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**INVESTIGATION OF THE RESEARCH AND DEVELOPMENT AND
INNOVATION PROCESSES OF NORTHERN HUNGARIAN COMPANIES
FOR THE PURPOSE OF IMPROVING THE INNOVATION CAPACITY
OF THE ORGANIZATIONS**

Theses of doctoral (PhD) dissertation



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PRESENTATION OF THE RESEARCH TOPIC

The world is changing faster than ever. Due to globalization, technological development, and the transformation of communication, the needs of the market are constantly renewed. Actors in society and economic life have realized that innovation has become a factor providing a significant competitive advantage. Several measures supporting research and development and innovation of the European Union confirm that innovation is increasingly considered one of the most important sources of competitive advantages of modern economies. Compared to this, the European Union is far behind the world's leading innovative states in the rankings examining research and development and innovation (more recently, the literature already mentions R&D&I systems at the level of national economies, Csuka-Török, 2014). This problem is even more intense for Hungary, since it has been among the moderate innovators for decades based on the data of the European innovation scoreboard, but it is even lagging behind the Visegrád countries. The reasons for this must be sought, among other things, in the functioning of the Hungarian economy and society, as well as the R&D&I system, which is supported by research conducted at several national (macro), regional (meso) and corporate (micro) levels (Takács 2017, Kocziszy-Szendi, 2018, Benedek, 2020).

In addition to all this, because of the globalized world economy, the nation-state is increasingly losing its importance and the regional level is becoming the focal point of economic activities (Lundvall 1992, Dóry, 2005), since the challenges of global competition can only be met with effective local reactions, specifically the concentration of specialized expertise, know-how and institutions. As a result, international and domestic literature increasingly appear in addition to the analysis of countries' innovation capacity, as well as regional or local level analyzes (Dóry 2005, Kocziszy 2004). This change in attitude is supported by the 2020 and 2030 objectives of the Research, Development and Innovation Strategy of Hungary prepared by NKFIH, which include a number of actions to strengthen regions, including businesses.

One of the most important tasks for the state is to create an entrepreneurial environment that supports and encourages innovation. And businesses can succeed by developing an innovation strategy based on real market needs, by developing innovation capabilities and by working together with actors in the innovation ecosystem.

In recent years numerous researches have highlighted that the Northern Hungarian region is geographically, socially and economically located on the periphery of Hungary, and has been unable or barely able to break out of this peripheral position for decades (Takács 2017, Kocziszy-Szendi 2018, Tóth-Kiss, 2021). Conditions for innovation in the region are unfavourable.

The value of R&D expenditure in Northern Hungary totalled HUF 28.313 billion in 2020, which, although increasing steadily over the last 10 years, did not reach 4% of the national rate in any single year (RIS, 2021).

In terms of regional innovation performance, the Northern Hungarian region belongs to the group of emerging innovators, a significant difference compared to the EU average in 2020 (49,1%) (RIS, 2021).

Based on the examined regional data, the improvement of the competitiveness of Northern Hungary cannot wait any longer, one of the means of which is the development of the regional innovation potential, in which, in my opinion, the enterprises present in the region play a major role. The motivation for the research is also generated for personal reasons, since I have been living and doing research in Miskolc since my university studies, so I personally experience that the examination and development of companies' innovation capacity in the Northern Hungarian region is now a task of strategic importance.

Based on these, my research topic covers three large areas, which are the following: innovation, enterprises, and one of the most disadvantaged territorial units of Hungary, the Northern Hungarian region. My questionnaire data collection took place before the emergence of the coronavirus situation, so I do not intend to provide a picture of the effects of this special situation, my investigations characterized the innovation behavior and processes of companies in the region under 'normal market' conditions.

1. PURPOSE OF THE RESEARCH, RESEARCH QUESTIONS

The purpose of my research is to explore critical areas (GAPs) in order to develop the innovation capacity of companies in Northern Hungary, which enables the improvement of R&D&I performance, contributing to organizational performance and, in the long term, to the competitiveness of the region.

Based on the experience of empirical research, there is a need to create an integrative framework that reveals the ways to explain innovation performance, sheds light on the analysis of external and internal factors and stakeholders influencing the R&D&I process from a new perspective, and their relationship with organizational performance.

The detailed research questions and aspects that can be derived from the basic research objectives are as follows:

- What external and internal factors influence the R&D&I activities of Northern Hungarian companies?
- Can companies in Northern Hungary be grouped based on the use of tools, methods, and institutions that support innovation activity? Is it possible to

discover common characteristics in the companies' R&D&I activities and processes?

- Can typical mistakes be found in the innovation activity of Northern Hungarian companies?
- What strategy can be used to support each type of company? How can companies with different characteristics be successful?
- Does carrying out R&D&I activities have an impact on organizational performance?
- What are the factors on the basis of which the R&D&I processes of companies in Northern Hungary are successful?

2. THE SYSTEM OF RESEARCH HYPOTHESES

Based on the research objectives, the hypotheses of the research were formulated based on research and development, innovation, and organizational performance literature sources, as well as the results and experiences of my previous research.

Figure 1 shows the location of the hypotheses in the research model, as well as the relationships and correlations between the explanatory and response variables. Among the explanatory variables, the first hypothesis refers to the external and internal factors related to the performance of the innovation activity, which I established during the literature research. I examine the relationship between these explanatory factors and the performance of innovation activities. The second hypothesis focuses on the factors affecting the R&D&I process, their direction of influence, and their effect on the effectiveness of each type of innovation. The third hypothesis examines further internal correlations of the characteristics of the R&D&I process with the help of IPA analysis (Importance Performance Analysis) of the factors. The fourth hypothesis examines the innovation activity itself, its outputs (innovation types), as explanatory variables, the direction and strength of influence on the components of the response variable, i.e., organizational performance, as well as the internal relationships of the components of organizational performance. The fifth hypothesis examines the influence direction and strength of the explanatory variables of the groups of factors that prevent the implementation of innovation activity on the components of the response variable, i.e., organizational performance. Regarding organizational performance, I consider the Kaplan-Norton (2002) Balanced Scorecard dimensions, which are financial performance, customer performance, operational process performance, and learning and development performance. The relationships examined in the

fourth and fifth hypotheses - based on what was also presented in the literature section- have been proven by others, but for the sake of my model creation, I would like to receive confirmation from my own database so that the final model is sufficiently grounded. The sixth hypothesis formulates an integrative innovation capability building model for companies operating in the Northern Hungarian region based on the literature and empirical experience.

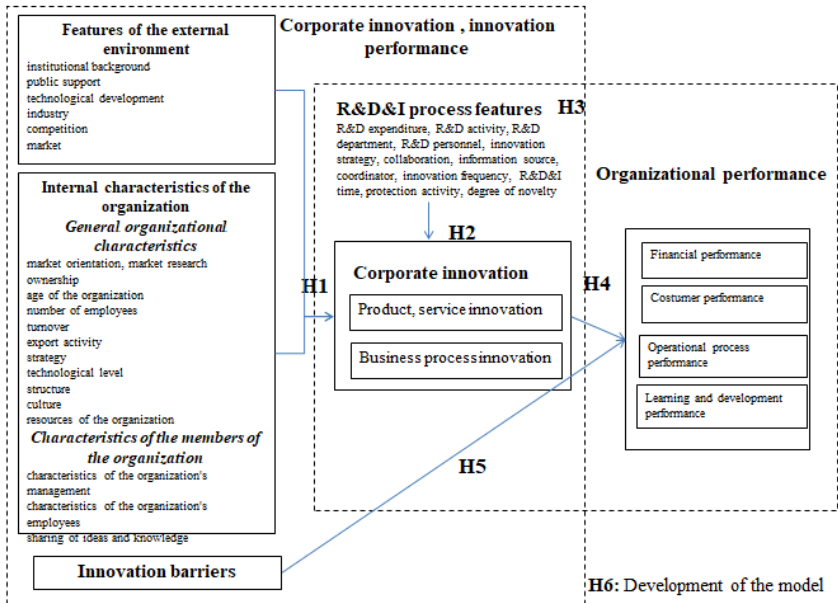


Figure 1: Relationship model of research hypotheses (own compilation)

Research hypotheses

- H1: The chance of innovative activities of Northern Hungarian companies can be explained on the basis of external characteristics and internal characteristics (general organizational characteristics and the characteristics of the organization's members).
- H2: Organizations carrying out innovation in Northern Hungary can be characterized based on the tools (methods, institutions) supporting innovation activity. The effectiveness of the innovation activities of companies in Northern Hungary can be explained with the help of the characteristics of the R&D&I process.
- H3: There is a difference between the factors of the R&D&I process in terms of the extent to which companies consider them important, and at the same time, how effectively and with good performance they are present in the organizations' R&D&I processes.
- H4: Among the organizations in Northern Hungary, organizations carrying out innovation activities are more effective and have better corporate performance.
- H5: The existence of factors that hinder innovation has a negative effect on the organization's performance. The company is more effective and has better organizational performance, where there are fewer inhibiting factors.
- H6: The key areas of organizational innovation ability and suitability conditions can be determined and a multi-level innovation framework model based on this, supporting the response to regional challenges, can be defined, by applying which the effectiveness of the research and development and innovation processes of companies in Northern Hungary can be increased.

3. THE RESEARCH PROCESS

The following table sets out the research process and the tasks carried out at each stage and their results.

Table 1: Research process, phases and results (*own editing based on Babbie (2016)*)

Phase	Method, content	Result
Phase 1: research concept	Evaluation of previous research experience, formulation of research concept	Research objective, questions, research model
Phase 2: exploratory research	Defining the research object, refining the research line, preparing the empirical survey	Hypotheses
Phase 3: descriptive research	Creation of analysis model, first version of questionnaire, testing with potential participants, analysis and finalisation of questionnaire, interviews with experts, questionnaire survey	Questionnaire form and completed questionnaires
Phase 4: analysis and evaluation	Organising and summarising data, carrying out statistical analysis, evaluating results	Research findings, conclusions
Phase 5: modelling and validation	Expert confirmation of the applicability of the model, conditions of use	Finalised model
Phase 6: documentation	Publication of research results	Publication, dissertation

The data collection

I conducted both primary and secondary research to meet my research objectives and to verify my preliminary hypotheses. Secondary research was carried out by reviewing national and international literature on the understanding, process and models of R&D and innovation. The results of the secondary research work should provide a thorough underpinning for the process, methods and results of the empirical research, which forms the second main part of my thesis. The primary research work was carried out by designing empirical research based

on pre-designed qualitative and quantitative data collection. Data collection was carried out through interviews and a questionnaire survey, which is the most common primary information gathering technique in social research. The focus of the research is on companies operating in Northern Hungary. This is the scope of the research, which aims to obtain valid correlations in this area. For the empirical study, an online questionnaire survey was conducted between January 2019 and February 2020 using Evasys system. Since answering the questions required a comprehensive knowledge of the organization, the research questionnaire was sent to senior managers of the companies to fill in. In compiling the questionnaire, I used the Community Innovation Survey questionnaire and the experience of previous research in the region. The questionnaire covers data over a five-year period and is divided into four main parts. It first focuses on general information about companies, followed by questions on external and internal capabilities. Then, R&D and innovation characteristics (R&D activity, innovation inputs, innovation process characteristics, innovation outputs) are assessed, followed by questions based on a self-assessment of organizational performance.

A key objective in the data collection was to exceed the minimum number of items criterion for the statistical methods to be used to test the hypotheses. In addition, it was important to have the largest possible sample, which would allow the best possible representation of reality. At the end of the survey (February 2020), 297 questionnaires had been completed and evaluated. The sampling was simple random sampling. Due to the random sampling and unsuccessful interviews, the sample of 297 companies does not accurately reproduce the business population in the region. This, however, may not reduce the value of the results (Dusek, 2019). The completed questionnaires were pre-processed in excel and then transferred to SPSS. After setting the measurement levels of the variables in SPSS, it became possible to run the corresponding analytical tests.

4. METHODOLOGIES USED TO TEST THE HYPOTHESES

A summary of the hypotheses - methodology matrix is presented in Table 2.

Table 2: Summary of the methods used in my quantitative research based on Sajtos - Mitev (2007), George - Mallery (2019)

Hypotheses	Empirical calculations and econometric tests carried out
H1	descriptive statistical methods, binary logistic regression
H2	descriptive statistical methods, cluster analysis, linear regression
H3	importance-performance analysis (IPA), correlation analysis, paired samples t-test
H4	descriptive statistical methods, principal component analysis, correlation analysis, box-plot, independent samples t-test
H5	descriptive statistical methods, factor analysis, linear regression
H6	expert interview methodology

5. SUMMARY OF RESEARCH RESULTS – THESES

I summarize the main results of the research based on the hypotheses that serve as the starting point of the research.

First research hypothesis: examination of external and internal factors influencing innovation activity

The chance of innovative activities of Northern Hungarian companies can be explained on the basis of external characteristics and internal characteristics (general organizational characteristics and the characteristics of the organization's members).

According to the results of the empirical research, 69.02% of companies in the sample of the companies in Northern Hungary have carried out innovation activities according to their own declaration in the last five years, which shows a higher innovation activity than the national central statistical mandatory data collection. Based on the definition of innovation types based on the 2018 edition

of the Oslo Manual, product or service innovation was implemented by 52 companies, and business process innovation by 198 companies, but in the case of both types, the need to innovate less than 20 times is typical. Based on the research results, innovative sectors can be clearly identified in the sample, such as industry (89.87%), construction (77.27%), trade, vehicle repair (84.62%), transport, storage (66, 67%), information and communication (100%), professional, scientific and technical activities (75.61%). On the basis of the results of the investigation, we can say that with regard to the investigated companies in Northern Hungary, a statistically significant relationship can be identified with the implementation of innovation activities in the entire sample or a smaller part of it, both in terms of external environmental features and internal organizational characteristics (general organizational characteristics and the characteristics of the organization's members). With the help of the binary logistic regression analysis, among the selected factors, it was possible to determine the factors most likely to influence innovation and the execution of each type of innovation. Nine regression models were constructed to fit the conditional tests, with the most prominent explanatory power being at the point of innovation. Among the **external factors**, the technical and industrial field of action (exp $\beta=12,469$), the presence primarily in the regional market (exp $\beta=11,897$), and the most intensive technological development (exp $\beta=9,488$) are the most likely influencing factors. Among the **general internal organizational characteristics**, although many factors influence the implementation of innovation, the most likely are the existence of a visible, written strategy (exp $\beta=43,049$), the best possible technical and technological exposure (exp $\beta=4,585$), the internal structure supporting innovation (exp $\beta=3,297$) and the existence of an organizational culture supporting innovation (exp $\beta=3,671$). Among **the internal human factors**, the education and language skills of management (exp $\beta=4,665$ and exp $\beta=4,449$), the supply of specialists (exp $\beta=3,513$) and the willingness of employees to share innovative ideas (exp $\beta=9,831$) have a high influence.

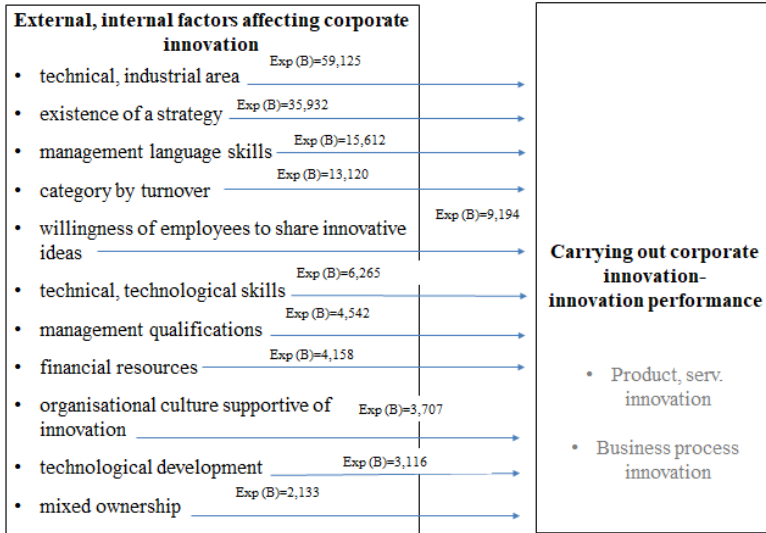


Figure 2: The final model of the combined external and internal factors affecting corporate innovation with the indication of odds ratios

Figure 2 considers the most plausible factors together in one model. In this final model, the external and internal factors most likely to influence the performance of innovation activities are present with an explanatory power of 94.5% in terms of the sample. Among them, activities in the technical and industrial fields are the most decisive (exp. $\beta=59,125$) in carrying out innovation. Conscious strategy creation (exp. $\beta=35,932$), the management’s language skills (exp. $\beta=15,612$), the highest possible sales revenue as a financial factor (exp. $\beta=13,120$), and the involvement of employees in the sharing of innovation ideas (exp. $\beta=9,194$) are also significant. A better technical and technological standard (exp. $\beta=6,265$) also means a greater chance for innovation than where it is of a lower standard. Compared to them, management education (exp. $\beta=4,542$), financial resources (exp. $\beta=4,185$), organizational culture supporting innovation (exp. $\beta=3,707$), technological development (exp. $\beta=3,116$) and joint ownership (exp. $\beta=2,133$) have a smaller but still significant chance of increasing innovation. While the other characteristics increase the probability of carrying out innovation only for a certain group of companies (e.g.: foreign companies, companies with changing customers). The conclusion can be drawn from all of this that by developing the above-mentioned key factors, a strong impact can be exerted on the innovation activities of the sampled Northern Hungarian companies. While, in terms of external conditions, the choice of

scope and market is a major milestone for innovation prospects. Based on the tests, I accepted the first hypothesis and formulated the following thesis:

Thesis 1: Internal organizational drivers of innovation in North Hungarian companies are the availability of resources, the competences and commitment of management (education, language skills, strategic approach, innovation-supportive culture) and the willingness of employees to share ideas.

Among the external environmental characteristics and internal organizational characteristics that can be identified in the case of the Northern Hungarian companies examined are activity in the technical and industrial field, conscious strategy creation, the highest possible sales revenue (as a financial factor), the knowledge and language skills of the management, the adequate financial resources, the presence of a supportive culture, technological development, joint venture ownership, and the higher willingness of employees to share innovative ideas have a high chance of influencing the performance of innovation activities. Companies focusing on these factors are more likely to innovate than companies that do not pay enough attention to these factors.

Second research hypothesis: examination of the relationship between the R&D&I characteristics of the companies and the effectiveness of the innovation carried out

Organizations carrying out innovation in Northern Hungary can be characterized based on the tools (methods, institutions) supporting innovation activity. The effectiveness of the innovation activities of companies in Northern Hungary can be explained with the help of the characteristics of the R&D&I process.

Among the examined R&D&I process characteristics, there are factors that determine how successful the output of the innovation effort will be for the responding companies (product or service innovation, business process innovation). Based on the linear regression analysis, the factors explaining the effectiveness of product and service innovations can be clearly defined.

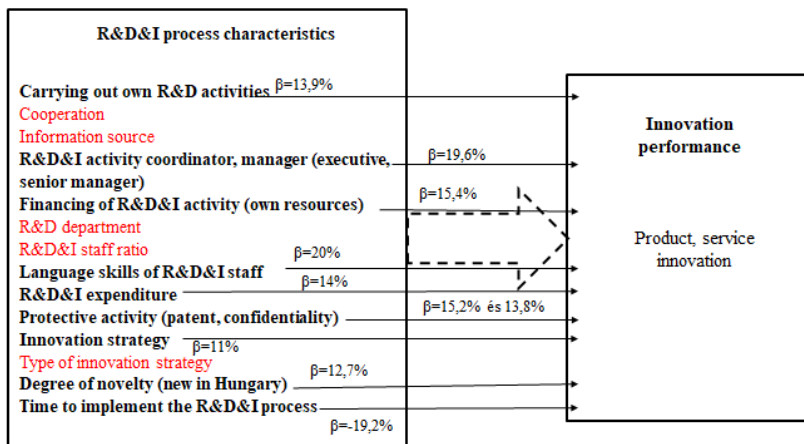


Figure 3: The effect of the factors of the R&D&I process on the effectiveness of product and service innovation (*own compilation*)

These are conducting own R&D activities ($\beta=13,9\%$), innovation that is new in Hungary ($\beta=12,7\%$), patenting ($\beta=15,2\%$) and secrecy ($\beta=13,8\%$) as protective activities, developing the innovation strategy ($\beta=11,1\%$), and selecting the appropriate innovation coordinator ($\beta=19,6\%$). It is also beneficial if the primary funding source is an own source ($\beta=15,4\%$), the employees participating in the R&D&I process speak a foreign language ($\beta=20\%$), the implementation time of the R&D&I process is as short as possible ($\beta=-19,2\%$) and the amount spent on R&D&I activity is as high as possible ($\beta=14\%$).

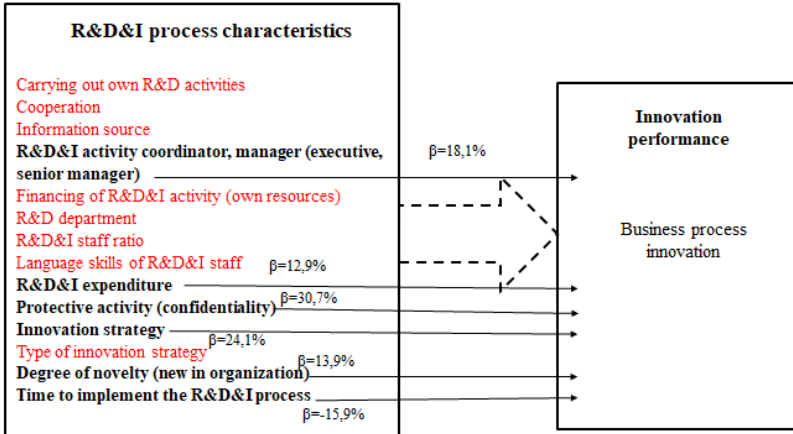


Figure 4: The effect of the factors of the R&D&I process on the effectiveness of business process innovation (own compilation)

Among the protection activities, the effectiveness of business process innovation is influenced by secrecy ($\beta=30,7\%$), the development of the innovation strategy ($\beta=18,1\%$), the selection of the appropriate person coordinating the innovation ($\beta=24,1\%$) and the amount spent on the R&D&I activity ($\beta=12,9\%$). The implementation time of the R&D&I process ($\beta=-15,9\%$) has an inverse effect. Furthermore, in their opinion, it is sufficient if only the given innovation is new for the organization (13,9%). It can be seen that there are influencing factors in the same way in the case of the two innovation types. In addition, my research also confirmed the previous experience that companies are distrustful when developing their R&D&I activities and their own internal processes and adopt a more defensive attitude, since in both cases secrecy is there as a determining factor in terms of effectiveness.

Based on the tests carried out, hypothesis H2 was only partially confirmed. On the one hand, the innovative organizations in Northern Hungary cannot be grouped using the built-in clustering procedure of the statistical program, and only a part of the examined R&D&I characteristics clearly explain the effectiveness of the innovation performance of the companies.

Thesis 2:

The effectiveness of product-, service innovation and business process innovation among companies in Northern Hungary is related to the successful management of the factors of the R&D&I process. For both types of innovation are equally important: the existence of an innovation strategy, the manager or top manager as the R&D&I coordinator, the rate of the R&D&I expenditure, the confidentiality and the duration of the process.

Among the Northern Hungarian companies included in the sample, on the effectiveness of product and service innovations the following factors has a positive effect:

- carrying out own research and development,
- innovation that can be considered new in Hungary,
- the patent,
- secrecy (including secrecy agreements),
- the existence of the innovation strategy,
- if, in the case of R&D&I activity, the executive or senior manager is the coordinating person,
- if the own source is present in terms of R&D&I funding),
- if the R&D&I employees know a foreign language,
- the higher the R&D&I expenditure,
- and the time of the R&D&I activity process is as short as possible.

The effectiveness of business process innovations is determined by:

- if the innovation is new for the organization,
- secrecy (including secrecy agreements),
- the existence of the innovation strategy,
- if, in the case of R&D&I activity, the executive or senior manager is the coordinating person,
- the higher the R&D&I expenditure,
- and the time of the R&D&I activity process is as short as possible.

The presence or realization of these factors during the R&D&I activity can explain why the created innovation output is considered effective for the company by the management.

Third research hypothesis: IPA analysis of R&D&I characteristics

There is a difference between the factors of the R&D&I process in terms of the extent to which companies consider them important, and at the same time, how effectively and with good performance they are present in the organizations' R&D&I processes.

Based on the test results of the previous hypothesis, I considered it important to examine the R&D&I factors from another perspective in relation to the innovation process. I try to find those factors during the R&D&I process that are important to the stakeholders, they feel that they contribute greatly to the effectiveness of the R&D&I process. In addition, I examined how strongly and with what performance the individual R&D&I process factors are present in the company's R&D&I processes, that is, in the opinion of the respondents, how effective the individual factors are during core innovation activities implemented in the last 5 years well in companies. The study is based on the classical importance-performance analysis (IPA) method, which is based on the work of Martilla and James (1977), which was further developed by Ramirez-Hurtado (2017) in order to make the practical application even more effective.

According to the responding managers, in terms of the organization's R&D&I processes, knowledge of market demand (4.66), the person of the R&D&I activity coordinator (4.37), the defense activity (4.29), the innovation strategy (4.68), the time of the R&D&I process (4.65), the transformation ability (4.48), and the diffusion ability (4.28) are the most important factors. The R&D department, employees (3.22), the novelty of the innovation (3.12), the own R&D activity (2.89) are at the end of the importance list. These are the ones that are not given too much of a role in the implementation of innovation in the responding organizations. Regarding the performance of the individual factors, the cooperation partner (4.05) and the employees' willingness to share innovative ideas (4.02) show a performance higher than the average value of four (4.02). The lowest performances (below value 3) are the time of the R&D&I process (2.77), the novelty of the innovation (2.66), and the own R&D activity (2.42).

Considering Slack's stricter classification of the 14 factors examined during the IPA analysis (Slack, 1994 and Szász et al., 2014), 3 factors belong to the 'appropriate' category: the cooperation partners, the R&D department, employees and the willingness to share innovative ideas. Based on the results of the survey, none of the factors was classified in the 'excessive' zone. The 'to be improved' zone includes most of the factors: the amount of R&D&I spending, the funding source of the R&D&I activity, the novelty of the innovation, the own R&D activity, the person of the R&D&I activity coordinator, knowledge

of diffusion capacity, transformation capacity and market demand. Innovation strategy and defense activity are on the borderline. In these cases, performance falls short of its importance. The ‘urgent intervention’ zone includes the time of the R&D&I process. This factor is very important in the R&D&I process and its performance is particularly low (Figure 5).

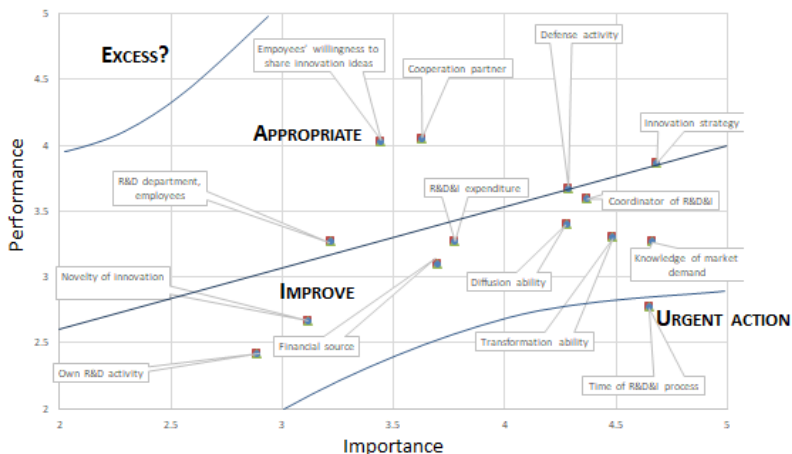


Figure 5: R&D&I characteristics importance – performance analysis (IPA) based on Slack (1994) and Szász et al. (2014) (own compilation)

Based on the examination of the correlation of the importance and performance factors separately and of the two categories together, there are few significant and high value correlations. This suggests that the factors are independent of each other, for example, they are important in parallel for carrying out the innovation task. According to the paired samples t-test, there was a significant ($p < 0.05$) difference between the importance and performance of almost all R&D&I factors, except for the own R&D department factor group. Based on the investigations, I accepted the third hypothesis and formulated the following thesis:

Thesis 3:

The R&D&I activities of companies in Northern Hungary are both key and high performing areas: collaborations, R&D departments and employees, and the sharing of innovative ideas by employees. The performance of the other factors in the R&D&I process lags behind their importance and needs to be improved.

Overall, the examined factors of the R&D&I process are equally and parallel important for the sampled companies in Northern Hungary. Based on the results, the key development areas of the companies' R&D&I processes are:

- degree of novelty of the innovation,
- mapping of market demand,
- the ability to diffuse and transform,
- own or joint R&D activities,
- R&D&I expenditure,
- funding sources for R&D&I activity,
- selection of the coordinator of the R&D&I activity,
- the time of the R&D&I process.

The evaluation of the above factors is in the eminent interest of the company's management, as the R&D&I processes can be improved by strengthening them.

Fourth research hypothesis: examination of the relationship between innovation activity and organizational performance

Among the organizations in Northern Hungary, organizations carrying out innovation activities are more effective and have better corporate performance.

In the literature, several researches are aimed at measuring the effectiveness of the R&D&I initiative and verifying its contribution to organizational performance, but most of them are aimed at evaluating or quantifying the financial results. In the course of my research, with the help of a preliminary expert examination, I determined among the factors measuring organizational performance those that may be relevant in the measurement of innovation activity. *Figure 6* summarizes the grouping of performance indicators belonging to each main component.

<p><i>Financial perspective</i></p> <ul style="list-style-type: none"> • Profit • Sales revenue • Balance sheet • Profitability • Costs • Customer perspective 	<p><i>Client perspective</i></p> <ul style="list-style-type: none"> • Number of customers • Organizational image, reputation • Customer satisfaction • Customer knowledge • Market share • Sale
<p><i>Operational processes perspective</i></p> <ul style="list-style-type: none"> • Supply chain management • Product and service quality • Productivity, production and serv. process efficiency • Organizational internal operating processes • Cycle time • Management processes • Product and service portfolio • Technological level • Amount of R&D&I expenditures 	<p><i>Learning and development perspective</i></p> <ul style="list-style-type: none"> • Information and idea sharing, knowledge management • Long-term, strategic approach • Innovative organizational culture • Training, development projects • IT developments • Employee satisfaction

Figure 6: Summary of performance indicators (*own compilation*)

Then, the examined companies in Northern Hungary evaluated these performance-related indicators in relation to their own organization. I compared the main component groups created along the Balanced Scorecard dimension of the evaluation results with the performance of the innovation activity using the independent sample t-test. Based on the analysis, we can clearly state that carrying out innovation activities improves the organization's performance in all performance dimensions. My research also confirmed the previous findings that the financial ($p < 0.001$), customer ($p < 0.001$), operational process ($p = 0.002$), learning and development ($p < 0.001$) performance of the organization improves thanks to innovation. In addition, it contributed to the understanding of the mid- and long-term organizational effects of innovation with additional findings. In the next step, I conducted the analysis described above for the types of innovation, but in this context I could not find a significant relationship. So, within the innovation performance, currently the sampled firms do not follow up on the effectiveness and organizational added value of each innovation. Further analysing the closeness of the relationship between the performance dimensions, an interesting phenomenon can be pointed out by looking separately at the relationship between the four dimensions for firms that have not innovated in the last five years. For companies that have not innovated in the last five years, no significant correlation can be found for any of the

dimensions with the other three dimensions, in other words, even if the company's performance is higher on any of the dimensions, there is no evidence that the company performs better on any of the other dimensions. Hypothesis H4 was confirmed on the basis of the above, as the studies confirmed that among the companies in Northern Hungary, the organizations carrying out innovation activities are more effective, and their performance is better in the areas of finance, customer, operational process and learning and development.

Thesis 4: Examining companies in Northern Hungary along the dimensions of the Balanced Scorecard method, the performance of companies that innovate is better than those that do not, especially from the learning-development performance perspective.

Examining the performance of the responding companies in Northern Hungary along the dimensions of the Balanced Scorecard method, the 205 companies in the sample performing innovation activities show better financial, customer, operational process and learning and development performance than companies that are not engaged in such activities. The most significant difference is in learning and development performance. It can be concluded that there is a benefit for companies to engage in innovation activities and that there is a need for management to use organizational performance indicators to get a more complete picture.

Fifth research hypothesis: examination of the relationship between the factors hindering innovation and the organization's performance

The existence of factors that hinder innovation has a negative effect on the organization's performance. The company is more effective and has better organizational performance, where there are fewer inhibiting factors.

I assume that the innovation capacity of companies can be hindered by certain factors, and this has an impact on the company's effectiveness and organizational performance of the implemented innovation. Based on literature studies, it can be established that several research have already been aimed at mapping and examining the factors hindering the implementation of innovation, but the causes were mostly assessed in relation to the implementation of the innovation activity. In the course of the investigation, there is a discrepancy regarding the hindering factors among companies in Northern Hungary based on the performance of innovation activities. For innovative companies,

obstacles related to the inflexible, rigid organization and the initial ideation and need recognition phase appear in the first place, such as the lack of recognition of specific market needs, the uncertainty of demand for new goods or services, and the lack of the ability to turn an idea into a product or a service. In the case of companies that do not carry out innovation activities, the external circumstances (together with the risk) immediately prevent them from thinking about carrying out innovation activities at all, in addition, these companies cannot financially afford such developments. By grouping the 21 innovation-inhibiting factors that I examined using factor analysis, 6 groups of factors could be determined, which are management and strategy barriers; finance, risk barrier; the R&D, technology barrier; the knowledge and ability barrier; the employees, organization barrier and the external conditions barrier.

In the four linear regression models written to examine the effects between variables, the explanatory variables are the factor groups that inhibit innovation, the explained variables are the main components of organizational performance. According to the significance test for the validity of the regression models, each model is significant. The conditions prescribed for the variables and error terms were checked and showed compliance in all cases. In the case of four regression models adopted during this research, in three cases the deterministic coefficient (R square) exceeds the critical value of 0.1, so the effects identified by them can be considered acceptable. Values below 20% are not very high, but they are noteworthy, since the entire objective life situation is complex, and the model applied to it can only cover a small part of it. The relationship model built by linear regression models is shown in *Figure 7* On the arrows are the standardized regression coefficients (β) and significance levels (p), for the organizational performance dimensions, the determination coefficients (R^2) and the significance level (p) of the F test measuring the fit of the model.

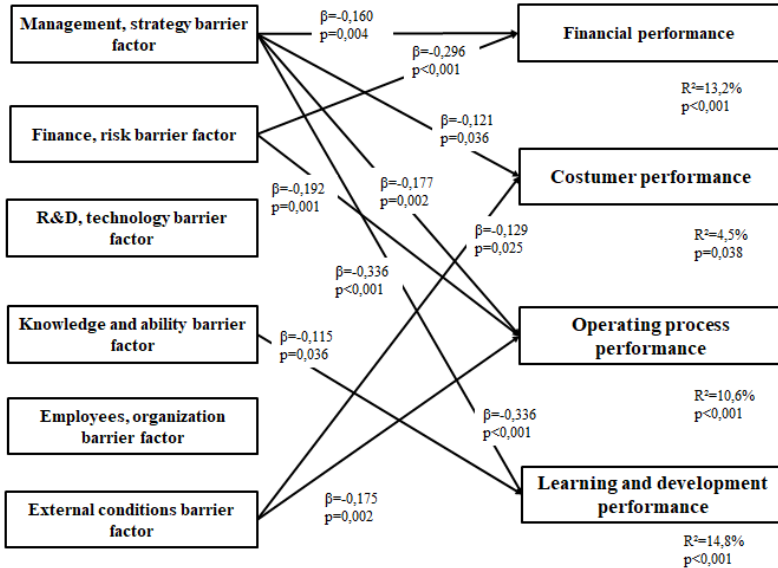


Figure 7: The linear regression relationship model (*own compilation*)

Based on the factor groups of the inhibiting factors and the linear regression functions written using the main components of the Balanced Scorecard-based organizational performance, it can be established that the factors most affecting organizational performance are leadership, strategic barriers; finance, risk barrier; the barrier of knowledge and ability and the barrier of external circumstances. Examining them in detail, management, strategy barrier ($p=0.004$) and finance, risk barrier ($p<0.001$) affect the organization's financial performance. Customer performance is affected by management, strategy barrier ($p=0.036$) and external circumstances barrier ($p=0.025$). The management, strategy barrier affects the performance of the operating process ($p=0.002$); finance, risk barrier ($p=0.001$) and external circumstances barrier ($p=0.002$). Learning and development performance is affected by the knowledge and ability barrier ($p<0.001$) and the leadership and strategy barrier ($p=0.036$). For the other barrier factors, only a small group of the organizations in the sample showed an effect on each of the organizational performance dimensions. When examining the effects of the barrier factors, the barrier of leadership and strategy clearly stands out from the others, which has a significant effect on all performance dimensions, and therefore deserves special attention in the life of every company. Hypothesis H5 was confirmed based on the above tests and I accept it.

Thesis 5:

As a result of the grouping of barriers to innovation, the following factors have a negative impact on the performance of companies in Northern Hungary: the leadership and strategy barrier; the finance and risk barrier; the R&D and technology barrier; the knowledge and capability barrier; the employees and organization barrier and the external environment barrier. Among them, the leadership and strategy barrier clearly stands out, which has an impact on all organizational performance dimensions and therefore deserves special attention in the life of companies.

Among companies in Northern Hungary, the main groups of factors that affect organizational performance through innovation activity are management and strategy barriers; the finance and risk barrier; the R&D and technology barrier; the knowledge and ability barrier; the employees and organization barrier; external conditions barrier. Among the barriers, the organization's financial performance is hindered by the leadership, strategy barrier, and the finance and risk barrier. The client's performance is hindered by leadership, strategy barrier, and external circumstances barrier. The performance of the operational process is hindered by management, strategy barrier; the barrier of finance and risk, as well as the barrier of external circumstances. Learning and development performance is hindered by the barrier of knowledge and ability, as well as the barrier of leadership and strategy. Among the companies, the most successful ones have better organizational performance, where the inhibiting factors appear less.

Sixth research hypothesis: a synthesizing study aimed at increasing the effectiveness of the research and development and innovation processes of companies in Northern Hungary

The key areas of organizational innovation ability and suitability conditions can be determined and a multi-level innovation framework model based on this, supporting the response to regional challenges, can be defined, by applying which the effectiveness of the research and development and innovation processes of companies in Northern Hungary can be increased.

The purpose of the model is to compile a product service business process innovation framework model for the entire innovation career path that supports the response to regional challenges. By defining the areas to be developed related to the innovation capability revealed with the help of the model, corporate learning also comes to the fore. The target group of the model is the companies operating in the region of Northern Hungary. The model I made can

be considered as a basic model, which can become suitable with additions appropriate to the particularities of each industry and company.

The requirements for the model are as follows:

- synthesizing theoretical models and empirical research,
- holistic approach,
- simultaneous display of evolutionary and parallel elements,
- consideration of regional specialties and peculiarities,
- consideration of the user’s perspective,
- adaptability to the strategic thinking of the examined organization,
- providing the opportunity to develop static and dynamic skills,
- the possibility of connecting to innovation policies,
- support for tendering capacity building,
- point out the areas to be improved,
- be suitable for comparative analysis of companies,
- be usable for both scientific research and practical application.

As a result of processing the literature, Rothwell’s generational theory (1994) is the basis for the development of the model, which in recent times (Galanakis, 2006, Traferner, 2017, Vukosazvlyev et. al., 2019) has been supplemented and improved by the internal and external factors resulting from their own research goals for the highest possible level of adaptation to environmental changes. I supplemented this with the results of my questionnaire survey, with additional factors discovered in the literature, and with the results of foundational research. These provided the upper level of the model.

For the lower level, I took as a basis the literature on innovation capability and organizational capability, supplemented by the work of Crossan and Apaydin (2010), which approaches the innovation capability of organizations on a process basis. I further developed this foundation by synthesizing the innovativeness factors found in the literature and used in the theories defining my research, the results of my questionnaire survey, and the comments and suggestions made during the expert interviews conducted in several rounds. I continued the model validation supported by the expert methodology carried out in several rounds until the research reached the state of ‘theoretical saturation’ (Glaser-Strauss, 1967, Csedő, 2006) and further expert interviews did not further expand the model.

In the final model created on the basis of the above (*Figure 8*), the performance of the companies’ innovation activities is determined both by the elements of **the external (regional) innovation environment** and the **internal**

characteristics of the organization. On one side of *Figure 8*, among the elements of the external (regional) innovation environment, the *intensity of competition, the industry and market where the company is present, the dynamic change of the technological environment, the availability of cooperating partners, and the possible sources of access to information* appear. Equally important influencing external elements can be the *formation of the national and regional institutional background, the presence and supportive behavior of intermediary organizations, as well as the existence of research and development and innovation subsidies available to the company*. On the other hand, the internal organizational characteristics of a given company and the determining elements of its organizational capabilities in carrying out innovation activities can also influence the carrying out of innovation activities of the given company. The **general internal organizational characteristics and features** are the *type of ownership, the age of the organization, the size of the company in terms of turnover or number of employees, the technological level of the organization, the organizational structure, the market orientation, the conduct of market research, the export activity, the organizational culture, the level of the organization's resources*. **Characteristics of the members of the organization** are the *education level of management and employees, foreign language skills of management, level of professionalism of the organization, level of knowledge of the members of the organization, willingness of the members of the organization to share ideas and knowledge*. These two sets of characteristics (external and internal) have an impact on whether a given company carries out innovation activities or not.

The next important area of the model is the elements related to the **innovation life cycle and the conditions for its implementation**. In this innovation process, the time of implementation, the time of the entire innovation life cycle, can be decisive. The model takes the existence of all the features and conditions related to the research and development innovation process throughout the innovation process, from the emergence of an **idea** that responds to market demand, through the **transformation** process to **market distribution, diffusion**. The part of an **R&D&I process and features** can be the carrying out of its own R&D&I activity, the performer of the R&D&I activity (e.g. in-house or external), its coordinator, how the R&D&I activity is financed, the existence of R&D department, employees, the language skills of the R&D&I staff, the average percentage of turnover spent on R&D&I activities, the type of protection activities carried out, whether the organization has a visible innovation strategy, the type of innovation strategy followed, the novelty of the innovation and the time taken to implement the R&D&I process.

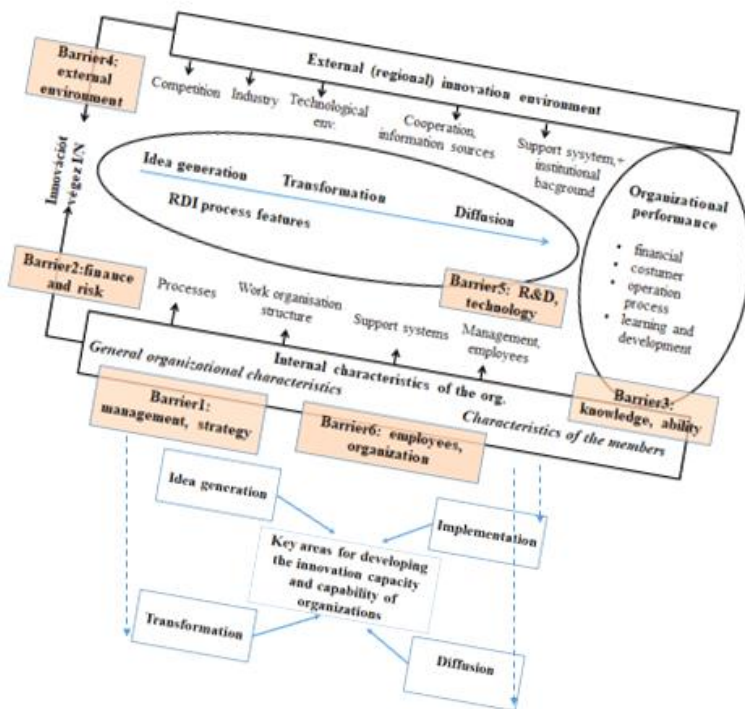


Figure 8: Two-level regional innovation model adaptation
(own compilation)

According to the model, the performance of companies' innovation activities can affect the **performance of organizations**, including *financial, customer, operational process, learning and development performance*. Of course, during the implementation, disturbances may arise in the research and development innovation process, there may be conditions and groups of conditions that can inhibit the implementation of the innovation process and its appearance in organizational performance. These can be *barriers related to leadership and strategy creation, barriers related to the existence of knowledge, skills, and competencies, financial obstacles or excessive risk, barriers related to research and development and technological capabilities, as well as barriers related to employees and organizational structures*. In addition, obstacles from the external environment may also appear. If companies want to develop their organizational innovation capacity and capability, the key areas in terms of

ideation, implementation, transformation, and diffusion or utilization can be determined, with the help of their effective knowledge, the innovation process can be carried out as effectively as possible throughout the entire innovation life path, and higher organizational performance is more likely to appear. Based on the investigation, I accepted the sixth hypothesis and formulated the following thesis:

Thesis 6:

A two level organizational innovation capability building model can be used to identify and adapt the capabilities needed for successful innovation activities, which can be defined by the external innovation environment, internal capabilities and barriers identified along the R&D&I processes and helps to determine the tasks of ideation, transformation, implementation and exploitation required for organizational innovation.

The effective implementation of R&D&I processes based on external and internal capabilities and organizational innovation capabilities of Northern Hungarian companies contributes to increasing the performance of the implementing organization. The company's two-level organizational innovation capability building model is used to adapt the missing capabilities, the current form of which was developed and refined by synthesising the results of the overall research. Based on the experience of the sampled companies and the 19 expert interviews, as a result of the application of the framework model, the barrier factors can be eliminated and the R&D&I process can be implemented effectively.

6. USABILITY OF THE RESULTS, FURTHER RESEARCH DIRECTIONS

In the course of my research work, I gained a number of experiences related to the R&D&I processes of Northern Hungarian companies, which have both theoretical and practical implications. The actuality of the research can be emphasized, as far as I know, such a complex, two-level framework model aimed at the development of organizations' innovative capacity, based on the elimination of factors that hinder innovation, has not yet been prepared for the companies of Northern Hungary, which also shows the contribution of the successful R&D&I process to organizational performance. The investigation yielded several new research results that, in my opinion, can be used both in the academic sphere and among company professionals. Some of these were highlighted during the presentation of these.

As a limitation of the research, it should be pointed out that the composition of the respondents of the questionnaire survey is not representative of companies in Northern Hungary, therefore the data collected in this form cannot be used to

evaluate the general state of the region's corporate innovation actors. The results incorporated into the model from the literature and secondary sources, the use of the experiences of my preliminary research, and the expert interviews try to supplement this. So, even if the created model cannot be generalized to all companies in the region, it can be used as a framework model with due caution and the context it presents is certainly worth considering.

On the basis of the secondary information presented in the thesis, I have established that companies play an important role in the development and competitiveness of the economy of the Northern Hungarian region, which is why their emergence as a research focus is well-founded. The research model proved to be a correct logical guide, the dissertation contributes to the increase of knowledge related to the innovative activities of companies and their organizational utilization. My empirical experience supported and expanded with additional knowledge the literature findings related to innovation and organizational performance. I can state that innovation is a key factor in the improvement of the organizational performance of companies, so it must appear as a continuous goal in the strategies of companies, government policies and strategies regarding competitiveness. The indicators that can be used to evaluate the organizational performance finalized by expert interviews can be supportive in making managerial decisions and support the advantages and organizational benefits of carrying out innovation activities. Based on experience, currently the examined companies do not carry out similar measurements regarding their innovation performance, if there is an effort to do so, they mostly only examine financial indicators.

The results of the analysis of the companies in the sample showed that there are areas of activity, markets and industries where actors are under greater pressure and more likely to innovate. These include, but are not limited to, activities in the technical and industrial fields and where technological development is intensive. Contrary to expectations, competition has a negative impact on innovation. It can therefore be concluded that, before choosing an industry or market, firms must consider whether they have the internal endowments and motivations to gain an advantage in that market through innovation.

Most previous studies and literature focus only on the existence and quantity of innovations. The research draws attention to improving the quality of the factors and elements of the innovation process. The company's results highlighted that the presence of the investigated factors in the R&D&I process does not guarantee their effectiveness during innovation in accordance with management expectations.

Based on the experience of secondary information and expert interviews, government policies aimed at improving the competitiveness of companies should emphasize the highest possible degree of innovation. Based on the company's experience, they are currently creating innovations that are considered new for the organization and possibly in Hungary, even though according to their own admission, the degree of novelty is important during the R&D&I process.

I think it is important to highlight the role of strategic behaviour in the success of innovation processes: management must make investment and development decisions based on a strategic approach and in line with conscious innovation objectives.

The dissertation contributes to the expansion of the body of knowledge related to the topic by examining the key areas related to innovation capacity building. The role of management, knowledge, the quality of R&D&I processes, and the ability to cooperate play an increasingly important role in the innovation capacity (competitiveness) of companies. Some of the companies have already realized that they can only be effective and competitive in the long term by building these capabilities. In order to monitor market and technological changes and integrate new scientific results, they must put more emphasis in their innovation processes on the search for and application of new knowledge and information created outside their organizational boundaries, as well as on cooperation with professional associations and specialized universities.

Hungary's R&D Strategy for the period 2021-2030 is also based on increasing the efficiency of knowledge production - knowledge flow - knowledge use. Based on company experience, this requires a higher level of cooperation, information flow and trust through the expansion of the innovation ecosystem. According to our current knowledge, there are fewer and fewer organizations operating in complete isolation. In the field of inter-organizational relations, there is a difference between companies that carry out innovation and those that do not, but they are primarily motivated by the acquisition of resources during cooperation. As a result of the research, the need arises that professional service and intermediary organizations should put more emphasis on expanding the knowledge of economic organizations about the various forms of cooperation related to innovation activities, emphasizing their economic and social advantages. In line with other researches, my doctoral research also confirms that the continuous development of the institutional framework of the innovation system, which has been experienced so far, is well founded, since the results of the examined companies also reflect the determining role of external factors in organizational performance through innovation activity.

The *possibility of further development of the research* definitely lies in the implementation of the questionnaire survey on a representative sample in order to apply the results as widely as possible and to extend the sampling to the whole of Hungary, and possibly to the neighbouring countries. This is also because in the description of the sample composition in the thesis I pointed out that micro and small enterprises were very reluctant to fill my questionnaire for the reasons described there, and I would like to get to know the experience and attitudes of this group of companies towards innovation. In addition, I also defined additional new research directions. It would be justified to supplement the results of the quantitative study with qualitative methodologies in order to further refine the previously obtained results. For this, I aimed to implement qualitative methodologies such as field research and case study-based investigations to collect good practices. My research among the companies also drew my attention to another valuable direction to continue. The results of the quantitative research confirmed that the existence of the leader, manager and strategic thinking plays a major role in R&D&I activity. On the domestic and international level (even by examining large international companies), useful experience could be gained regarding the leadership competencies of R&D&I managers. Finally, going beyond the company level, getting to know, and examining the functioning and connections of the entire regional innovation system could contribute to the development of the region's innovation potential, in which the above-mentioned intermediary organizations could receive outstanding attention.

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