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CHALLENGES OF THE NATIONAL INNOVATION SYSTEM FOR THE APPLICATION OF OPEN INNOVATION PRACTICES IN THE REPUBLIC OF NORTH MACEDONIA

Nowadays, products become increasingly complex, their development and production is a result of the application of a wide range of external ideas, technologies and knowledge. In the complex economy, it is impossible for any single enterprise to keep abreast of all modern technologies. In the production process enterprises include development of specialized knowledge assets, using a wide range of knowledge from different areas. At the same time, enterprises make their specialized knowledge assets available for usage by the other actors. Those activities are referred as open innovation practices. The great interest in applying the open innovation practices is a result of the positive impact that open innovation has on the enterprise performance and on the overall economic system as a central element in the modern knowledge-based societies. However, for successful implementation of the open innovation practices, which is essentially based on the cooperation between the key actors within the national innovation systems, government, academy and the business sector, there is a need for significant institutional support at a national level, a developed innovation system and a particularly developed system for technology and knowledge transfer. Hence, the paper primarily analyzes the institutional factors (national innovation system), with a view to the institutional and financial support in cooperation and knowledge transfer. At the same time, an analysis of the innovation of the Macedonian business sector is made, with particular emphasis on the application of open innovation practices in terms of the representation of the key model dimensions in the enterprises. On the basis of the analysis made, conclusions are presented and measures are proposed to improve the environment for applying the open innovation practices in the Macedonian business sector.
JEL: O36; O38; L52

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1. Introduction

Enterprises cannot protect and isolate themselves from the rapid changes that take place in the everyday environment: the competition is becoming stronger, the knowledge is constantly expanding, the research and development investments are significantly increasing, and at the same time the product and technology life cycle is becoming shorter. The application of the open innovation through the use of knowledge from different sources enables optimization of the time period of transformation of the knowledge into innovation and commercialization of the innovation to the market (Savitskaya et al., 2010).

The open innovation model enables enterprises to improve their innovative performances through the usage of knowledge from external sources, as well as to realize financial benefits of placing internally developed technology on the market, which cannot be used within the enterprise because it does not fit into the current business model of the enterprise (Chesbrough, 2003; Gassmann and Enkel, 2004).

An important element of the knowledge-based economy is the use of intellectual knowledge in the process of creating material values. However, the knowledge itself does not lead to growth and development, the national innovation system enables the creation of new knowledge and transformation of the new knowledge into innovation and its commercialization. Since in the open innovation model, the innovation development is a result of the cooperation within the business sector and between the business sector, the academic community and other relevant parties, consequently the open innovation model is not important only for the business sector but for the economy as a whole. The establishment of an efficient national innovation system is a crucial factor in applying the open innovation practices.

Practically in the paper, the focus is on examining the relevant factors that influence the innovativeness of the Macedonian business sector, with particular reference to their impact on the application of open innovation practices. In particular, in the paper the focus is put on: the current situation of the Macedonian innovation system, i.e. the impact of the current innovation policy and the existing financial instruments in supporting the introduction of innovation, with particular reference to supporting investments in the open innovation practices, knowledge transfer and cooperation between the business sector, the academic community and other relevant participants of the national innovation system. At the same time, an overview of the innovation of the business sector in North Macedonia is made. Particular emphasis is placed on examining the representation of the key dimensions of the open innovation model in enterprises, in order to understand the current situation in introducing the open innovation practices in the country.

2. Theoretical background

The term open innovation was first introduced by Chesbrough (2003) and it strongly stimulated the interest of the researchers and the practitioners in the business sector. Open innovation is defined as the flow of ideas that come from different sources with the goal of their practical application Chesbourg (2003) or as a methodology for measuring and

implementing cooperative solutions, by involving all stakeholders in an interactive process (Carayannis and Campbell, 2011). The open innovation enables enterprises to use a wide range of knowledge coming from consumers, suppliers, universities, laboratories and even the competitors.

The combination of this diverse knowledge through the open innovation process increases the possibility of finding creative solutions that lead to larger, high technological, radical innovation, different from the innovation introduced through the traditional model and which at the same time have even greater positive impacts on the enterprise performance (Chesbrough at al. 2011).

Hence, the essence of the open innovation lies in treating the enterprise in the research and development process as an open system, which enables an inflow and outflow of knowledge, to be used to accelerate the internal activities of the enterprise in introducing the innovation and in expanding the market for successful introduction and commercialization of the innovation (Chesbrough, 2006).

Based on the different knowledge flows, three types of open innovation have been defined (Chesbourg and Bogers 2014):

- Outside – in (input) open innovation, the innovation is introduced through an inflow of external knowledge into the enterprise, so that the external sources of knowledge are used in the internal processes within the enterprise;
- Inside – out (output) open innovation, the innovation is introduced through an outflow of knowledge from the enterprise, the knowledge in the enterprise is enhanced through the external processes of commercialization;
- Coupled open (joint) open innovation, the innovation is introduced combined through an inflow of knowledge into the enterprise and commercialization activities, i.e. it is a combination of the aforementioned types of open innovation.

In terms of the enterprise size, mostly the large, high technological and internationally competitive enterprises apply the open innovation model. Although the open innovation is not very used in small and medium-sized enterprises, the model of open innovation is very important for their performance, because these enterprises are facing with lack of financial resources for conducting internal research and development activities, for developing new products and their commercialization, and the open innovation can largely help in overcoming these deficiencies.

The open innovation practices first were applied in the high technological industries Wang et al. (2015), that is, in the software, electronics, telecommunications, pharmacy and biotechnology industries, yet the software and electronics industries stand out as industries that base their growth mainly on using the open innovation practices (Chesbrough at al., 2011). In recent years, however, the application of the concept of open innovation has been applied in other industries as well.

The open innovation has several primary dimensions (Ebersberger et al. 2011, p. 29):

1. identifying the external information (searching);

2. interactive knowledge development and transfer (cooperation);
3. market-based sources (external expenditures of innovation) and
4. commercialization of the external technologies (licensing out).

The positive impact of applying the open innovation model in the direction of reducing the operating expenditures of the enterprise, improving the internal processes and efficient use of new knowledge, is the reason behind the growing acceptance of open innovation as an effective strategy for accomplishing growth and improvement of the performance of enterprises (Scott and Chaston, 2013).

These tendencies are also confirmed in the EU annual reports on open innovation strategy and policy[3], which show that there has been an increase in the level of openness in the EU countries, followed by increased sophistication and complexity in introducing innovation (Curly and Salmelin, 2013).

According to the open innovation model, the innovations are developed as a result of inter-organizational cooperation; therefore the conditions for cooperation are very important for the application of open innovation models, i.e. the setting up of national innovation systems. According to Freeman (1987), the national innovation system is a network of private and public sector institutions that, through interaction, initiate, introduce, modify and distribute innovation. The National Innovation Systems (NIS) is a framework that explains the difference in the level of innovation of countries, through the different level of institutional support that they provide for introducing innovation (Lundvall, 1992; Nelson, 1993). NISs emphasize the idea that the flow of knowledge and technologies between individuals and organizations is crucial to the innovation process. Within the NIS there are a number of factors that influence this flow of knowledge, but among the most significant is the existence of efficient institutions. One of the key institutions in the individual NISs are the institutions for the protection of intellectual property rights, which by regulating the intellectual property rights have a major impact on the process of distribution of knowledge. In addition, institutions providing state aid for the introduction of innovation, in particular through the establishment of instruments that facilitate the cooperation in the innovation process, are important for the application of open innovation practices.

3. National Innovation System in North Macedonia – institutions and measures to support cooperation and knowledge transfer

The economic growth, the level of competitiveness and innovation of a country, and in particular the quality of using the available research and development resources in relation to the potential of the country, depend on the national innovation system (Cvetanovic et al. 2017). The existence of a national innovation system is particularly important for small countries such as North Macedonia, because these countries do not have at disposal large research capacities. Since 2008 in the country have been taken systemic measures in order to establish a comprehensive National Innovation System. In 2008, the Parliament of the

[3] Open Innovation Strategy and Policy Group (OISPG)

Republic of Macedonia adopted a law on technological development that defined the legal framework for the establishment of incubators and technology parks. Since then, four main strategies have been adopted in the country that define the activities to improve the innovation and industrial development, and which are the basis for the construction of the Macedonian NIS (SEE Project FINNO, 2014).

The first strategy is the Strategy for Intellectual Property of the Republic of Macedonia 2009-2012. The strategy aims to strengthen the legal framework in the field of protection of the intellectual property rights, their effective and efficient implementation, development of the capacities of the individual holders and the business community for protection and enforcement of the intellectual property, as well as raising public awareness of the benefits of intellectual property (Government of the Republic of Macedonia, 2009).

The second strategic document is the Industrial Policy of the Republic of Macedonia 2009-2020, which is a national document for strengthening the Macedonian industry and economy.

The third document is the Program for Scientific Research and Technological Development of the Republic of Macedonia. Having in mind that scientific research and development is the key prerequisite for the development of knowledge-based economies, the development priorities defined in this document are the key prerequisite for the country's progress in this field.

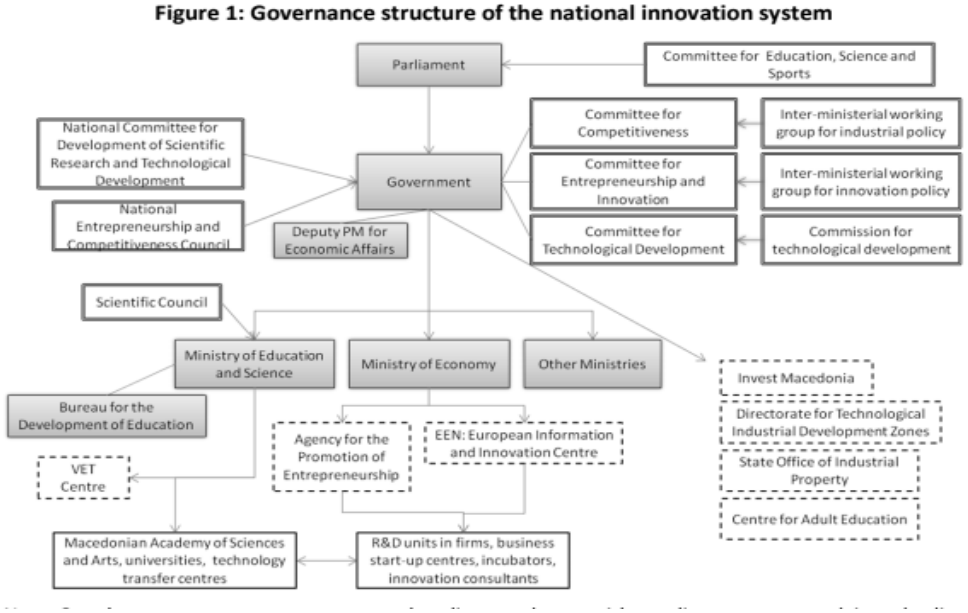
The fourth and most important strategic document, part of the Macedonian NIS is the Strategy for Innovation and Technological Development (2012-2020). The strategy aims to transform the national economy into a knowledge-based economy, capable and competitive on the global market, with skilled labour force and innovative enterprises. In the strategy, the competitiveness of the business sector is identified as the key factor in achieving economic growth by increasing the knowledge and introducing innovation. The main strategic goals are: increasing the propensity of the business sector to innovate, strengthening the human resources to introducing innovation, creating a regulatory environment to support the innovation and increasing the flow of knowledge among the stakeholders in the innovation process (Government of the Republic of Macedonia, 2012). In addition to the above mentioned strategic documents, other strategic documents and programs are also part of the Macedonian NIS.

An important document in the Macedonian NIS is the Law on Innovation Activity, adopted in 2013, which regulates the innovation activities, the principles of commercialization of the output of innovation and the interactions between different stakeholders in the innovation process. A particularly important segment of the Law is the definition of the organizational forms for infrastructure support to the innovation activities. Such organizational forms are: technology business incubators and accelerators, science and technology parks and technology transfer centres. In order to systematically monitor the development of innovations and their commercialization, in parallel with the adoption of the Law, an Entrepreneurship and Innovation Committee has been established. The Committee is composed of a President and 16 members, the Chairman of the Committee is the Prime Minister, and members are the relevant ministers or their deputies (Law on

Innovation Activity, 2013). The institutions as part from the national NIS are identified in the Strategy for Innovation and Technological Development 2012-2020 (Figure 1).

Figure 1

Governmental structure of the National Innovation System



Source: Strategy for Innovation and Technological Development of the Republic of Macedonia in the period 2012-2020, p. 12.

In addition to the competent ministries, other significant institutions that are part of the Macedonian NIS which are responsible for supporting the innovation and the technological development of the business sector are: Agency for Promotion of Entrepreneurship, Agency for Foreign Investment and Export Promotion, Directorate for Technological and Industrial Development Zones (Free Zones Authority), Fund for Innovations and Technology Development, State Office of Industrial Property. Within the Macedonian NIS, 28 support measures for the introduction of innovation and technology development of the business sector have been identified, which are implemented through the programs of the relevant ministries, agencies or funds, and which have been implemented by the end of 2018. In 2018, EUR 23.18 million have been allocated to the business sector through the institutions that are part of the Macedonian NIS, intended to support the introduction of innovation and technological development. The majority of the funds (96.6%) have been implemented through the Fund for Innovation and Technology Development (FITD), and the rest of the funds have been implemented through the Ministry of Economy (3.3%) through the Competitiveness, Innovation and Entrepreneurship Support Program (MoE-CIEP) and the smallest share of the funds has been implemented through the Agency for Promotion of Entrepreneurship of the Republic of North Macedonia (0.1%) (FITD, 2019).

FITD is a relatively new institution, part of the NIS, which main goal is to provide financial support to innovation activity in micro, small and medium-sized enterprises, to achieve accelerated technological development based on knowledge transfer, research and development and innovations, in order to improve the competitiveness of the enterprises (http://www.fitr.mk/).

The OECD, in its 2018 Policy Outlook: Competitiveness in South-East Europe, has identified five sub-dimensions for assessing technologies, innovation, investments and exports.[4] The second sub-dimension (2) Public-private knowledge transfer and linkages is closely linked to the current situations in the NIS for the introduction of open innovation in the business sector. The rating of this sub-dimension is made through the presence of innovation vouchers, technological development and innovation support grants, innovative clusters and science and technology parks. The main assessment of this sub-dimension for the Republic of North Macedonia is that there is a weak cooperation between the business sector and the academic community, accompanied by a high brain drain rate (OECD, 2018).

Innovative vouchers designed to support the already weak cooperation between the business sector and the academic community has not yet been introduced. Their introduction is expected to be made through the FITD in the 2019-2020 Action Plan as part of the Strategy for Innovation and Technological Development 2012 -2020.

In the work programs for 2018, the institutions that are part of the NIS do not have included grants intended for supporting the cooperation between the business sector and the academic community. Most of the agreements between the academic community and the business community involve the performance of a specific activity within a project. One of the main reasons for this low level of cooperation are the complicated administrative procedures, because the approval of the cooperation agreements and the payments often go through the universities, and not through the faculty itself, which complicates the procedure. The FITD Instrument of co-financed grants for innovation commercialization supports the cooperation between the business sector and the academic community. SMEs as applicants for the grants may have a higher education or scientific research institution as a consortium partner, it is even considered an advantage in applying for these grants. Also, within the Instrument of co-financed grants for technological development, the scientific and research institutions can be engaged as contractors in the process of adapting and introducing modern and innovative technologies in the SMEs. The Ministry of Education and Science does not award grants intended for supporting the cooperation between the business sector and the academic community. As a result of these identified weaknesses, the OECD recommends in the future to increase the "triple-helix" events that would emphasize the need and importance of strengthening the cooperation, and at the same time, this cooperation would be adequately supported by awarding innovative vouchers and projects (OECD, 2018).

[4] The five sub-dimensions are: 1) Innovation in the enterprises, 2) Public-private knowledge transfer and linkages, 3) Human resources for introducing innovation, 4) Investment promotion, and 5) Export assistance/ facilitation.

Clusters as one of the modern forms of networking, knowledge exchange and innovation development are not very developed in North Macedonia. The key weakness in the existing clusters in the country is the insufficient potential for innovation development. Since enterprises in the country do not have high benefits from the cluster membership, they are not willing to pay large membership fees; consequently, the clusters are not sustainable in the long run. Although there is a governmental support for clusters, it is very small and is not aimed at supporting the scientific and research activities within the cluster.

In the 2017 study on the Macedonian business sector innovation capacity, conducted by the Knowledge Management Center it was identified that there is a very weak infrastructure support for SMEs in introducing innovation, such as the existence of technology transfer centres, technology parks and centres of excellence, whose primary role is connecting and exchanging knowledge between the business sector and the academic community (Innoplatform, 2017). A feasibility study for the establishment of a Science and Technology Park is ongoing. SEEU TechPark was opened in 2013 within the South-East Europe University (SEEU), aiming to connect the business sector with the academic community, and in 2017, projects by 23 companies were supported. The Technology Transfer Office has not been open yet as part of NIS, but its establishment is planned in the near future through a World Bank project. As a part from the Macedonian NIS there is established a Center for Technology and Innovation Transfer in the scope of the Faculty of Electrical Engineering and Information Technologies, which is a potential candidate for the Center for Excellence in the Western Balkans (FITD, 2019).

Concerning the protection of the intellectual property rights as one of the key components of open innovation, the analysis shows that in the future there is a need for changes in the conditions for the patenting and commercialization procedures of innovation. The changes are particularly addressed to the intellectual property rights which are not clearly defined, and which in particular show their weaknesses in projects involving multiple partners, for example from the academic and from the business community.

4. Analysis of the innovation and application of the open innovation practices in the Macedonian business sector

4.1. Analysis of the innovation of the Macedonian business sector

The Macedonian business sector, which today comprises more than 70 000 active business entities, indicates a modest innovativeness, which according to the State Statistical Office (SSO) data for the last reference period (2014-2016) is 37.4% (Table 1).

Table 1

Innovative enterprises by size, in North Macedonia

2014-2016					
Enterprises by size	Total	Innovative (number)	%	Non-innovative (number)	%
Total	**3.114**	**1.166**	**37.4**	**1.949**	**62.6**
Small	2.448	871	35.6	1.577	64.4
Medium-sized	552	232	42	321	58.2
Large	114	63	55.3	51	44.7

Source: SSO, 2018.

According to the size of the enterprises the highest innovation activity is observed in the large enterprises (55.3%), followed by the medium-sized enterprises (42%) and last are the small enterprises (35.6%).[5]

In terms of sectoral distribution, the enterprises in the sectors Information and communications and Financial and insurance activities are rated as the most innovative (SSO 2018). Within these two sectors, 56.3% and 52.1%, respectively, of the enterprises are innovative.

The lowest innovation activity in the analyzed period is shown by the enterprises in the sector Water supply; wastewater disposal, waste management and environmental remediation activities. The share of innovative enterprises in the total number of enterprises in the sector is only 22.1% (SSO, 2018).

At the same time, very low innovation activity was registered in the enterprises from the manufacturing sector, where the share of innovative enterprises in the total number of enterprises in this sector amounts to 36.2%. In the Manufacturing sector, the most innovative are the large business entities, where the share of the large innovative enterprises in the total number of large enterprises accounts for more than 50% (SSO, 2018). This situation is understandable, especially considering that the Manufacturing sector accounts for about 30% of the total number of medium-sized and large enterprises in the country.

The modest innovation determines modest results from the innovation activity of the Macedonian business sector, especially in terms of the intellectual property rights, as one of the most relevant, direct indicators of the innovative and economic business performance. According to the assessments in the European Commission (EC) Annual Report on the progress of the Republic of North Macedonia in the process of EU accession from 2019, in the field of protection of the intellectual property rights, the Republic of North Macedonia, as in the previous period, remains "moderately prepared" (European Commission, 2019).

From the point of view of the sectoral distribution of enterprises, in the reference period 2014-2016, out of the total of 164 accomplished intellectual property rights, 82 belong to the Manufacturing sector, 19 to the Information and Communications sector and 5 to the Financial and Insurance activities sector (Eurostat, 2019).

[5] Micro enterprises are excluded from the SSO surveys because the innovative activity in them, with few exceptions, is absent, i.e. it does not exist.

4.2. Analysis of the Representation of the Key Dimensions of the Open Innovation Practices in the Macedonian Business Sector

In order to examine the application of the open innovation practices in the Macedonian business sector, an analysis of the data obtained through the SSO survey – Innovation and Innovation Activities of the businesses entities was made for the last available reference period 2014-2016. From the survey are identified data that can be used to analyze the extent of the open innovation application among the Macedonian business sector as measured by the representation of the key dimensions of open innovation previously mentioned in the paper. The key principle of open innovation is the wide distribution of knowledge. Even highly competitive enterprises with quality human resources need to be linked to external sources of knowledge, because the large researches are often too complex to be performed in a single enterprise. External sources of knowledge other than universities and laboratories include specialized companies, individual researchers, clients, competitive enterprises in the sector of activity, etc. The analysis related to the first dimension – *The identification of external information* indicates the dominant use of internal sources of information within enterprises in the Macedonian business sector, during the innovation process. Of the total number of product and/or process innovative business entities (861), for 47% the use of internal sources of information from different sectors within the enterprise is of high importance for successful implementation of the innovation activities (Table 2). Only a small percentage of the enterprises have considered that the use of external sources of information and knowledge in the implementation of the innovation activities is of high importance. Concerning the external sources, enterprises mostly learn from equipment suppliers (30.5%) and from the private sector clients (26.6%), whereas the use of information from consultants, laboratories and universities and other higher education institutions is very low, 5.7% and 3.1% respectively. The analyzed data indicate a very low level of usage of the external knowledge necessary for implementation of innovation activities.

Table 2

Share of enterprises that have considered the use of information sources of great importance in the implementation of innovation activities, 2014-2016

	Number of enterprises	%
Within the enterprise or enterprise group	406	47.2
Suppliers of equipment, materials, components or software	263	30.5
Clients or costumers from the private sector	229	26.6
Clients or costumers from the public sector	59	6.9
Competitors or other enterprises in the sector	91	10.6
Consultants, commercial labs	49	5.7
Universities or other high institutions	27	3.1

Source: Eurostat, 2019.

Cooperation is a very important element in the open innovation model. Cooperation agreements are concluded between enterprises or organizations for the development of specific products, technologies or processes. There are different agreements, from bilateral projects to complex projects, which include networks for cooperation at the industry level.

However, there are generally three types of cooperation: horizontal, between enterprises of the same sector of activity; vertical, between entities at different levels of the supply chain, such as between suppliers and customers, and lateral cooperation that links the business sector to the academic community.

The analysis of the second dimension – *The interactive knowledge development and transfe*r, indicates a low level of cooperation in the innovation process among the Macedonian business sector. The analysis made shows that most of the enterprises develop the innovation independently, over 75%, which is an indicator of the low efficiency during the innovation process and the great efforts that enterprises should make in introducing innovation, rather than using the benefits of the open cooperation. Analyzed by the types of cooperation, the Macedonian business sector is dominated by the vertical cooperation, i.e. over 81% of the enterprises with concluded agreements cooperate with suppliers of equipment and materials in the innovation process (Table 3). As in the case of the use of information, also in terms of the cooperation, the data again indicate the low level of lateral cooperation, i.e. poor cooperation of the business community with the academic community. Even in cases when there is a cooperation between the academic and the business community, it is often unofficial and frequently refers to the appointment of students or PhD students on the practical work in enterprises, but very rarely the cooperation refers to cooperation for innovation development, by using an expert assistance from the academic community.

Table 3

Participation of the innovative enterprises that have cooperated in introducing innovation, by types of cooperation partners, 2014-2016

	Number of enterprises	%
Product and/or process innovative enterprises	861	
Any types of cooperation	210	24.4
Other enterprises within the enterprise group	82	39.0
Suppliers of equipment, materials, components of software	171	81.4
Clients or costumers form the private sector	115	54.8
Clients or costumers from the public sector	51	24.3
Competitors or other enterprises in the same sector	62	29.5
Consultants or commercial labs	47	22.4
Universities or other higher education institutions	48	22.9

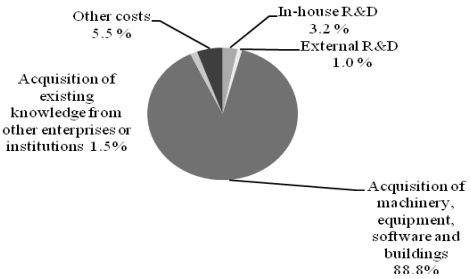
Source: Eurostat, 2019.

In order to reduce the expenditures and risk in the process of research and innovation development, enterprises reduce the internal research and development expenditures at the expense of increasing the external innovation expenditures. In order to explore the third dimension that relates to *Market-based sources*, data have been used from the question on the types of expenditures realized during the innovation process. As it can be seen from Chart 1, in the total realized expenditures, the largest share is for the acquisition of equipment, machinery and software (88.8%). The expenditures for external research and development are very low (3.2%), whereas the expenditures for the acquisition of practical

knowledge from other enterprises or organizations are slightly above 1% of the total expenditures.

Chart 1

Expenditures of innovation activities in 2016

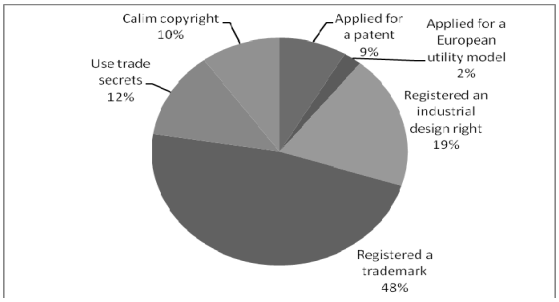


Source: SSO, 2018.

Intellectual property is considered as a product of the classical model of innovation and its role is mostly defensive. Without intellectual property rights, the innovator does not have any financial benefits due to the imitator, and will not have any incentive to innovate in the future. However, in the open innovation model, intellectual property is one of the central elements, because the intellectual property moves to and from the enterprise, thus enabling the exchange of knowledge, and is also used as an indicator for assessing the enterprise innovativeness. The figures presented for the last fourth dimension – *The commercialization of the external technologies* indicates the low usage of intellectual property rights. Only 14% of the innovators in the analyzed period have commercialized their innovations, i.e. they have registered their intellectual property rights. From the data presented in Chart 2, it can be seen that the most frequently used form of intellectual property in North Macedonia is the trademark (48%) and the least used form is patent (9%).

Chart 2

Share of types of registered intellectual property rights in the Macedonian business sector, 2014-2016



Source: Eurostat, 2019.

4.3. Distribution of sectors of economic activity into clusters (open innovation sector cluster and closed innovation sector cluster)

In the following section, a cluster analysis of the Macedonian business sector has been made, in order to group the sectors into clusters according to the characteristics of the innovation models they apply. As in the previous part of the paper, again, the source of data is SSO survey Innovation and innovation activities of the businesses entities, for the reference period 2014-2016. The cluster analysis has been made in the SPSS program using the type of K-Means cluster analysis with a predefined fixed number of groups (clusters), i.e. for the purposes of the analysis two groups of clusters have been defined (a cluster of sectors that introduce open type of innovation and a cluster of sectors that apply the traditional introduction of innovation). The indicators used by dimension have been analyzed in the previous paragraph and are presented in more detail in the Annex.

Before conducting the cluster analysis, it has been taken into account that the values of the variables used in the cluster analysis differ, and therefore standardization of the variable used has been made. With the standardization, the values of the variable are in the interval [0,1] and in this way are more suitable for conducting the analysis.

In Table 4 presented the cluster analysis results. Based on the variable used, it can be concluded that only one sector of the Macedonian economy, which is, the manufacturing sector, applies an open innovation practices. All other sectors and departments apply closed types of innovation, i.e. in the process of innovation, they mainly rely on their own resources and capacities. The enterprises in the manufacturing sector during the innovation process do not rely only on their own resources and knowledge, but are focused on utilizing external technologies and knowledge and market research. The introduction of market-oriented innovation is leading to greater efficiency in the innovation activity of the enterprise part of the manufacturing sector.

Table 4

Cluster analysis results – distribution of sectors and departments in clusters

Cluster Membership

Case Number	Sector	Cluster
1	B Mining and quarrying	1
2	C Manufacturing	2
3	D Electricity, gas, steam and air conditioning	1
4	E Water supply; sewerage, waste management and remediation activities	1
5	46 Wholesale trade, except of motor vehicles and motorcycles	1
6	H Transportation and storage	1
7	J Information and communication	1
8	K Financial and insurance activities	1
9	71 Architectural and engineering activities; technical testing and analysis	1
10	72 Scientific research and development	1
11	73 Advertising and market research	1

Source: Authors calculations

5. Conclusions and recommendations

The analysis made in the paper that focuses on the Macedonian National Innovation System (NIS), the innovativeness of the Macedonian business sector and the usage of open innovation practices, points to the following situations:

- The existence of numerous institutions within the Macedonian NIS and the overlapping of many of their functions and competences, at the same time accompanied with the existence of a number of measures (currently 28 active measures) intended to support the innovativeness of the business sector, dispersed in different programs and under the authority of different bodies, often creates confusion among their users.
- This situation, together with the identified low efficiency of NIS in transferring knowledge and the low level of cooperation between the government, the business sector and the academic community, determines a modest innovativeness of the Macedonian business sector (around 37%) and an extremely low prevalence of open innovation practices in the country.
- According to the results of the cluster analyzes, there is a significant share of open innovation in North Macedonia only in the Manufacturing sector. Enterprises from other sectors in the innovation process mainly rely on their own knowledge and / or internal research and development.
- The NIS of North Macedonia at the same time faces significant challenges in the field of intellectual property rights, both from the aspect of the established legal regulation and from the aspect of the modest results of the realized intellectual property rights. Given the recent EC assessments pointing to the country's "modest preparedness" in the area of protecting the intellectual property rights and their exceptional importance in encouraging the national innovation performance, it becomes clear that it is extremely important to take urgent measures to improve the situation in this area.

Recommendations

In order to improve the identified weaknesses in the Macedonian national innovation system and to establish adequate infrastructure for applying of the open innovation practices among Macedonian business sector, we propose the following measures:

- Straightening the cooperation among institutions part from the NIS, merging the active measures intended for supporting innovation and increasing the available funds by measure.
- Improving the legal framework in the field of protection of intellectual property rights by introducing clear intellectual property rights, which are particularly important for projects that involve more partners and its harmonization with the European legislation.
- Intensifying the process of building innovative infrastructure, i.e. establishing science and technology parks, technology transfer centers, centers of excellence, etc., which are

one of the key elements of NIS necessary for strengthening the cooperation, creating and transferring knowledge in the direction of improving the innovative and competitive performance of the economy as a whole.

- Strengthening the cooperation of the academia with the industry, i.e. involving the academic community in the, so-called, third mission, which implies activities to meet social needs and market demands, in addition to the activities related to the educational and scientific and research activities.
- Increasing the awareness of the business sector representatives about the benefits of implementing the open innovation practices, in order to start businesses active cooperation and knowledge transfer during the innovation process.
- Active participation of the enterprises in clusters and strengthening of the innovation component of the Macedonian clusters, i.e. putting the clusters in function of encouraging the innovation and competitive performance of the businesses.

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Annex

Source of information	Within the enterprise or enterprise group
	Suppliers of equipment, materials, components or software
	Clients or costumers from the private sector
	Clients or costumers from the public sector
	Competitors or other enterprises in the sector
	Consultants, commercial labs
Cooperation	Universities or other high institutions
	Other enterprises within the enterprise group
	Suppliers of equipment, materials, components of software
	Clients or costumers form the private sector
	Clients or costumers from the public sector
	Competitors or other enterprises in the same sector
	Consultants or commercial labs
	Universities or other higher education institutions
Types of expenditures	In-house R&D
	External R&D
	Acquisition of machinery, equipment, software and buildings
	Acquisition of existing knowledge from other enterprises or institutions
	Other expenditures
Registered intelectually property and rights	Applied for a patent
	Applied for a European utility model
	Registered an industrial design right
	Registered a trademark
	Use trade secrets
	Cleim copyright