
Analysis of the Determinants of Innovation in the 21st Century

Submitted 25/02/20, 1st revision 12/03/20, 2nd revision 26/03/20, accepted 05/04/20

Tomasz Jałowiec¹, Piotr Maśloch², Henryk Wojtaszek³,
Ireneusz Miciuła⁴, Grzegorz Maśloch⁵

Abstract:

Purpose: The main aim of this empirical research is to distinguish the characteristics of innovative and non-innovative organisations.

Design/Methodology/Approach: The occurrence of innovative and non-innovative enterprises was verified on the basis of stochastic independence test χ^2 . In order to illustrate the use of decision trees, the database was analysed using the Enterprise Miner module in SAS. For this purpose, it is sufficient to create an appropriate process diagram.

Findings: As a result of the study, it was observed that more than half of the non-innovative enterprises that performed their business functions also abroad were included in the section - transport and that most of the non-innovative enterprises performed basic business functions mainly inside their company. The innovative activity is calculated from the Central Statistical Office showing that only 42% of enterprises showed innovative activity (26.1% of industrial enterprises and 21% of service enterprises) in the period 2016-2018. Most of the non-innovative companies performed basic business functions mainly inside their company.

Practical Implications: The results can be used to improve innovation in specific sectors. Research can contribute to finding where the innovation gap is. We show where there is a great opportunity for innovation and highlight non-innovative places (organisations).

Originality/Value: This study is an original study that brings a creative perspective on innovation and non-innovation to cover the research gap in the literature concerning Poland.

Keywords: Innovation, conditionality, analysis, enterprises, organisations.

JEL codes: O19, O31, D29, H19.

Paper type: Research article.

¹Professor, War Studies University, Management Institute, Management and Command Department, Poland, t.jalowiec@akademia.mil.pl

²Professor, War Studies University, Management Institute, Management and Command Department, Poland, p.masloch@akademia.mil.pl

³Ph.D., War Studies University, Management Institute, Management and Command Department, Poland, h.wojtaszek@akademia.mil.pl

⁴Ph.D., University of Szczecin, Faculty of Economics, Finance and Management Department of Sustainable Finance and Capital Markets, Poland, ireneusz.miciula@usz.edu.pl

⁵Ph.D., Warsaw School of Economics, Department of Local Government Economics and Finance Poland, grzegorz.masloch@sgh.pl

1. Introduction

There are many different definitions of innovation in both Polish and foreign literature. Taking into account foreign literature, the most concise definition is given by Allen (1998) as *"an innovation is the introduction of new products, processes or practices into wide use"*. From Polish literature it is worth quoting the general definition of innovation proposed by Pietrasiński (1970), according to which *"innovations are changes deliberately introduced by man or cybernetic systems designed by him, which consist in replacing the existing state of affairs with others, positively assessed in the light of specific criteria and making up the progress"* (Ebadi and Utterback, 1984).

So, we can say that innovations are a consequence of scientific and technical progress, are closely related to entrepreneurship and their implementation is associated with a particularly high degree of risk, which is why in highly developed market economies special ways of financing them have been developed (Keith and Mitchell, 2010).

From the point of view of marketing and industrial marketing, innovation is the application of new ideas, types of market policy, ways of distribution and promotion, technology, entering new markets, launching a new product or any conscious, significant change in the element of marketing used by the company. Product innovation plays a very important role in the marketing strategy of companies producing both goods and services (Chesbrough, Vanhaverbeke and West, 2006). The life cycle of each product produced by a company comes to a decline indicating the time the innovation is a prerequisite for the company's long-term development.

Market-accepted product innovations give the company an advantage over its competitors and, in some cases, may create an opportunity to gain a temporary monopoly position. In the era of globalisation and continuous integration of European countries, the competitiveness of enterprises on a microeconomic scale depends on the degree of technological advancement and competitiveness of the whole country (Markowska and Müller, 1996).

In a market environment we can distinguish a certain group of consumers who are willing to be the first to purchase and try out newly introduced goods and services. This group of consumers was called "innovators" (Drucker, 1998). The theory of innovation in economic sciences was introduced by Schumpeter (Hospers, 2005), who for the first time in economic theory, formulated five cases of the emergence of new combinations of natural elements and the productive power of man. Schumpeter states that innovations are new combinations occurring in the following cases:

- the production of a new product or the introduction of goods with new properties; the introduction of a new production method;

- the opening of a new market;
- the acquisition of new sources of raw materials;
- the implementation of a new industry organisation (Govindarajan and Euchner, 2012).

Innovation (from Latin *innovatio*, i.e. renewal) is a sequence of activities leading to new or improved products, technological processes or organisational systems. This term was introduced to economics by Schumpeter, thus indicating five cases of innovation:

- Creating a new product;
- Application of new technology, production methods;
- Creating a new market;
- The extraction of previously unknown raw materials;
- Reorganisation of a specific economic sector (Aghion and Tirole, 1994).

According to Zbiegień-Maciąg and Pawnik (1995), one of the dominant features of modern societies is the presence and influence of the organization. Organizations, both large and small, cover a wide range of activities. From an organisational point of view, its environment represents a set of independent variables. These variables are factors that are overwhelmingly beyond its control. Most of these factors retain this character despite numerous attempts by the organisation to shape its environment. By environment is meant a set of components, such as money, materials, people, energy, information, which are not included in the organization itself, but their direct impact or change of properties can change the state of the organization itself. So the environment is the environment in which the organization operates (Birkinshaw, Hamel and Mol, 2008). The behaviour of the organisation is shaped by the environment. This environment can be divided into a closer environment, called the microenvironment, and a further environment, called the macroenvironment. In real systems, the proper behavior of an organization consists in reacting to changes in the environment, as well as in the organization itself, in order to prevent a decrease in the effectiveness of the system. No change is due to just one reason (Klein and Sorra, 1996). The motives for change are always a combination of many factors, both external and internal, with a relatively changeable environment (Makrides, 1997).

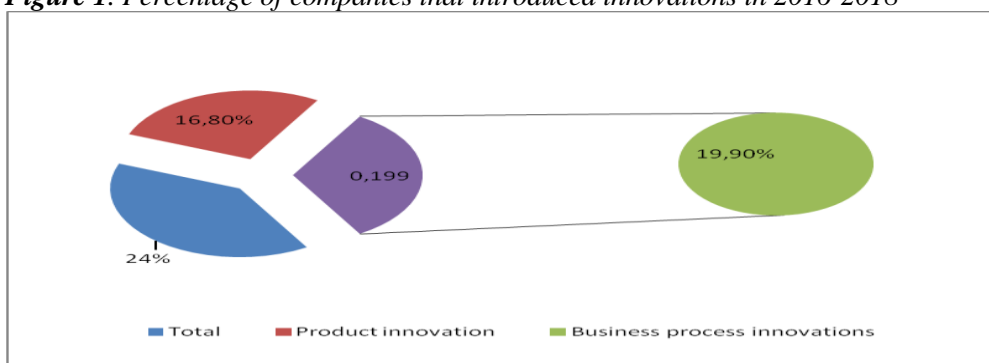
In some cases we can see a strong dominance of one cause, such as competition or technology, while in other cases there are many different causes. The scale of innovation is closely linked to the level of industrial investment and the rate of economic growth (Cooke, Uranga and Etzebarria, 1997). If the economy is characterised by a low level of industrial investment and low economic growth, innovation development cannot be expected. Therefore, innovative companies should pay a lot of attention to researching the environment in which they operate. For testing purposes it is necessary to classify the elements of the environment. The division of the organisation's environment can be made from the point of view of

factors that shape it and from the point of view of organisational units (Tushman and Nadler, 1986).

2. Characteristics of Innovative Activity in Poland in 2016-2018

In the period 2016-2018, 26.1% of industrial enterprises and 21.0% of service companies showed innovation activity. Outlays on innovative activity incurred in 2018 in industrial enterprises amounted to PLN 23388.7 million, and in service enterprises - PLN 13094.8 million. In 2018, the share of revenue from sales of new or significantly improved products launched on the market in 2016-2018, in total revenues in industrial enterprises amounted to 9.1%, and in services 3.2%. Figure 1 shows the percentage of companies that introduced innovations in 2016-2018.

Figure 1. Percentage of companies that introduced innovations in 2016-2018

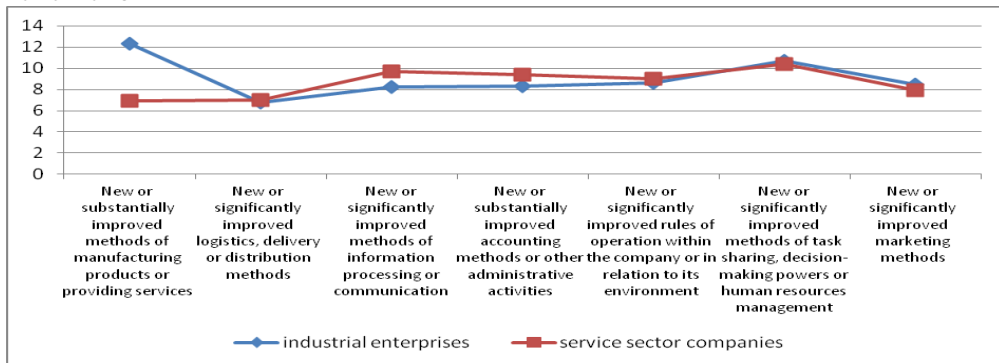


Source: Statistical data obtained from the Central Statistical Office.

Between 2016 and 2018, as part of product innovation, new or significantly improved products were introduced by 15.2% of industrial enterprises and 4.4% of service providers, while new or significantly improved services were introduced by 5.6% of industrial enterprises and 7.4% of service providers. Business process innovations were implemented by 19.9% of industrial enterprises and 17.5% of service companies. Industrial companies most often introduced new or significantly improved methods of manufacturing products (12.3%), and service providers - new or significantly improved methods of task sharing, decision-making powers or human resources management (10.4%). Figure 2 shows the percentage of companies that introduced business process innovations in 2016-2018.

The highest percentage of industrial enterprises that introduced product or business process innovations occurred in the sections manufacture of basic pharmaceutical substances and medicines and other pharmaceutical products (52.0%) and manufacture of computers, electronic and optical products (51.6%), while in services - in the sections insurance, reinsurance and pension funds, excluding compulsory social security (77.6%) and Research and Development (58.5%).

Figure 2. Percentage of companies that introduced business process innovations in 2016-2018

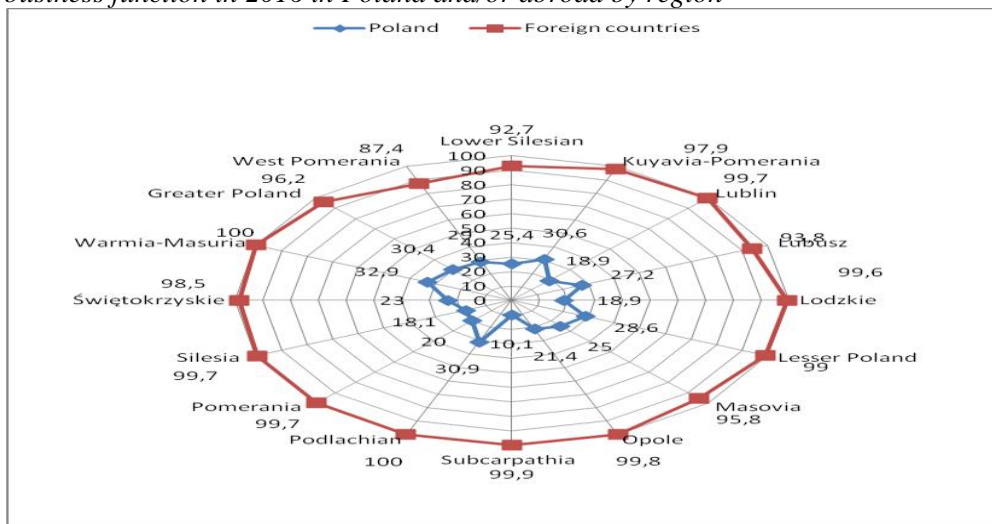


Source: Statistical data obtained from the Central Statistical Office.

2.1 Non-Innovative Enterprises

Almost all (97.5%) non-innovative enterprises performed their basic functions mainly in Poland, regardless of whether they were manufacturing or providing services. Nearly a quarter of the surveyed companies also conducted their core business abroad. The latter were more among companies providing services (24.5%) than those manufacturing products (17.8%). The highest percentage of non-innovative enterprises that performed their business functions also abroad was in the Warmińsko-Mazurskie (32.9%), Podlaskie (30.9%) and Kujawsko-Pomorskie (30.6%) regions. On the other hand, the smallest percentage of such enterprises was located in the Podkarpacki region (10.1%), as shown in Figure 3.

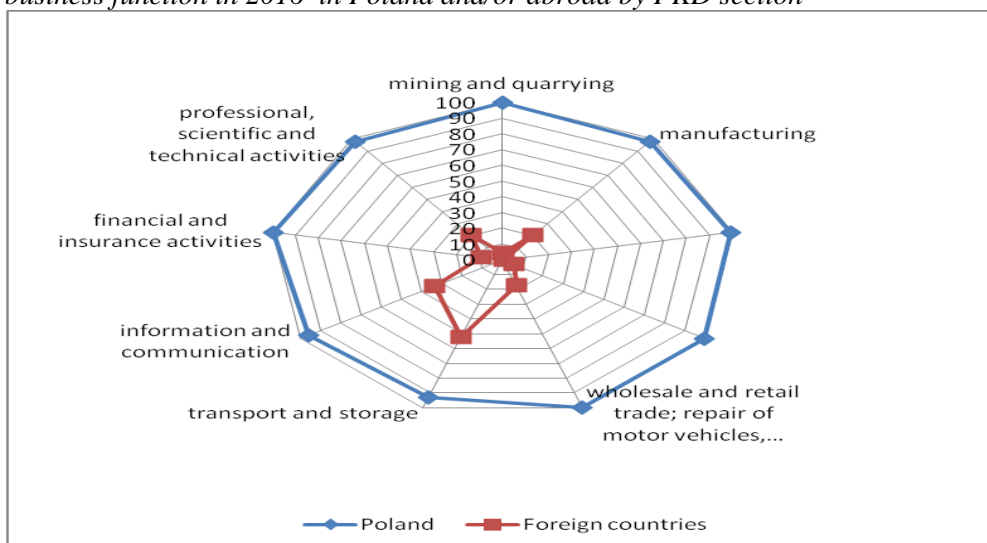
Figure 3. Percentage of non-innovative enterprises that performed their primary business function in 2016 in Poland and/or abroad by region



Source: Statistical data obtained from the Central Statistical Office.

As a result of the survey, it was observed that more than half of the non-innovative enterprises that performed their business functions also abroad, as indicated in Figure 4 were classified in section H - Transport and warehouse management. The smallest percentage of such enterprises belonged to section D - Production and supply of electricity, gas, steam, hot water and air conditioning systems (0.6%).

Figure 4. Percentage of non-innovative enterprises that performed the basic business function in 2016 in Poland and/or abroad by PKD section

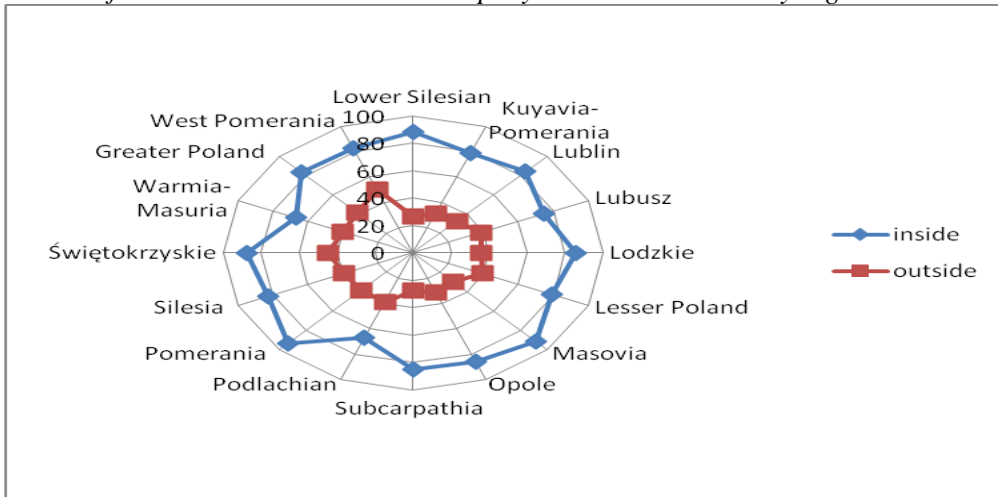


Source: Statistical data obtained from the Central Statistical Office.

Non-innovative enterprises performed basic business functions mainly within their company (83.2%). However, a high percentage (37.7%) of them outsourced part of their business functions to other entities. Among non-innovative enterprises - in terms of functions performed in Poland - 88.7% of enterprises producing products, basic business functions were performed inside the company, while 18.5% - outsourced them. In comparison to enterprises producing products - a smaller percentage (73.1%) of non-innovative enterprises providing services performed the aforementioned functions within the company, and the larger one (38.3%) outsourced these functions. The highest percentage of non-innovative companies outsourcing their business functions (Figure 5) was noted in the region of Wielkopolska (50.1%), Świętokrzyskie (44.9%) and Warsaw (41.3%), while the smallest - in the region of Lower Silesia (26.3%) and Podkarpackie (27.2%). Figure 5 shows the percentage of non-innovative enterprises that performed their primary business function in 2016 inside the company and/or outsourced by region.

Non-innovative enterprises outsourcing their business functions were the most frequent (Figure 7) in the sections - transport and warehouse management (54.6%) and information and communication (49.6%). The lowest percentage of such enterprises was recorded in financial and insurance activities (22.1%).

Figure 5. Percentage of non-innovative enterprises that performed the primary business function in 2016 inside the company and/or outsourced by region



Source: Statistical data obtained from the Central Statistical Office.

2.2 Differences in Innovative and Non-Innovative Organisations

In order to identify the relevant innovation factors of an organisation, the following were modeled on empirical research carried out by Wojnicka-Sycz and Sycz (2016), who analysed the differences in the characteristics of innovative and non-innovative economic organisations based on the survey of enterprises which received support from the Operational Programme Innovative Economy (OPIE) and those which did not apply for this support effectively. The author of the survey indicates that for the needs of evaluation of the Programme, a survey was carried out using a questionnaire with 716 enterprises benefiting from support from the OP IE and 639 enterprises that ineffectively applied for support from the population of all beneficiary enterprises and ineffectively applying.

The analysis of the significance of differences between the percentage of pre-businesses with a given intensity of trait among innovative and non-innovative enterprises was carried out using U-Mann Whitney's non-parametric test for independent samples, which can be used for dichotomous variables.

From among the characteristics of the surveyed, a statistically significantly higher percentage of innovative than non-innovative enterprises occurred in relation to the following features: intensive strategic planning 70.16% of innovative companies compared to 56.03% of non-innovative ones are characterized by high intensity of strategic planning, high equipment in modern machines and technologies and software - declared 74.34% of innovative organizations compared to 57.27% of non-innovative ones - strong focus on risky breakthrough solutions - 58.41% of innovative entities compared to 45.21% of non-innovative ones (Hisses, 2018).

It should be clearly indicated that the distinguishing feature of innovative enterprises is a strong focus on strategic planning involving the implementation of breakthrough solutions and at the same time acceptance of greater risk associated with such undertakings. Moreover, the technological potential in the form of appropriate equipment with modern technologies, machines and software is crucial. This reflects the complexity of today's innovation process, which is often impossible without modern technologies. At the same time, larger and more internationally active companies have greater innovative potential. The importance of strategic planning means, however, that innovation is currently not an ad hoc activity and the result of happy, one-off discoveries, but rather a systematic, planned strategy. Innovative companies also strive not only to implement innovations developed by others, but also to do their own research and development. At the same time, innovative enterprises cooperate with the scientific sector much more often than non-innovative ones.

2.3 Variable Analysis of the Occurrence of Innovative and Non-Innovative Enterprises

The aim of the research was to assess the innovativeness of enterprises from the Silesian Province. Both databases contained a decision variable classifying an undertaking as innovative or non-innovative. The analyses and publications of research results so far have been limited to descriptions using only descriptive statistics tools.

Research has been carried out in the field of enterprise innovation. The target of the research was 400 active companies in the Silesia Voivodeship in terms of innovation and acquisition of new technologies. The sample was selected on purpose. Companies of different sizes (large, medium, small and micro) were selected for the research whose area of activity is contained in sections of the PKD: C, D, E, F, G, I, K, O. The number of selected companies was proportional to their number in the Silesian Voivodeship, moreover, the database of companies was supplemented with companies that applied for funds from the European Union and companies that were included in the rankings of companies that stand out in business activity. A completed questionnaire was received from 279 companies.

For the research methodology a questionnaire was used, supplemented by the observation technique based on the determined indicators. The questionnaire contained both closed and open questions, which concerned quality characteristics and quantitative concerning the innovativeness of the company. Pilot studies were carried out to verify the validity of the questionnaire. The result indicators concerned the number and type of innovations introduced in enterprises increasing their competitiveness, financing of innovative activity and horizontal cooperation and vertical entities in terms of innovative activities. The survey covered technological (product, process) and non-technological (organisational, marketing) innovations. The database contained various data on 279 companies. These were, among others

legal form, organizational form, year of establishment, involvement of foreign capital, training, having a website, offering employees an e-mail account. Obtaining the histogram is only the initial step for further analysis. Such histograms provide information and should be properly interpreted and read. It is apparent that in all types of legal forms, there are less than 50% of companies considered innovative. Public limited companies look best in this respect, and civil partnerships look worst. Almost 60% of the analysed companies had an active website. The analysis was carried out using the stochastic independence test X^2 . By considering two variables, X-forma of the enterprise, Y-innovation of the enterprise making hypotheses about stochastic independence as follows:

H_0 : Variables X and Y are independent.

H_1 : Variables X and Y are not independent.

Table 1. Bipartite table of innovativeness of enterprises depending on the year of establishment

x	Innovative		Non-innovative		Sum
	S1	S2	L1	L2	
y					X
Natural person	26	33,81	112	108,24	138
Civil law partnership	6	8,45	29	26,66	35
General partnership	6	3,88	11	10,13	17
Ltd.	26	17,18	38	45,89	64
Joint stock company	13	6,88	17	19,33	30
Sum	77		207		284

Source: Own study.

The variable X takes $k=5$ and the variable Y takes two $l=2$ levels. For example, the figure of 23 means that there were as many individuals running a business that were considered innovative. The last column contains the edge distribution of the X variable. For example, we see 182 individuals doing business, whether innovative or not. Similarly, there are 77 innovative entities regardless of their legal form. Table 1 also contains theoretical quantities, which we interpret as those that should occur in the absence of variable dependencies. For example:

$$\hat{n}_{11} = \frac{n_{1\cdot} \cdot n_{\cdot 1}}{n} = \frac{138 \cdot 77}{284} = 37,41 \quad \hat{n}_{12} = \frac{n_{1\cdot} \cdot n_{\cdot 2}}{n} = \frac{138 \cdot 207}{284} = 100,58$$

The other results were obtained in the same way as:

$$K = (\chi^2_{1-\alpha}, \infty) = (9,79, \infty).$$

The test statistics are:

$$\chi^2 = \sum_{i=1}^k \sum_{j=1}^l \frac{(n_{ij} - \hat{n}_{ij})^2}{\hat{n}_{ij}} =$$

$$\frac{(26 - 33,81)^2}{33,81} + \frac{(112 - 108,24)^2}{108,24} + \dots + \frac{(13 - 6,88)^2}{6,88} + \frac{(17 - 19,33)^2}{19,33} = 18,94 \in K$$

We reject the null hypothesis as a true alternative, so we can conclude that the changes are dependent. The strength of the relationship was investigated by calculating the convergence factor:

$$V = \sqrt{\frac{\chi^2}{n \cdot [\min(k,l) - 1]}} = \sqrt{\frac{18,94}{284 \cdot 1}} = 0,26$$

The legal form has an impact on innovation, but the dependence is quite weak. The data in Table 1 indicate that natural persons conducting business activity and civil partnerships are less innovative. More innovative include capital companies - limited liability companies and joint stock companies. To illustrate the use of decision trees, the database was analyzed using the Enterprise Miner module in SAS. To do this, it is enough to create a proper process diagram and execute it. First, select the data set for analysis. Then the role of the variables is selected and defined and the data set is divided into training, validation and test parts. In particular, one target variable should be indicated. As before, it is a variable that determines whether an enterprise is innovative. Once the process is complete, you get the decision tree and the resulting set of rules.

3. Discussion

The study focused on the analysis of business characteristics of non-innovative enterprises. Most of them (almost 80%) provide services, while more than half produce products. The majority of enterprises operate in Poland, but almost a quarter of them also operate abroad. This suggests that innovative products are not always a condition for participation in international economic links (at least in the short term). However, in the long or medium term, the necessary condition for maintaining market power is to adapt the changes taking place in competitors and thus to innovate. Perhaps these companies which developed their operations outside Poland in the period preceding the survey they have also introduced innovations. The results of this survey indicate that it was not a large group of surveyed companies.

In terms of performing core functions, more than one third of the number of non-innovative companies outsourced them. Thus, a significant proportion of non-innovative companies used the benefits of outsourcing to other entities.

More than three quarters of the surveyed non-innovative enterprises see that in achieving a competitive advantage, it is crucial to care about the quality of goods or services and a good company brand. More than half of these companies consider that, in the long term, the aim should be to improve products and one third to introduce new goods and services. However, in contradiction to these declarations, there are identified plans of companies for 2017-2020. Relatively few companies plan to introduce specific changes in this area. Namely, a very small number of non-innovative companies (14.3%) intend to introduce new products or services or to improve their existing ones. This in turn may mean that in the coming years the number of innovative enterprises in Poland will increase to a relatively small extent, only 12.4%

The number of surveyed non-innovative enterprises plans to establish cooperation or increase its intensity with other entities, scientific, production or service. This, in turn, may not be conducive to the development of the National Innovation System, which in literature is treated as an important factor in stimulating innovative activity of enterprises.

A significant part of the surveyed enterprises do not see the possibility of using public support to achieve these objectives as important. The largest, although still relatively small (less than a third), percentage of companies saw the importance of obtaining public support for improving employees' professional qualifications and investment support. For most of these companies, public aid for cooperation with the science sector and other companies or research and development activities would be of little importance. A small number of enterprises recognised the importance of this aid for the implementation of scientific work and the creation of R&D infrastructure. This may put a question mark on the future development of the scientific base of non-innovative companies, and thus create conditions to change this situation.

The results of the study can be used by public administrations and other stakeholders to further analyse non-innovative enterprises, in terms of their functions, plans, strategies and management standards, and provide a starting point for monitoring cohesion policy in the 2014-2020 financial perspective: *"Research, technological development and innovation"* and *"Improving the competitiveness of micro, small and medium-sized enterprises, the agricultural sector and fisheries and aquaculture"*.

4. Conclusion

Innovative activity from statistical data from the sources of the Central Statistical Office shows that only 42% of enterprises showed innovative activity (26.1% of industrial enterprises and 21% of service enterprises) in the period 2016-2018. It can be considered that the increase in sales of new products in industrial enterprises was 9.1%, and 3.2% in service enterprises.

Industrial companies most often introduced new or significantly improved methods of manufacturing products, while service companies introduced new or significantly improved methods of dividing tasks, decision-making powers or human resources management. The largest percentage of non-innovative enterprises that performed their business functions also abroad were in the Warmia-Masuria, Podlasie and Kujawy-Pomerania regions. On the other hand, the smallest percentage of such enterprises was located in the Podkarpackie region.

As a result of the survey, it was observed that more than half of the non-innovative enterprises that performed their business functions also abroad were classified in the section - transport and warehouse management. The smallest percentage of such enterprises belonged to the section - generation and supply of electricity, gas, steam, hot water and air for air conditioning systems. Most of the non-innovative companies performed basic business functions mainly inside their company.

References:

- Aghion, P., Tirole, J. 1994. The management of innovation. *The Quarterly Journal of Economics*, 109(4), 35-46.
- Allen, J.P. 1998. Information systems use in continuously innovative organizations. *Information systems innovation and diffusion: issues and directions*, 29-47.
- Birkinshaw, J., Hamel, G., Mol, J.M. 2008. Management innovation. *Academy of management Review*, 33(4).
- Chesbrough, H., Vanhaverbeke, W., West, J. 2006. Open innovation. *The new Imperative for creating and profiting from technology*, 1(3).
- Cooke, Ph., Uranga, M.G., Etxebarria, G. 1997. Regional innovation systems: Institutional and organisational dimensions. *Research policy*, 26(4-5).
- Drucker, P.F. 1998. The discipline of innovation. *Leader to Leader*, 9.
- Ebadi, Y.M., Utterback, J.M. 1984. The effects of communication on technological innovation. *Management science*, 30(5).
- Govindarajan, V., Euchner, J. 2012. Reverse innovation. *Research-Technology Management*, 55(6).
- Hisses, P. 2018. Features differentiating between innovative and non-innovative organisations - empirical verification. *Management and Finance* 16(3).
- Hospers, G.J. 2005. Joseph Schumpeter and his legacy in innovation studies. *Knowledge, Technology and Policy*, 18(3), 20-37.
- Keith, G., Mitchell, R. 2010. *Innovation management*. Palgrave Macmillan, NY.
- Klein, K., Sorra, J.S. 1996. The challenge of innovation implementation. *Academy of management review*, 21(4).
- Markides, C. 1997. Strategic innovation. *Sloan management review*, 38.
- Markowska, E., Müller, A. 1996. Economic rationale for Poland's accession to the European Union. *Innovation Foundation*.
- Pietrasinski, Z. 1970. General and psychological issues of innovation, PWN, Warsaw.
- Tushman, M., Nadler, D. 1986. Organizing for innovation. *California Mgt Review*, 28(3).
- Wojnicka-Sycz, E., Sycz, P. 2016. Public innovation policy and other determinants of innovativeness in Poland. *The Innovation Journal*, 21(3), 1.
- Zbiegień-Maciąg, L., Pawnik, W. 1995. *Management of the organization*. Publishing House of the AGH University of Science and Technology.