
11. Are the designed and/or implemented innovation support measures for dairy and biotech industry in accordance with industries' needs? Are these sectors in better or worse situation compared to other sectors?

12. According to your knowledge what are the biggest problems in the public sector linked to innovation support measures? What may have caused those problems?
13. Describe the situation in innovation policy and its measures in 5 years. Have there been any changes?
14. Do you have anything to add about the topics we already discussed?

# Appendix 5. Interview plan for enterprise/industry (pre-prepared questions)

1. Has your enterprise been engaged in innovative activity during last 5 years? What types of innovation activities? What have been the reasons for doing/not doing it? or How would you evaluate the innovativeness of the dairy/biotech sector?
2. Please describe innovation process taking place in your enterprises/industry.
3. How appropriate for your enterprise/industry is an innovation process model which divides the innovation process into three stages, namely: generation of ideas (incl. idea generation linked to different sources of ideas like markets, business partners, universities, research institutes, employees of the firm, and self-evaluation of the idea), problem solving (incl. screening and feasibility evaluation of ideas, selection of the most feasible idea, and preliminary solutions for problems which may rise in the implementation stage), and application of the ideas (incl. activities linked to the introduction of the idea into practice)?
4. If we divide the innovation process into 3 stages presented in Q3 then which stage of the innovation process and why is most problematic for your enterprise/industry while innovating?
5. What factors influence the innovation process in the dairy/biotech industry the most?
6. How do you evaluate the importance of innovation process factors which are internal to firm in innovative activities of your enterprise/industry?
7. How do you evaluate the importance of innovation process factors which are external to firm in innovative activities of your enterprise/industry?
8. Should the public sector help enterprises/industry to deal with factors influencing the innovation process (including both internal and external factors)? Please elaborate.
9. Have your enterprise/industry got any support from public sector for innovation activities? If yes, what kind of public support measures and for what activities? Would these activities have taken place also without public sector support? How did this measure influence the innovative activities of the enterprise/industry?
10. How have you dealt with the innovation process factors mentioned previously but not supported by the public sector either because there are no measures directed to these factors or you have not applied for these measures?
11. What kind of public sector innovation support measure should additionally be designed and/or implemented to increase the innovativeness of your enterprise/industry, and why? How would the implementation of that measure influence the innovative activities of the enterprise/industry?

12. According to your knowledge what are the biggest problems in the public sector linked to innovation support measures? What may have caused those problems?
13. Describe the situation in your enterprise/industry in 5 years. Have there been any changes?
14. Do you have anything to add about the topics we already discussed?

# Appendix 6. Overview of innovation support measures implemented by EARIB

| Policy measure | Support given to applicant | Application period | Amount of the measure/programme in 2009 |
|---|---|---|---|
| Adding value to agricultural and non-wood forestry products | 10 million EEK over 3 years and 20 million EEK per programming period per enterprise. Own financing 50% | 03.08–14.08.2009 | 90 million EEK |
| Cooperation in the development of new products, processes and technologies | Applied research and product development: up to 5 million EEK Comparative research: up to 3 million EEK | 19.07-02.08.2010 | 356 million EEK |
| Diversification of the rural economy | 1 564 660.00 EEK for small projects;<br>1 564 660.00–4693980.00 EEK for big projects.<br>Own financing 50%. | 31.08–21.09.2009<br>31.08-13.09.2010 | 185,7 million for small project;<br>121,4 million for big projects |
| Export licences and support | Support given to applicant depends on the product. Currently the support rate for milk products is zero. | | |
| Market development support | 2 million EEK if non-profit institution represents 1 domain;<br>4 million EEK if non-profit institution represents 2 or more domains. | 08.03-05.04.2010 | N/A |
| Setting up and development of producer groups | Up to 4,85 million EEK over 5 year period | 30.08-13.09.2010 | 200 million EEK |
| Training and information activities | Up to 500 000.00 EEK depending on activity. | 19.04-27.04.2010 | In 2009:<br>5,5 million for national projects;<br>4,5 million for local projects |

Source: Composed by the author on the bases of EARIB webpage

# Appendix 7. Overview of innovation support measures implemented by KredEx

| Policy measure | Support given to applicant | Application period | Amount of the measure/programme in 2009 |
|---|---|---|---|
| Business loan guarantee | Up to 30 million EEK | 2007-31.08.2015 | 281,4 million EEK |
| Investment guarantee | Up to 100% for political risks | | |
| Investment loan guarantee | Up to 30 million EEK | 2007–31.08.2015 | 181,4 million EEK |
| Long term credit risk guarantee | 90% level of coverage for business risks and up to 100% for political risks (supplier credit guarantee) | 2009-2015 | 200 million EEK |
| Long-term loan resource offer in cooperation with banks | Up to 30 million EEK | 2009–31.08.2015 | 400 million EEK |
| Pre-shipment risk guarantee | 90%-100% level of coverage | | |
| Credit insurance of short term transactions | 85% level of coverage | | |
| Start-up loan | 30 000–1 million EEK | 2008–2013 | 94,1 million EEK |
| Subordinated loan | 1–16 million EEK, but not more than enterprise's equity capital | 2008–31.08.2015 | 400 million EEK |

Source: Composed by the author on the bases of KredEx and KredEx Krediidikindlustus webpage

# Appendix 8. Overview of innovation support measures implemented by EE

| Policy measure | Support given to applicant | Application period | Amount of the measure/programme in 2009 |
|---|---|---|---|
| Base financing of transfer of knowledge and technology | For R&D institutions | 2007–2013 | 120 million EEK |
| Business incubator program | For incubators. Amount of the grant N/A | 2007–2013 | 28 million EEK |
| Cluster development | Preliminary application: up to 400 000.00 EEK with 25% own financing<br>Full application: the amount of the support has not been specified but up to 30% own financing | | |
| Competence centre grant | Up to 140 000 000.00 EEK covering the period of 7 years | 2007–2013 | 904 million EEK |
| Development of creative industry | 106 907 324.00 EEK | 2007–2013 | 107 million EEK |
| Development of knowledge and skills:<br>Base training for star-ups<br>Business mentoring program<br>Trainings in topics related to export<br>Training in area of space technology<br>Centrally organized trainings | <br>3 401 901.00 EEK for EE<br>3 753 911.00 EEK for EE<br>7 382 248.00 EEK for EE<br>2 000 000.00 EEK for EE<br>20 737 816.00 EEK for EE | <br>2007–2013<br>N/A<br>N/A<br>N/A<br>N/A | <br>3 401 901.00 EEK<br>N/A<br>N/A<br>N/A<br>N/A |
| EXPO 2010 | For EE. Participation at EXPO 2010 with Estonian pavilion | N/A | N/A |
| Export marketing grant | 150 000.00–2 500 000.00 EEK with 50% own financing | 2007–2013 | 400 million EEK |
| Foreign trade fair grant | 30 000.00–1 000 000.00 EEK with 50% own financing | 2007–2013 | 100 million EEK |
| Information about export | 3 100 470.00 EEK for EE | 2007–2013 | 3 100 470.00 EEK |

| Policy measure | Support given to applicant | Application period | Amount of the measure/programme in 2009 |
|---|---|---|---|
| Infrastructure investment programme for test- and half industrial laboratories | Over 1 000 000.00 EEK with up to 60% own financing | 2009–2010 | 61,7 million EEK |
| Innovation vouchers | 50 000.00 EEK with 0% own financing | 2009–2010 | 15 million EEK |
| Joint marketing grant | 40 000.00–1 000 000.00 EEK with 50% own financing | 2007–2013 | 30 million EEK |
| Joint stands on foreign fairs | For EE. Amount of the grant N/A | N/A | N/A |
| Offset programme for export opportunities | 3 contracts signed | N/A | N/A |
| Product development grant | Preparation of applied research or product development: up to 300 000.00 EEK with 25–60% own financing<br>Applied research and product development: from 500 000.00 to 50 000 000.00 EEK with 25–60% own financing | 2007–2013 | 1,08 billion EEK |
| Programme of energy technology | N/A | N/A | N/A |
| Programme of entrepreneurship and innovation awareness:<br>Activa.ee<br>Entrepreneurship awareness<br>Export awareness<br>Innovation awareness<br>Management awareness | <br><br>624 169.00 EEK for EE<br>7 476 665.00 EEK for EE<br>2 868 108.00 EEK for EE<br>29 003 210.00 EEK for EE<br>9 820 897.00 EEK for EE | <br><br>2007–2013<br>N/A<br>N/A<br>N/A<br>N/A | <br><br>624 169.00 EEK<br>N/A<br>N/A<br>N/A<br>N/A |
| Programme of international cooperation | N/A | N/A | N/A |
| Programme of internationalization | For EE | N/A | N/A |

| Policy measure | Support given to applicant | Application period | Amount of the measure/programme in 2009 |
|---|---|---|---|
| Start-up and development grant | Start-up grant: up to 100 000.00 EEK with 20% own financing<br>Development grant: up to 500 000.00 with 35% own financing | 2007–2013 | 117,6 million EEK |
| Support for development of knowledge and skills | Over 25 000.00 EEK per project with 50% own financing | 2007–2013 | 200 million EEK |
| Support for involvement of R&D employees | Up to 7 823 300 EEK | 2008–2013 | 210 million EEK |
| Technology investment programme for industrial enterprises | Over 1 000 000.00 EEK with 60–80% own financing | | |
| Training voucher | Up to 15 000.00 EEK with 0% own financing | 2010 | 5 million EEK |

Source: Composed by the author on the bases of EE webpage

# Appendix 9. Alignment between innovation process factors and innovation support measures based on Estonian dairy processors

| | Factors | Innovation support measures |
|---|---|---|
| Idea generation (1) stage | • The quality and development stage of basic research (+)<br>• Recognition of employees as source of innovative ideas (+)<br>• Scanning of business and research environment (+) | • Base financing of transfer of knowledge and technology<br>• Competence centre grant |
| Problem solving stage (2) | • Market has few competing products (-)<br>• Large market (-)<br>• High-quality of technical and market-directed feasibility assessment of the ideas (-)<br>• New products related to market needs/trends (+) | • Product development grant (preparation of product development or applied research)<br>• Competence centre grant<br>• Development of knowledge and skills: business mentoring program<br>• *Innovation vouchers*<br>• <u>Cooperation in the development of new products, processes and technologies</u> |
| Idea application stage (3) | • The adaptability/acceptance of innovation by users (+/-)<br>• Emphasis on marketing (+/-)<br>• Proficient marketing and commitment of resources (-)<br>• Existence of necessary production volumes (-)<br>• Product testing (+/-) | • Subordinated loan<br>• Investment loan guarantee<br>• Working capital loan guarantee<br>• Business loan guarantee<br>• Long-term loan resource offer in cooperation with banks<br>• Credit insurance of short term transactions<br>• Product development grant (product development)<br>• Foreign trade fair grant<br>• Export marketing grant<br>• EXPO 2010<br>• Competence centre grant<br>• Infrastructure investment programme for test and half-industrial laboratories<br>• Cluster development<br>• Development of knowledge and skills: trainings in topics related to export<br>• Joint marketing grant<br>• *Innovation vouchers*<br>• *Start-up loan*<br>• *Start-up and development grant*<br>• <u>*Adding value to agricultural and non-wood forestry products (investment support)*</u><br>• <u>Technology investment programme for industrial enterprises</u><br>• <u>Cooperation in the development of new products, processes and technologies</u><br>• <u>Market development support</u><br>• <u>Setting up and development of producer groups</u> |

| | Factors | Innovation support measures |
|---|---|---|
| 1st and 2nd stage | • Willingness of R&D institutions to cooperate with enterprises (+/-)<br>• Cooperation in R&D (+/-)<br>• High R&D intensity including R&D investments (+/-) | • Product development grant (preparation of product development or applied research , applied research)<br>• Export marketing grant<br>• Base financing of transfer of knowledge and technology<br>• Competence centre grant<br>• Development of creative industry (3 programs)<br>• *Start-up and development grant*<br>• *Innovation vouchers*<br>• Cooperation in the development of new products, processes and technologies |
| 2nd and 3rd stage | • Ability to absorb risks coming from export markets (-)<br>• Product's performance to cost ratio (-) | • Subordinated loan<br>• Investment loan guarantee<br>• Business loan guarantee<br>• Long-term loan resource offer in cooperation with banks<br>• Short- and long-term credit risk guarantee<br>• Pre-shipment risk guarantee<br>• Product development grant (preparation of product development or applied research, product development)<br>• Information about export provided by EE<br>• Export marketing grant<br>• Programme of entrepreneurship and innovation awareness: export awareness<br>• Infrastructure investment programme for test and half-industrial laboratories<br>• Cluster development<br>• Infrastructure investment programme for test- and half industrial laboratories<br>• Development of knowledge and skills: trainings in topics related to export<br>• Information about export provided by EE<br>• Joint marketing grant<br>• *Start-up loan*<br>• *Start-up and development grant*<br>• *Innovation vouchers*<br>• *Adding value to agricultural and non-wood forestry products (investment support)*<br>• Technology investment programme for industrial enterprises<br>• Cooperation in the development of new products, processes and technologies<br>• Export licences and support<br>• Setting up and development of producer groups<br>• Market development support |

| | Factors | Innovation support measures |
|---|---|---|
| All the stages | • Established international relations (+/-)<br>• No contradiction between public and private sector (-)<br>• Country image (+/-)<br>• Structure of the industry (+/-)<br>• Stable economic environment (-)<br>• External financing of innovations (-)<br>• Public sector's innovation support measures (-)<br>• No resistance to change and development (+/-)<br>• Risk-taking behaviour (+/-)<br>• Willingness to cooperate (-)<br>• Identification of suitable partners for cooperation (+/-)<br>• Existence and harmony btw different strategies (-)<br>• Existence of long-term innovation strategy (-)<br>• Allocation of resources (-)<br>• Manager's characteristics (+/-)<br>• (Intrinsic) motivation of employees (+/-)<br>• Competent and skilled employees (-)<br>• Existence of formal NPD process (+/-) | • Subordinated loan<br>• Investment loan guarantee<br>• Working capital loan guarantee<br>• Long-term loan resource offer in cooperation with banks<br>• Investment guarantee<br>• Support for development of knowledge and skills<br>• Support for involvement of R&D employees<br>• Foreign trade fair grant<br>• Export marketing grant<br>• EXPO 2010<br>• Programme of entrepreneurship and innovation awareness: innovation, management, export and entrepreneurship awareness<br>• Programme of entrepreneurship and innovation awareness: aktiva.ee<br>• Centrally organised trainings by EE<br>• Development of knowledge and skills: business mentoring program<br>• Competence centre grant<br>• Cluster development<br>• Joint marketing grant<br>• Programme of internationalization<br>• Programme of international cooperation<br>• Joint stands on foreign fairs<br>• EXPO 2010<br>• *Start-up loan*<br>• *Training vouchers*<br>• *Innovation share*<br>• *Development of knowledge and skills: base training for start-ups*<br>• *Business incubator program*<br>• Training and information activities<br>• Setting up and development of producer groups<br>• Market development support |

Source: Composed by the author on the bases of EE webpage

# Appendix 10. Alignment between innovation process factors and innovation support measures based on Estonian biotech enterprises

| | Factors | Innovation support measures |
|---|---|---|
| Idea generation (1) | • Support for basic research by the public sector (+)<br>• The quality and development stage of basic research (+)<br>• The availability of basic principles helping assembling of invention (+)<br>• Recognition of employees as source of innovative ideas (+)<br>• Existence of internal tacit knowledge (+)<br>• Scanning of business and research environment (+)<br>• Use of lead-user ideas generation model and involvement of clients (+) | • Base financing of transfer of knowledge and technology<br>• Competence centre grant |
| Problem solving stage (2) | • Market has few competing products (-)<br>• Large market (-)<br>• Unique advantage of the product (+/-) | • Product development grant (preparation of product development or applied research)<br>• Competence centre grant<br>• Development of knowledge and skills: business mentoring program<br>• *Innovation vouchers*<br>• **Offset programme for export opportunities** |
| Idea application stage (3) | • Emphasis on marketing (+/-)<br>• Proficient marketing and commitment of resources (-)<br>• Existence of necessary production volumes (-) | • Subordinated loan<br>• Investment loan guarantee<br>• Working capital loan guarantee<br>• Business loan guarantee<br>• Long-term loan resource offer in cooperation with banks<br>• Credit insurance of short term transactions<br>• Product development grant (product development)<br>• Foreign trade fair grant<br>• Export marketing grant<br>• EXPO 2010<br>• Competence centre grant<br>• Infrastructure investment programme for test and half-industrial laboratories<br>• Cluster development<br>• Development of knowledge and skills: trainings in topics related to export<br>• Joint marketing grant<br>• *Start-up loan*<br>• *Start-up and development grant*<br>• *Innovation vouchers*<br>• ***Diversification of the rural economy(investment support)*** |

| | Factors | Innovation support measures |
|---|---|---|
| 1st and 2nd stage | • Willingness of R&D institutions to cooperate with enterprises (+/-)<br>• Patent regulation system of the country (+)<br>• Cooperation in R&D (+/-)<br>• Existing R&D activities (+/-)<br>• High R&D intensity including R&D investments (+/-)<br>• Knowledge, ability and willingness to use patenting (-) | • Product development grant (preparation of product development or applied research , applied research)<br>• Export marketing grant<br>• Base financing of transfer of knowledge and technology<br>• Competence centre grant<br>• Development of creative industry (3 programs)<br>• *Start-up and development grant*<br>• *Innovation vouchers*<br>• ***Diversification of the rural economy (investment support)*** |
| 2nd and 3rd stage | • Knowing (potential) markets (+/-)<br>• Ability to absorb risks coming from export markets (-) | • Subordinated loan<br>• Investment loan guarantee<br>• Business loan guarantee<br>• Long-term loan resource offer in cooperation with banks<br>• Short- and long-term credit risk guarantee<br>• Pre-shipment risk guarantee<br>• Product development grant (preparation of product development or applied research, product development)<br>• Information about export provided by EE<br>• Export marketing grant<br>• Programme of entrepreneurship and innovation awareness: export awareness<br>• Infrastructure investment programme for test and half-industrial laboratories<br>• Cluster development<br>• Infrastructure investment programme for test- and half industrial laboratories<br>• Development of knowledge and skills: trainings in topics related to export<br>• Information about export provided by EE<br>• Joint marketing grant<br>• *Start-up loan*<br>• *Start-up and development grant*<br>• *Innovation vouchers*<br>• ***Diversification of the rural economy(investment support)*** |

| | Factors | Innovation support measures |
|---|---|---|
| All the stages | • Legislations and regulations introduced by government (+/-)<br>• Influence of regulations on duration of innovation process (-)<br>• Favourable tax system (-)<br>• Country image (-)<br>• Structure of the industry (-)<br>• External financing of innovations (-)<br>• ***Public and private sector's innovation support measures (-)***<br>• Size of the company (-)<br>• Age of the company (+/-)<br>• Innovation capability (-)<br>• Risk-taking behaviour (+/-)<br>• Big ambitions (-)<br>• Identification of suitable partners for cooperation (+/-)<br>• Being part of international networks (-)<br>• Previous NPD experiences (+)<br>• Allocation of resources (-)<br>• Manager's characteristics (+/-)<br>• Competent and skilled employees (-)<br>• In-depth understanding of customers and market place (-) | • Subordinated loan<br>• Investment loan guarantee<br>• Working capital loan guarantee<br>• Long-term loan resource offer in cooperation with banks<br>• Investment guarantee<br>• Support for development of knowledge and skills<br>• Support for involvement of R&D employees<br>• Foreign trade fair grant<br>• Export marketing grant<br>• EXPO 2010<br>• Programme of entrepreneurship and innovation awareness: innovation, management, export and entrepreneurship awareness<br>• Programme of entrepreneurship and innovation awareness: aktiva.ee<br>• Centrally organised trainings by EE<br>• Competence centre grant<br>• Cluster development<br>• Joint marketing grant<br>• Programme of internationalization<br>• Programme of international cooperation<br>• Joint stands on foreign fairs<br>• EXPO 2010<br>• *Start-up loan*<br>• *Training vouchers*<br>• *Innovation share*<br>• *Development of knowledge and skills: base training for start-ups*<br>• *Business incubator program*<br>• Development of knowledge and skills: business mentoring program, **trainings in area of space technology**<br>• **Programme of energy technology** |

Source: Composed by the author on the bases of EE webpage

# SUMMARY IN ESTONIAN – KOKKUVÕTE

## Innovatsiooniprotsessi tegurte ja avaliku sektori innovatsiooni toetusmeetmestiku vaheline kattuvus: Eesti piimatöötlejate ja biotehnoloogia ettevõtete analüüs

### Töö aktuaalsus

Enamik riike soovib toetada firmade innovatiivsust, kuna selles nähakse konkurentsivõime peamist tegurit. Ka firmad ise on innovatiivsusest huvitatud, sest uuendusmeelsus suurendab tulu ja/või parandab firma teisi majandusliku edukuse näitajaid. Samas kaasnevad innovatsiooniprojektidega ettevõtte jaoks suured riskid ja ebakindlus, mis toovad kaasa kõrge kulukuse määra. Innovatsiooniprotsessidega kaasneva ebakindluse ja riskide vähendamiseks saab valitsus töötada välja ja rakendada innovatsiooni toetavaid meetmeid. Samal ajal ei tohi need meetmed minna vastuollu ettevõtete vajadustega.

Tihti on innovatsiooni toetusmeetmestik ebaefektiivne, põhjusi võib olla mitmeid. Esiteks, peamised elemendid Euroopa innovatsiooni toetusmeetmestikus on teadus- ja arendustegevuse finantseerimine ja võtmetehnoloogiate kasutamisele kaasaaitamine. Sageli eiratakse riigi keskkonna ja arengustaadiumi mõju ettevõtete käitumisele, kuigi toetusmeetmed peaksid neid elemente arvesse võtma. Kui nende elementidega pole arvestatud, ei pruugi tarvitusele võetavad abinõud olla efektiivsed.

Teine põhjus on seotud piiratud ressurssidega. Kuna finantsressursid, mida kasutatakse ettevõtete innovatiivsuse toetamiseks, on piiratud, tuleb poliitika kujundajatel teha valikuid. Mõnel juhul propageerib avalik sektor teatud võtmetehnoloogiate ja/või tööstusharude toetamist. Samas valikute tegemine on suhteliselt riskantne, kuna keegi ei saa kindlalt väita, et just see sektor või tehnoloogia on strateegiliselt oluline riigi majanduse tuleviku jaoks. Valitud tehnoloogiad ja/või sektorid võivad antud riigis olla hästi arenenud, kuid võrreldes teiste riikidega pole see areng piisav. Samuti tuleb arvestada ajateguriga. Sarnased sektorid erinevates riikides võivad areneda erineva kiirusega, kuna raamtingimused on erinevad. Seetõttu, selle asemel, et toetada teatud sektorit või tehnoloogiat, tuleks toetada neid innovatsiooniprotsessi tegureid või etappe, mis põhjustavad probleeme suuremale osale riigi ettevõtetest.

Et seda teha, peab iga riik analüüsima, millised on need barjäärid või innovatsiooniprotsessi etapid, mis põhjustavad probleeme ettevõtetele, ning kujundama innovatsiooni toetusmeetmestikku vastavalt sellele. See tähendab, et innovatsiooni protsessi mõjutavad tegurid ja innovatsiooni toetusmeetmestik peaksid omavahel kattuma. Ilma kattuvuseta raisatakse ressursse ja innovatsiooni toetusmeetmestiku efektiivsus on oodatust madalam. Ida-Euroopa riikide tootlikkus on madalam kui võiks eeldada, kui võtta aluseks vastavate riikide teadus- ja arendustegevus ning innovatsiooni suutlikkus. Ülejäänud maailmaga võrreldes ei kirjuta nendes riikides teadus-arendustöötajad nii palju publikatsioone ja ei patenteeri teadustulemusi. Eelnev võib olla põhjustatud ebaefektiivsustest innovatsioonisüsteemis. (Kravtsova, Radosevic 2009: 1)

Innovatsiooni toetusmeetmestiku mõju ja rakendamise efektiivsust on hinnatud suhteliselt palju. Viimane hindamisanalüüs Eestis viidi läbi Riigikontrolli poolt ning selle tulemused olid väga kriitilised. Antud doktoritöös hinnatakse innovatsioonipoliitika meetmeid toetudes kattuvuse kontseptsioonile. Kattuvuskontseptsiooni kasutamine innovatsiooni toetusmeetmestiku analüüsimisel ja poliitikate hindamisel ei ole väga laialt levinud. Paljud poliitikaanalüüsid toovad küll ühe ebaefektiivsuse põhjusena sageli välja kattuvuse puudumise innovatsiooni süsteemis, kuid rakendatavat meetodit kattuvuse analüüsimiseks pole loodud. Antud doktoritöös on välja töötatud raamistik hindamaks innovatsiooni toetusmeetmestikku kasutades kattuvuse kontspetsiooni. See võib olla esimene katse kasutada vastavale kontseptioonile tuginevat meetodit poliitikameetmete hindamiseks. Välja töötatud meetod koos selles sisalduvate vahenditega on universaalne ja rakendatav erinevates riikides ning innovatsioonisüsteemides.

Vastava meetodi arendamiseks analüüsiti olemasolevaid innovatsiooniprotsessi mudeleid ja koostati ülevaade innovatsiooniprotsessi mõjutavatest teguritest. Ülevaate koostamine aitas võtta kokku varasemate empiiriliste uuringute tulemused ja tuua välja valdkonnad, mis vajavad lisaanalüüsi.

## Uurimuse eesmärk ja ülesanded

Doktoriöö eesmärgiks on ettepanekute tegemine innovatsiooni toetusmeetmestiku efektiivsuse tõstmiseks, toetudes kattuvusanalüüsi tulemustele. Kattuvusanalüüsi käigus võrreldakse innovatsiooniprotsessi tegureid teatud kindlas sektoris ja vastava riigi innovatsiooni toetusmeetmestikuga. Analüüsi käigus selguvad innovatsiooniprotsessi tegurid, mis põhjustavad probleeme ettevõtetele, kuid ei ole kaetud innovatsiooni toetavate meetmetega, see tähendab puudub kattuvus tegurite ja meetmete vahel. Eesmärgi saavutamiseks on püstitatud järgmised uurimisülesanded:

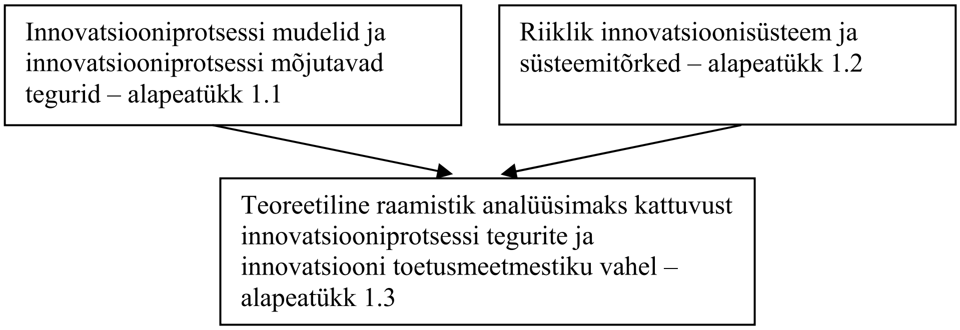
1) tuua välja olemasolevad innovatsiooniprotsessi mudelid ja nende kriitika,
2) töötada välja innovatsiooniprotsessi mudel, mida kasutatakse kattuvuse analüüsimiseks antud doktoritöös,
3) käsitleda ja analüüsida innovatsiooniprotsessi tegureid toetudes väljatöötatud innovatsiooniprotsessi mudelile,
4) antakse ülevaade riiklike innovatsioonisüsteemide käsitlusest ning tuuakse välja selle kriitika,
5) analüüsitakse avaliku sektori majandusse sekkumise põhjuseid süsteemitõrgete raamistikus,
6) viiakse läbi avaliku sektori innovatsiooni toetusmeetmestiku analüüs toetudes riiklike innovatsioonisüsteemide käsitlusele,
7) töötatakse välja raamistik innovatsiooniprotsessi tegurite ja avaliku sektori innovatsiooni toetusmeetmestiku vahelise kattuvuse analüüsimiseks,

8) analüüsitakse Eesti piimatöötlejate ja biotehnoloogia ettevõtete tähtsust,
9) formuleeritakse teesid ja tutvustatakse kasutatavat uurimismetoodikat,
10) tuuakse välja probleemid Eesti ettevõtete innovatsiooniprotsessis ja innovatsiooni toetusmeetmestikus,
11) viiakse läbi kattuvusanalüüs, võttes aluseks innovatsiooniprotsessi mõjutavad tegurid Eesti piimatöötluse ja biotehnoloogia ettevõtetes ning Eesti innovatsiooni toetusmeetmestiku,
12) sünteesitakse uurimistulemusi,
13) töötatakse välja ettepanekud avaliku sektori innovatsiooni toetusmeetmestiku efektiivsuse suurendamiseks.

## Teoreetiline taust

Et töötada välja kattuvuskontseptsioonile toetuv meetod innovatsiooni toetusmeetmestiku hindamiseks, tuli ühelt poolt analüüsida ettevõtete innovatsiooniprotsessi ja seda mõjutavaid tegureid ning teiselt poolt innovatsioonisüsteemi ja avaliku sektori sekkumise põhjuseid süsteemitõrgetest lähtuvalt (Joonis 1). Selleks kasutati antud doktoritöös kirjandust, mis käsitleb nii innovatsiooniprotsessi mudeleid ja selle tegureid kui ka innovatsioonisüsteeme. Innovatsioonisüsteemi käsitlus toob välja ettevõtet ümbritseva keskkonna olulisuse ning sellega seotud süsteemitõrgete raamistik aitab analüüsida avaliku sektori sekkumise vajalikkust ja tõhusust.

Innovatsiooniprotsessi on uuritud juba pikka aega. Et lihtsustada seda keerukat protsessi ja hõlbustada selle analüüsi, on välja töötatud mitmeid innovatsiooniprotsessi mudeleid, alustades lihtsatest pakkumispoolsetest mudelitest ja lõpetades võrgustikmudelitega. Analüüsimaks kattuvust innovatsiooniprotsessi tegurite ja avaliku sektori innovatsiooni toetusmeetmestiku vahel töötas doktoritöö autor välja uue innovatsiooniprotsessi mudeli, võttes arvesse olemasolevate mudelite puudusi. Valminud kolmeetapilise mudeli alusel algab innovatsiooniprotsess ideede genereerimisega, millele järgneb probleemide lahendamise etapp. Protsess lõppeb idee rakendamise etapiga. Kõik need etapid on omavahel seotud ressursside vahetamise ja jagamise kaudu. Näiteks liiguvad erinevate etappide vahel finantsid, informatsioon, teadmine ning teadus- ja arendustegevuse tulemused. Innovatsiooniprotsess võib peatuda ning alata uuesti kas eelnevast või esimesest etapist, kui avastatakse teatud ületamatu takistus. Kolmeetapiline protsess on ümbritsetud ettevõtte sise- ja väliskeskkonnast ning nende teguritest.




**Joonis 1.** Doktoritöö teoreetilise osa ülesehituse üldine loogika

Väljatöötatud innovatsiooniprotsessi mudel on küllaltki üldine. Seda võib kasutada innovatsiooniprotsesside kirjeldamiseks erinevates sektorites, see tähendab, et mudel ei ole sektorispetsiifiline. Mudel võimaldab ka erinevate innovatsioonitüüpide analüüsimist. Seega võib mudelit kasutada erinevate sektorite innovatsiooniprotsesside analüüsimiseks innovatsioonitüübist hoolimata.

Toetudes väljatöötatud innovatsiooniprotsessi mudelile, jagati innovatsiooniprotsessi mõjutavad tegurid erinevatesse gruppidesse. Nii moodustus seitse alagruppi: tegurid, mis mõjutavad innovatsiooniprotsessi esimest etappi; teist etappi; kolmandat etappi; esimest ja teist etappi; teist ja kolmandat etappi; esimest ja kolmandat etappi ning kõiki etappe. Iga seitsme alagrupi sees jagati tegurid omakorda kaheks – välis- ja sisekeskkonna tegurid. Väliskeskkonna tegureid ei saa ettevõte otseselt muuta ega mõjutada, sisekeskkonna tegurid on aga ettevõtete poolt teatud tingimustel muudetavad. Seega peab ettevõte võtma arvesse välis- ja sisekeskkonda ning nende tegureid, mis moodustavad koos kehtivate institutsioonide ja loodud organisatsioonidega innovatsioonisüsteemi. Et analüüsida kattuvust innovatsiooniprotsessi tegurite ja innovatsiooni toetusmeetmestiku vahel tuleb seetõttu uurida ka innovatsioonisüsteemi käsitlust ning avaliku sektori majandusse sekkumise põhjuseid.

Innovatsioonisüsteemi käsitlus pärineb Friedrich Listilt, kes püüdis selgitada erinevusi riikide vahel juba 1841. aastal. Seda tehes analüüsis List riikide sotsiaalseid, kultuurilisi ja majanduslikke tegureid ning tõi välja valitsuse sekkumise tähtsuse. Kuigi Listi peetakse esimeseks, kes uuris innovatsioonisüsteeme, muutus käsitlus populaarseks alles alates Freemani ja Lundvalli töödest, mis avaldati 1980. aastatel.

Innovatsioonisüsteemi käsitlus on mõjutatud interaktiivse õppimise ja evolutsiooniteooria ning suutlikkuse ja rajasõltuvuse kontseptsioonide poolt. Kuigi käsitlust on alates 1980. Aastatest edasi arendatud, ei ole siiski jõutud ühtse definitsioonini ning eksisteerib mitmeid erinevaid innovatsioonisüsteemi tõlgendusi. See on toonud kaasa teatud vasturääkivused erinevate definitsioonide ja tõlgenduste vahel. Samas on teatud ühised aspektid, mida tunnustavad kõik innovatsioonisüsteemide uurijad. Näiteks on kõikide erinevate käsitluste keskmes innovatsioon ja õppimine, toimub evolutsiooniline areng ning ei ole olemas optimaalset ja kõigile sobivat innovatsioonisüsteemi.

Innovatsioonisüsteemi käsitlust on palju kritiseeritud, mis on omakorda aidanud kaasa selle parendamisele. Peamine innovatsioonisüsteemi käsitluse kriitika on olnud seotud raskusega süsteemi piiritleda, süsteemi piirid tulenevad aga innovatsioonisüsteemi definitsioonist. Vastavalt innovatsioonisüsteemi laiale definitsioonile, kuuluvad innovatsioonisüsteemi kõik organisatsioonid ja institutsioonid, mis on seotud innovatiivse tegevusega. Eelnev tähendab, et teatud juhtudel on terve Maa üks innovatsioonisüsteem. Sageli püütakse piiritlemise probleemi lahendada uurimiseesmärgi abil, see tähendab, et võetakse arvesse vaid kõige tähtsamad organisatsioonid ja institutsioonid, et saavutada uurimiseesmärki.

Kriitikat aitab vähendada ka innovatsioonisüsteemi funktsioonide määratlemine. Innovatsioonisüsteeme võib uurida süsteemi funktsioonidest ning funktsioonide efektiivsusest lähtuvalt. Funktsioonide määratlemine aitab kaasa süsteemi piiritlemisele, kvantitatiivsete näitajate väljatöötamisele ning kõikide oluliste seoste ja voogude analüüsi kaasamisele. Käesolevas doktoritöös võetakse aluseks funktsioonid, mis on väljatöötatud Edquisti ja Hommeni poolt 2008. aastal. Nad toovad välja neli innovatsioonisüsteemi funktsiooni: innovatsiooniprotsessi varustamine teadmistega, nõudluspoolsete tegevuste väljatöötamine, innovatsioonisüsteemi osade loomine ja ettevõtetele suunatud toetusmeetmete rakendamine. Et toetada olemasolevaid ja efektiivselt toimivaid funktsioone ja/või eemaldada süsteemi tõrkeid, tuleb välja töötada ja rakendada erinevaid poliitika meetmeid. Eelnev toetab ka ettevõtete innovatsiooniprotsesside läbiviimist ja aitab tõsta poliitika meetmete efektiivsust.

## Uurimismetoodika ja kasutatavad andmed

Kattuvuse analüüsimiseks kasutati teoreetilist raamistikku, mis töötati välja peatükis 1.3.2. Teoreetiline raamistik toetub autori poolt loodud innovatsiooniprotsessi mudelile, innovatsiooniprotsessi mõjutavate tegurite alagruppidele ja innovatsiooni toetavatele meetmetele. Tegurid, mis mõjutavad innovatsiooniprotsessi Eesti piimatöötlus- ja biotehnoloogia ettevõtetes ning innovatsiooni toetavad meetmed on jagatud seitsmesse alagruppi innovatsiooniprotsessi etappide alusel: tegurid/meetmed, mis mõjutavad innovatsiooniprotsessi esimest, teist ja kolmandat etappi eraldi, esimest ja teist etappi, teist ja kolmandat etappi, esimest ja kolmandat etappi ning kõiki etappe.

Tegurite ja meetmete grupeerimine seitsmesse alagruppi võimaldab uurida innovatsiooniprotsessi tegureid, innovatsiooni toetavaid meetmeid ja nendevahelist kattuvust. Innovatsiooniprotsessi tegurite analüüsi käigus võrreldakse tegureid, mis mõjutavad innovatsiooni ühes kindlas ettevõtete grupis alapeatükis 1.1.2. välja toodud tegurite loeteluga. Innovatsiooni toetusmeetmestiku analüüs hindab aga alapeatükis 1.1.2. välja toodud tegurite kaetust nende meetmete poolt. Kattuvus tegurite ja meetmete vahel hindab teatud ettevõtete grupi innovatsiooniprotsessi tegurite kaetust vastava riigi innovatsiooni toetusmeetmestikuga.

Kattuvusanalüüs viiakse läbi kahes ettevõtete grupis: piimatöötlejad ja biotehnoloogia ettevõtted. Piimatöötlejad esindavad traditsioonilist tööstusharu, biotehnoloogia ettevõtted aga kõrgtehnoloogilisi ettevõtteid. Biotehnoloogiliste lahenduste kasutamine piimatöötlejate poolt võimaldab analüüsida ka kõrgtehnoloogia kasutamist traditsioonilises sektoris.

Analüüsimiseks kasutati juhtumanalüüse. Andmed koguti intervjuude käigus. Intervjueeritavateks olid piimatööstuse, biotehnoloogia ja avaliku sektori organisatsioonide esindajad. Kõik intervjueeritavad omasid sidemeid või olid tegevad kahes ettevõtete grupis või avalikus sektoris. Lisaks koguti andmeid avalikest informatsiooniallikatest ja eelnevalt läbiviidud uuringutest. Et kirjeldada piimatöötlejate ja biotehnoloogia ettevõtete innovatiivsust, kasutati Eesti Ettevõtete Innovatsiooniuuringu andmeid, Eesti Äriregistri andmebaasi ja lisaküsimustikku, mis saadeti täitmiseks Eesti biotehnoloogia ettevõtetele.

## Töös püstitatud uurimisväited ja analüüsi tulemused

Doktoritöö autor püstitas seitse teesi testimaks innovatsiooniprotsessi mudelit ja tegureid, Eesti innovatsiooni toetusmeetmestiku kujundamist ja kattuvust. Allpool on esitatud ülevaade teesidest ja tulemustest.

**Tees 1.** Alapunktis 1.1.1. väljatöötatud innovatsiooniprotsessi mudel kirjeldab innovatsiooniprotsessi nii piimatöötlus kui ka biotehnoloogia ettevõtetes, see tähendab, et mudel ei ole tegevusalapõhine.

Intervjuude käigus selgus, et väljatöötatud innovatsiooniprotsessi mudel sobib kasutamiseks nii piimatöötlus- kui ka biotehnoloogia ettevõtetes. Kuigi innovatsiooniprotsess võib tegevusalade lõikes natuke erineda, võimaldab väljatöötatud innovatsiooniprotsessi mudel neid erinevusi uurida. Innovatsiooniprotsess algab ideede genereerimisega, millele järgneb probleemide lahendamise ja idee rakendamise etapp mõlemas ettevõtete grupis. Kui põhjalik ja pikaajaline iga etapp on, sõltub vastavast olukorrast.

**Tees 2.** Riigi-spetsiifilised innovatsiooniprotsessi tegurid domineerivad tegevusala-spetsiifiliste innovatsiooniprotsessi tegurite üle Eesti piimatöötlus- ja biotehnoloogia ettevõtetes.

Innovatsiooniprotsessi tegurite võrdlus kahes ettevõtete grupis tõi välja mõned tegevusala-spetsiifilised tegurid. Näiteks biotehnoloogia ettevõtete innovatsiooniprotsess on rohkem kui piimatöötlejate innovatsiooniprotsess mõjutatud arengutest teaduses, intellektuaalse omandiõiguse süsteemist, riskikapitalistide olemasolust ja regulatsioonide ühtlustamisest. Samas, suurem osa innovatsiooniprotsessi mõjutavatest teguritest olid mõlemas ettevõtete grupis sarnased. Need sarnased tegurid olid riigi-spetsiifilised tegurid, seega Tees 2 leidis kinnitust.

**Tees 3.** Eesti avaliku sektori esindajad peavad teadmistega varustamist kõige tähtsamaks innovatsioonisüsteemi funktsiooniks.

Hindamaks Teesi 3, paluti avaliku sektori esindajatel nimetada funktsioone, mis peaksid ühes innovatsioonisüsteemis olemas olema. Kõige sagedamini nimetati ettevõtetele suunatud toetusmeetmete rakendamist, sellele järgnes innovatsioonisüsteemi osade loomine, teadmistega varustamine oli tähtsuselt kolmas funktsioon. Seega tulemused ei toeta Teesi 3 ja Tees 3 ei leidnud kinnitust.

**Tees 4.** Arengud Euroopa Liidu innovatsiooni toetusmeetmestikus mõjutavad Eesti innovatsiooni toetusmeetmestiku kujunemist.

Euroopa Liit mõjutab Eesti innovatsiooni toetusmeetmestiku kujunemist kahel viisil – läbi finantsressursside ja liikmesriikide poliitikameetmetest õppimise (*policy learning*). Innovatsiooni toetavate meetmete rakendamiseks kasutatakse peamiselt Euroopa Liidust tulevat raha. Seepärast peavad Eesti poliitikakujundajad võtma arvesse õigusraamistikku, mis reguleerib struktuurifondide kasutamist ja riigiabi andmist. Lisaks finantsressurssidele ja nende kasutamisega seotud piirangutele, on Eesti innovatsiooni toetusmeetmestiku kujundamine mõjutatud Euroopa Liidu poolt ka liikmesriikide kogemustest ja poliitikatest õppimise kaudu. Selle protsessi käigus analüüsitakse esmalt olemasolevaid probleeme ning teiseks otsitakse parimat praktikat probleemi lahendamiseks. Teiste riikide kogemustest õppimist toetab ka Euroopa Liit, et vähendada ressursside raiskamist, mis võib kaasneda mittesobivate meetmete rakendamisega. Seetõttu võib öelda, et Tees 4 leidis kinnitust.

**Tees 5.** Peamised innovatsiooniprotsessi tegurid, mis tekitavad probleeme Eesti piimatöötlejate ja biotehnoloogia ettevõtete jaoks, on seotud innovatsiooniprotsessi kolmanda etapiga – idee rakendamise etapiga.

Tees 5 ei leidnud kinnitust. Kuigi intervjueeritavad tõid välja mitmeid tegureid, mis mõjutavad innovatsiooniprotsessi kolmandat etappi ja põhjustavad probleeme ettevõtete jaoks, ei olnud need tegurid domineerivad. Peaaegu iga innovatsiooniprotsessi etapp oli mõjutatud ühe või mitme problemaatilise teguri poolt. Ainsana ei nimetatud tegureid, mis mõjutavad innovatsiooniprotsessi esimest ja kolmandat etappi samaaegselt.

**Tees 6.** Eesti innovatsiooni toetusmeetmestik katab peamiselt innovatsiooniprotsessi esimesi etappe.

Kui võtta arvesse innovatsiooni toetavate meetmete arv, mis on suunatud innovatsiooniprotsessi esimestele etappidele, võiks öelda et Tees 6 ei leidnud kinnitust. Võrreldes esimese ja teise etapi toetamiseks rakendatud meetmete arvu kolmanda etapi toetamiseks rakendatud meetmete arvuga on viimane suurem. Kui aga võtta aluseks meetmete rahaline maht, on rohkem raha suunatud innovatsiooniprotsessi esimestesse etappidesse. Seega Tees 6 leidis osalist kinnitust.

**Tees 7a.** Kattuvus innovatsiooniprotsessi tegurite ja innovatsiooni toetusmeetmestiku vahel on sektorispetsiifiline.
**Tees 7b.** Kattuvus on suurem biotehnoloogia ettevõtete puhul.

Joonised 26 ja 27 kirjeldavad kattuvust innovatsiooniprotsessi tegurite ja innovatsiooni toetusmeetmestiku vahel, võttes aluseks Eesti andmed. Need joonised on täiesti sarnased. Seega, toetudes nendele joonistele, ei leia Teesid 7a ja 7b kinnitust. Täpsem analüüs toob aga välja erinevused kahe ettevõtete grupi vahel. Kattuvusanalüüsi tulemusena selgus, et piimatöötlejatele põhjustavad probleeme takistused, mis on seotud Venemaa turule sisenemisega ja need toetusmeetmed, mille raames on kehtestatud teatud piirangud suurettevõtetele. Biotehnoloogia ettevõtetele põhjustavad probleeme Euroopa Liidu regulatsioonid ja puuduv riskikapitaliturg. Samas on mitmed probleemid kahe ettevõtete grupi jaoks samad. Seega, Tees 7a leidis kinnitust, kuid Tees 7b kinnitust ei leidnud.

Esitatud tulemuste alusel töötati välja ettepanekud kattuvusanalüüsi instrumentide kasutamiseks ja innovatsiooni toetusmeetmestiku efektiivsuse tõstmiseks. Efektiivsuse tõstmise ettepanekud saab jaotada nelja gruppi: ettepanekud, mis on olulised Eesti piimatöötlejatele, biotehnoloogia ettevõtetele, mõlemale ettevõtete grupile ja avaliku sektori organisatsioonidele.

Ettepanekud, mis on olulised piimatöötlejatele, on järgmised:

- parandada Eesti ja Venemaa vahelisi suhteid, et toetada Eesti piimatöötlejate tegutsemist Venemaa turul;
- luua ekspordigarantiide süsteem, mis katab Venemaale eksportimise riskid.

Ettepanekud, mis on olulised biotehnoloogia ettevõtetele, on järgmised:

- luua riskikapitali turg, sh luua soodsad tingimused välisriskikapitalistide investeeringuteks;
- lisaks uute teadustulemuste loomisele, toetada ka maailmaturul olemasolevate biotehnoloogia toodete edasiarendamist;
- välja töötada meetmed, mis aitaksid biotehnoloogia ettevõtetel luua sidemeid rahvusvaheliste ravimifirmadega;
- toetada taotletud patentide kasutamisest huvitatud partnerite leidmist;
- kasutada riigihankeid kui nõudluspoolset poliitikameedet, et toetada biotehnoloogia ettevõtete innovatiivsust.

Ettepanekud, mis on olulised mõlemale ettevõtete grupile, on järgmised:

- vähendada innovatiivse tegevusega kaasnevaid riske ja pakkuda koolitusi, mis on suunatud innovatsiooni suutlikkuse tõstmisele;
- soosida kõrgtehnoloogia ja traditsioonilise sektori ettevõtete koostööd toetades kõrgtehnoloogiliste lahenduste kasutamist traditsioonilises sektoris;
- luua avaliku sektori organisatsiooni töökoht inimesele, kes vahendaks informatsiooni kõrgtehnoloogilise ja traditsioonilise sektori ettevõtete vahel;
- muuta innovatsiooni toetavate meetmete tingimusi ettevõtetele soodsamaks;
- rakendada maksusoodustusi teadus- ja arendustegevusele.

Ettepanekud, mis on olulised avaliku sektori organisatsioonide töö tõhustamiseks, on järgmised:

- kaasata innovatsiooni toetusmeetmestiku väljatöötamisse ja rakendamisse kõik olulised avaliku sektori organisatsioonid ning parandada informatsiooni vahetust nende osapoolte vahel;
- tõsta ministeeriumite analüüsi võimekust;
- vähendada innovatsiooniprojekti rakendamisega seotud riske ettevõtete jaoks suurendades avaliku sektori organisatsioonide vastutust;
- vähendada tööjõu liikuvust avaliku sektori organisatsioonides, et suurendada seal töötavate inimeste kogemuste pagasit.

Mitmed eelnevalt nimetatud probleemid ning ettepanekud on seotud Eesti innovatsioonipoliitika lühikese ajalooga. Võib öelda, et Eestis ikka veel luuakse baasi innovatsioonipoliitikale ja riiklikule innovatsioonisüsteemile. Seetõttu on innovatsioonisüsteemi osalejate rollid lõplikult välja kujunemata ning koordinatsioon ja kommunikatsioon erinevate osaliste vahel vajab parandamist. Kui süsteemi osalised saavad rohkem kogemusi, aitab see lahendada olemasolevaid probleeme kiiremini ja paremini. Samas on mitmed probleemid, mille põhjused peituvad mujal. Üheks selliseks probleemiks on järjepidevuse puudumine otsustusprotsessis. Innovatsiooni toetusmeetmestiku väljatöötamine ja rakendamine nõuab järjepidevust, alustades strateegiadokumentide koostamisega ning lõpetades püstitatud eesmärkide täitmise kontrollimisega.

## Soovitusi tulevasteks uuringuteks

Innovatsiooni toetusmeetmestiku ja innovatsiooniprotsessi tegurite vaheline kattuvus väärib uurimist ka tulevikus. Temaatika edasiarendamiseks on mitmeid erinevaid võimalusi. Üheks võimalikuks tulevikus tehtavaks uuringuks on uurida põhjalikumalt innovatsiooniprotsessi mõjutavaid tegureid. Antud töös esitatud ülevaade innovatsiooniprotsessi teguritest on suhteliselt detailne, kuid vajaks lisauurimusi. Käesolevas doktoritöös selle probleemistikuga põhjalikumalt ei tegeletud, kuna innovatsiooniprotsessi tegurid ja nende grupeerimine olid vaid üheks etapiks kattuvusanalüüsi teostamisel. Innovatsiooniprotsessi tegurite raamistikku saaks aga edasi arendada lisades analüüsi täiendavaid tegureid ja testides nende tegurite liigituse aluseks olnud raamistikku.

Teiseks võimaluseks on kasutada väljatöötatud kattuvusanalüüsi meetodit uute toetusmeetmete väljatöötamiseks. Et seda teha, peaks muutma vaid intervjuuplaani. Samuti võib lisada kattuvusanalüüsi täiendavaid poliitikameetmeid, avaliku sektori organisatsioone, ülikoole ja/või tööstusharusid. Üheks võimaluseks on täiendada uurimust näiteks Teadus- ja Haridusministeeriumi poolt väljatöötatud toetusmeetmestiku analüüsiga.

Kattuvusanalüüsi meetodit ennast saab samuti parendada, lisades analüüsile toetusmeetmete kaudu jaotatavad summad. Selleks on aga vaja analüüsida iga toetusmeedet eraldi ning hinnata positiivse otsuse saanud projekte. Eelnev annab informatsiooni, millise innovatsiooniprotsessi etapi jaoks raha küsiti, ning võimaldab analüüsida meetme eesmärkide täpsemat täidetust ja sobivust riigi keskkonda.

Samuti tuleks põhjalikumalt uurida süsteemitõrkeid ja seda nii erasektori kui ka avaliku sektori poole pealt. Süsteemitõrgetele ei ole seni piisavalt tähelepanu pööratud, kuid just süsteemitõrked võivad kaasa tuua ebaefektiivsuse toetusmeetmestiku kujundamises ja rakendamises.

# CURRICULUM VITAE

## Dorel Tamm


**Nationality:** Estonian
**Place and date of birth:** Kanepi, March 23rd 1978
**Present position:** Project manager, Faculty of Economics and Business Administration, University of Tartu
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**Education:**

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| 2004–to date | PhD Student, University of Tartu |
| 2002–2004 | MA, economics, University of Tartu |
| 1997–2002 | BA, economic policy and international economics (*cum laude*), University of Tartu |
| 1993–1996 | Nõo Science School |
| 1985–1993 | Ahja Secondary School |

**Foreign languages:** English, some Russian

**Employment:**

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| 2009–to date | Project manager, Faculty of Economics and Business Administration |
| 2008–2008 | Visiting researcher, SPRU, University of Sussex |
| 2008–2008 | Analyst, Estonian Academy of Sciences |
| 2006–2008 | Analyst, Institute of Baltic Studies |
| 2005–2008 | Extraordinary researcher, Doctoral School in Economics, Faculty of Economics and Business Administration, University of Tartu |
| 2005–2006 | Researcher, Chair of Public and International Economy, Faculty of Economics and Business Administration, University of Tartu |
| 2005–2006 | Specialist, Chair of Public and International Economy, Faculty of Economics and Business Administration, University of Tartu |
| 2003–2005 | Project manager, Chair of International Business and Innovation, Faculty of Economics and Business Administration, University of Tartu |

**Studies, research abroad:**

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| 2006 | Doctoral seminar „Gate2Growth Academic Network. Doctoral Tutorial", organised by IESE and Gate2Growth, Barcelona, Spain |
| 2005 | Doctoral seminar „Gate2Growth Academic Network. Doctoral Workshop", organised by Nottingham University Business School and Gate2Growth, Nottingham, UK |

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| 2004 | Study visit „Benchmarking with Swiss Science Enterprise", organised by Enterprise Estonia, Create Switzerland and Gerbert Rüf Stiftung, Zurich, Lausanne, Switzerland |
| 2004 | Seminar „Benchmarking, visitation of enterprises Koskisen OY ja UPM Kymmene", organised by Enterprise Estonia and Estonian Centre of Excellence, Lahti, Finland |
| 2004 | Doctoral seminar „The Doctoral Seminar Series in Entrepreneurship, Innovation and Finance", organised by Vlerick Leuven Gent Management School and Gate2Growth, Gent, Belgium |
| 2003 | Training "European Union in the Baltic Sea Region", organised by Jean Monnet Centre of Excellence, University of Turku ja EuroCollege, University of Tartu, Turku, Finland |

**Lecturing:** Public sector management
Economics of education

**Main research interests:**
- Role of innovations in competitiveness;
- Role of public sector in supporting innovativeness of enterprises;
- Influence of innovation policy measures on enterprises, regions, economy;
- Competitiveness of manufacturing industry

# ELULOOKIRJELDUS

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| **Sünniaeg ja -koht:** | 23.03.1978, Kanepi |
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| 2004–praeguseni | Tartu Ülikooli doktorant |
| 2002–2004 | MA, majandusteaduse eriala, Tartu Ülikool |
| 1997–2002 | BA, majanduspoliitika ja välismajanduse erialad (*cum laude*), Tartu Ülikool |
| 1993–1996 | Nõo Reaalgümnaasium |
| 1985–1993 | Ahja keskkool |

**Võõrkeeled:** Inglise keel, vähesel määral vene keel

**Teenistuskäik:**

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| 2009– praeguseni | Projektijuht, Tartu Ülikooli majandusteaduskond |
| 2008–2008 | Külalisuurija, SPRU, Sussexi Ülikool |
| 2008–2008 | Analüütik, Eesti Teaduste Akadeemia |
| 2006–2008 | Analüütik, Balti Uuringute Instituut |
| 2005–2008 | Erakorraline teadur, Majandusteaduse doktorikool, Tartu Ülikooli majandusteaduskond |
| 2005–2006 | Teadur, Riigimajanduse õppetool, Tartu Ülikooli majandusteaduskond |
| 2005–2006 | Spetsialist, Riigimajanduse õppetool, Tartu Ülikooli majandusteaduskond |
| 2003–2005 | Projektijuht, Rahvusvahelise ettevõtluse ja innovatsiooni õppetool, Tartu Ülikooli majandusteaduskond |

**Erialane enesetäiendamine:**

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| 2006 | Doktoriseminar „Gate2Growth Academic Network. Doctoral Tutorial", mille korraldasid IESE ja Gate2Growth, Barcelona, Hispaania |
| 2005 | Doktorikursus „Gate2Growth Academic Network Doctoral Workshop", mille korraldasid Nottingham University Business School ja Gate2Growth, Nottingham, Suurbritannia |
| 2004 | Õppereis „Benchmarking with Swiss Science Enterprise", mille korraldasid Ettevõtluse Arendamise Sihtasutus, Create Switzerland ja Gerbert Rüf Stiftung, Zurich, Lausanne, Šveits |

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| 2004 | Seminar „Benchmarking-ettevõttekülastus Soome firmadesse Koskisen OY ja UPM Kymmene”, mille korraldasid Ettevõtluse Arendamise Sihtasutus ja Eesti Juhtimiskvaliteedi Keskus, Lahti, Soome |
| 2004 | Doktorikursus „The Doctoral Seminar Series in Entrepreneurship, Innovation and Finance”, mille korraldasid Vlerick Leuven Gent Management School ja Gate2Growth, Gent, Belgia |
| 2003 | Koolitus “European Union in the Baltic Sea Region”, mille korraldasid Jean Monnet Centre of Excellence, University of Turku ja EuroCollege, University of Tartu, Turku, Soome |

**Õppetöö:** Avaliku sektori ökonoomika
Haridusökonoomika

**Peamised uurimisvaldkonnad:**

– Innovatsioonide roll konkurentsivõime tõstmisel
– Avaliku sektori roll ettevõtete innovaatilise tegevuse toetamisel
– Innovatsioonipoliitika meetmete mõju ettevõtetele, regioonidele, majandusele
– Eesti töötleva tööstuse konkurentsivõime

# DISSERTATIONES RERUM OECONOMICARUM UNIVERSITATIS TARTUENSIS

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