Innovative Activity of Companies in the Raw Material Industry on the Example of Poland and Slovakia – Selected Aspects

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Abstract

This paper discusses selected aspects of Innovative activity of companies in the raw material industry. The analysis included two countries from the group of Moderate Innovators (according to the Global Innovation Index, GII), namely Poland and Slovakia. A general comparison of the innovativeness level of Poland and Slovakia with the EU countries was conducted using indicators such as the Innovation-friendly Environment (IFE) or the Summary Innovation Index (SII). The presented structure of expenditures on industrial innovation among the analysed countries revealed the absence of concentration in organizational and marketing innovations, which nowadays possesses significant importance. The conclusion resulting from the study is that Poland and Slovakia should undoubtedly increase their innovative potential, i.a. in the use of their mineral raw materials as non-renewable resources, by identifying the sources of innovation, as well as the opportunities and threats associated with their implementation in raw material enterprises.

Keywords: *innovative activities, mining and quarrying, Global Innovation Index, Innovation-friendly Environment, Summary Innovation Index, innovation expenditure, mineral resources*

Introduction

The raw material sector is currently experiencing many difficulties. The coal markets crisis, the imposition of stricter environmental standards and transition from the traditional to a low-carbon economy, increasing competitiveness of other energy sources on the domestic market, low prices of raw materials, high production costs, an oversupply of coal on the markets, structural changes, the lengthening of decision-making processes, low efficiency of information transmission, information noise, poor optimization of work systems, small involvement of motivational elements in remuneration systems and excessive fragmentation of wage components are only some of the challenges that occur on the energy market [1, 2, 3, 4, 5, 6, 7, 8].

Nowadays, innovation has become a relevant issue in the activity of enterprises and should be incorporated into the process of strategic management, particularly in the case of raw material businesses [9]. Innovations and innovative activities are elements which have a significant impact on the company's competitive position on the market [10]. That is why the above-mentioned difficulties, as well as the complicated economic and financial situation of the industry, develop the need for the change and innovative activity [11]. Although the companies conduct innovative activity, it is primarily focused on the processes [12, 13]. Without a doubt, they require improvement, more effectiveness, or redirection of their focus, but most importantly, there is a need for programmes which support business management. The current mission of managers is not only to recognize the sources of innovation but also to identify the opportunities and threats associated with their implementation [14, 15, 16].

Methodology

The analysis included two countries from the group of Moderate Innovators (according to the Global Innovation Index, GII), namely Poland and Slovakia. It was based on the publicly available reports and statistical data on these countries. A general comparison of the innovativeness level of Poland and Slovakia with the EU countries was conducted using indicators such as the Innovation-friendly Environment (IFE) or the Summary Innovation Index (SII). The types of innovations implemented by innovatively active industrial enterprises have been correlated. Subsequently, the expenditures on innovative activities of these businesses have been compared. The subject of the research on innovative activities consisted only of the industrial enterprises, conducting activities classified according to the Polish Classification of Activities (PKD) and the Statistical Classification of Economic Activities in the European Community (NACE), into the section of Mining and Quarrying, more particularly: extraction of hard coal and brown coal (lignite), mining of crude oil and natural gas, mining of metal ores, other mining and quarrying, as well as service activities supporting mining.

Innovation ranking of the EU countries

The EU Innovation Scoreboard is announced annually, dividing the member states into four groups [17]:

- "Innovation Leaders", with innovation levels well above the EU average,
- "Innovation Followers", with innovation levels above or close to the EU average,
- "Moderate Innovators", with innovation levels below the EU average,
- "Modest Innovators", with innovation levels well below the EU average.

Countries which have been among the Innovation Leaders for a long time are Sweden, Denmark, Finland and

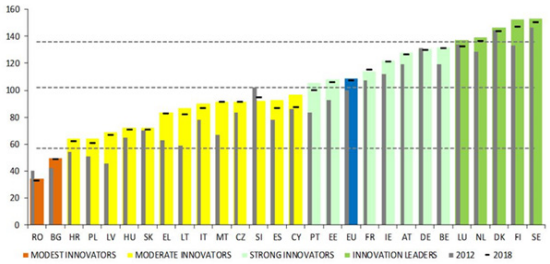

Fig. 1. Innovation Scoreboard. Source: [20]
Fig. 1. Tablica wyników innowacyjności. Źródło: [20]

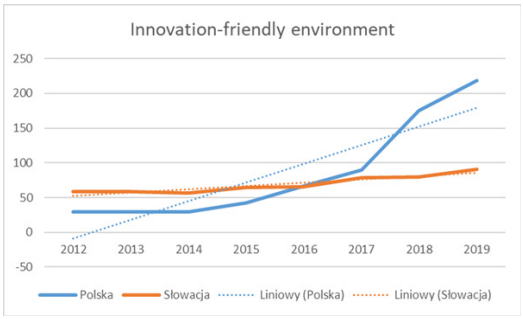

Fig. 2. Development of the Innovation-friendly Environment index for Poland and Slovakia. Source: Own study based on [21].
Fig. 2. Kształtowanie się wskaźnika Innovation-friendly enviroment dla Polski i Słowacji. Źródło: opracowanie własne na podstawie [21]

Germany. They are considered to be the most innovative countries, exceeding the average innovation level for the EU. It implies that in fields (areas) such as science base and higher education systems, entrepreneurship, intellectual capital and economic performance, the level of their innovativeness is above average, indicating a stable system of scientific research and innovation [17]. Innovative activity in the countries is undoubtedly related to their economic development. "The economic development of EU's countries depends on stable and permanent access to various energy sources" [18], and mining and the production of mineral resources in individual countries still play an important role in shaping the global economy [19].

From the innovation boards from 2010 onwards results, that Slovakia, unlike Poland, has consistently belonged to the group of Moderate Innovators. Initially, Poland was among the countries "well below the EU average", i.e., Modest Innovators, next to Bulgaria, Romania and Latvia. The country subsequently advanced to the group "below the EU average" (fig. 1). In the 2019 innovation ranking, Slovakia was ranked at the 7th, while Poland at the 4th lowest positions [20]. The shift within the group might have been influenced by the beginning of the transition from traditional to a low-carbon economy, as well as investments related to environmental protection. This situation has been reflected in the Innovation-friendly Environment index. The development of this indicator for Poland and Slovakia has been presented in Figure 2.

Between 2012 and 2019, the value of the indicator for Slovakia recorded an upward trend. With regard to Poland, the index value revealed an upward trend as well, but the growth rate of the indicator was higher. Initially, Poland's indicator value was lower than that of Slovakia's, however, since 2016 onwards, it has registered higher levels.

The study revealed that the innovativeness of Polish and Slovak enterprises significantly differs from the levels recorded in the majority of the EU countries [17, 22, 23]. It indicates that the innovation performance in the EU is improving annually (Poland changed groups while still remaining at the same position), however, the innovation gap between the EU member states is continuously widening (Fig. 3).

Figure 3 presents the development of the Summary Innovation Index for selected countries from the innovation ranking, one from each group of leaders, with Poland and Slovakia included in the comparison as countries with the level of innovation below the EU average. It reveals the amount of improvement our countries require to deliver in terms of the innovation indicator in order to be ranked at least within the group of Innovation Followers, where Austria is placed. The innovation level of Sweden, as one of the Innovation Leaders, is rather unattainable for our countries.

The above-mentioned widening of the innovation gap between the EU member states involves not only the product and process innovation but more importantly, the organizational and marketing innovation, whose importance in today's world increases [23].

Types of innovation

The participation of raw material businesses which introduce innovations is constantly increasing. According to the Central Statistical Offices of Poland and Slovakia, an innovatively active enterprise is one which, introduced at least one innovation in the studied period (product or process, or implemented a minimum of one innovative project).

The comparison of innovative activity in Poland and Slovakia reveals that between 2014 and 2016, the participation of Slovak enterprises which introduced every type of innovations was undeniably higher than the participation of Po-

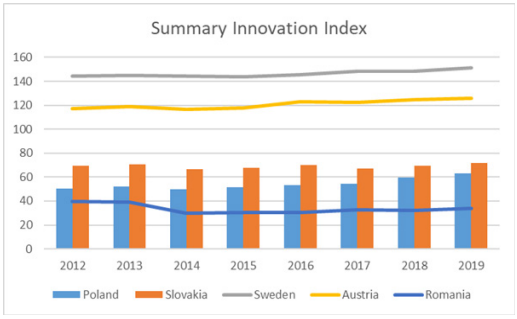

Fig. 3 Development of the Summary Innovation Index for Poland and Slovakia. Source: Own study based on [21]
Fig. 3. Kształtowanie się wskaźnika Summary Innovation Index dla Polski i Słowacji. Źródło: opracowanie własne na podstawie [21]

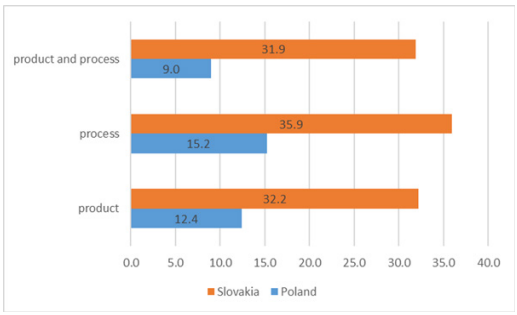

Fig. 4. Structure of the actively innovative enterprises in Poland and Slovakia in 2014–2016 [%]. Source: Own study based on [24, 25]
Fig. 4. Struktura przedsiębiorstw aktywnie innowacyjnych w Polsce i Słowacji w latach 2014–2016 [%]. Źródło: opracowanie własne na podstawie [24, 25]

lish businesses (Fig. 4). It is also confirmed by the relation between the position of Poland and Slovakia in the EU countries innovation ranking.

Process innovations in Slovakia were introduced by 35.9% of the companies, i.e. by 20.7 pp more than companies in Poland. The participation of enterprises in product innovations in Poland was 19.8 pp lower, amounting to 12.4%. On the other hand, the percentage of Slovak companies which introduced product and process innovations was 22.9 pp higher.

More information on the innovation types in the energy sector, as well as the participation of mining and quarrying companies which implemented innovations in Poland between 2016 and 2018 was provided in [13, 26]. The presented analyses have indicated, that the participation of industrial, innovatively active enterprises in the following years has increased, compared to 2016, while within the structure of the implemented changes, more process innovations appeared. Since 2016, Poland's situation in terms of innovation has improved, which is presented by the previously mentioned Innovation-friendly Environment and Summary Innovation Indexes.

Expenditure on innovation

Innovation expenditure includes science, technology and costs associated with trade as well as any steps leading to the implementation of new or significantly improved products or processes, such as expenditure on the ongoing or abandoned innovations. The structure of industrial innovation expenditure in Slovakia from 2016 is presented in Figure 5, while in Poland – in Figure 6.

With regard to Slovakia, 5 groups of expenditures on innovation may be distinguished (Fig. 5). A very broad group, consisting of the purchase of machinery and equipment, hardware, software and buildings is the main component of the innovation expenditures in industrial enterprises. As much as 68.3% of the outlays was allocated to this group in 2016. The second group within the structure of innovation expenditures was internal research and development (19.6%). Much smaller participation in the outlays structure was allocated to the purchase of external research and development (6.26%), the acquisition of knowledge from other companies or organizations (2.99%), and to all other innovative activities – 3.1%.

While comparing innovation expenditures in Poland, a different classification may be observed (Fig. 6). Although the expenditures on machinery and equipment are separated from the outlays on buildings and software (such was the case in Slovakia), they represent almost 50% of total expenditures on innovation (49.4%). The outlays on the purchase of buildings and land with 26.7% are placed second. In 2016, the expenditures on research and development activities were 8.4 pp lower than outlays on the purchase of buildings, amounting to 18.3% of the structure of the total expenditure. The smallest participation was recorded for other innovations (2.6%), software purchases (1.6%) and marketing activities (1.4%).

Due to the different distribution within the structure of expenditures on innovation in Slovakia and Poland, they were divided into three groups: machinery, hardware, software and buildings, R&D activities and others. Such sequence facilitates a better comparison (Fig. 7).

The presented comparison reveals that in 2016, Poland incurred higher expenditures (77.7%) on machines, hardware, software and buildings than Slovakia (68.29%). However, the R&D and other outlays were higher in Slovakia by 7.56 and 1.85 pp respectively.

The presented structure of expenditures on innovation in Poland and Slovakia confirms the widening of the innovation

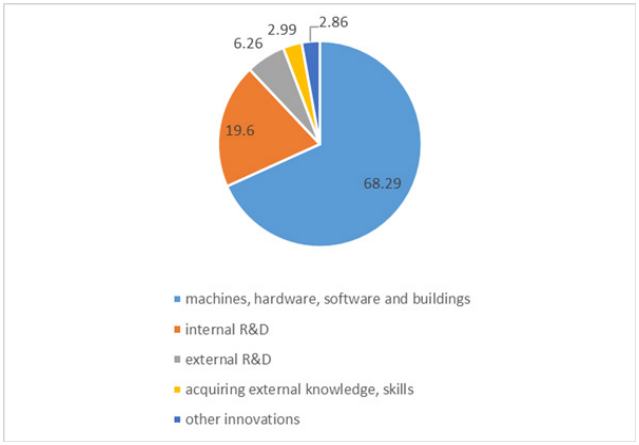

Fig. 5. Structure of expenditures on innovative activities in industrial enterprises in Slovakia, 2016 [%]. Source: Own study based on [25]
Fig. 5. Struktura nakładów na działalność innowacyjną w przedsiębiorstwach przemysłowych na Słowacji w 2016 roku [%]. Źródło: opracowanie własne na podstawie [25]

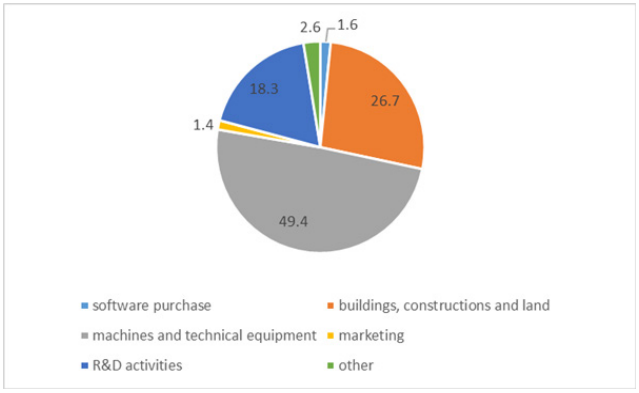

Fig. 6. The structure of outlays on innovative activity in industrial enterprises in Poland, 2016 [%]. Source: Own study based on [24]
Fig. 6. Struktura nakładów na działalność innowacyjną w przedsiębiorstwach przemysłowych w Polsce w 2016 roku [%]. Źródło: opracowanie własne na podstawie [24]

gap between the EU member states, reflected in the absence of organizational and marketing innovations. Analyses of the structure of investment outlays in the energy sector were the subject of other works and articles as well [22, 27, 28, 29].

Mineral resources in the Moderate Innovators countries versus directions of innovation activities

Both analysed countries – Poland and Slovakia – are countries rich in mineral resources. 4 groups of mineral resources occur in each of them: energy, chemical, metallic and rock raw materials. The amount of raw material deposits varies, as presented in Figure 8. The occurrence of natural resources in both countries is related to the geological past and phenomena that have been taking place over millions of years. The mineral raw materials are included in the group of finite resources, which means they are non-renewable resources. Thus, on the one hand, it is important to use them rationally, and on the other to pursue replacing them with renewable resources. This issue concerns energy raw materials the most, therefore we have a growing number of wind farms, solar and hydropower stations. The manufacture of biofuels is also increasing, which contributes to the improvement of environmental cleanliness.

While studying the mineral resources in the deposits, it can be observed that Slovakia has a small volume of raw materials, but a significant amount of non-metallic resources in relation to its other minerals (15,747 million tons in 2018). The second place in terms of resources is occupied by building materials (2,642 million tons in 2018). There appear to be slightly less metallic raw materials (1,343 million tons in 2018) and energy raw materials (1,133 million tons in 2018).

Compared to Slovakia, Poland owns a significant amount of all mineral resources deposits. The majority are chemical raw materials (91,547.17 million tons in 2018), and a slightly less energy raw materials (85,017.25 million tons in 2018) and rock raw materials (61,344.59 million tons in 2018). Metallic raw materials constitute the smallest number of resources (2,540.44 million tons in 2018).

The raw materials deposits that occur in the presented countries in the largest quantities have shaped the industry development, as well as the direction of the applied technologies. The resources provide them with a significant amount of independence [19, 33, 34, 35, 36, 37, 38], as well as reduce the costs of development of industries that use mineral resources. Such independence of Poland is possible particularly with the use of hard coal and lignite seams, which are used in the energy and metallurgy industries. Apart from the energy raw materials, in terms of the overall possessed resources, a significant amount of metallic and rock materials is extracted in Poland. However, the independence of Slovakia is possible

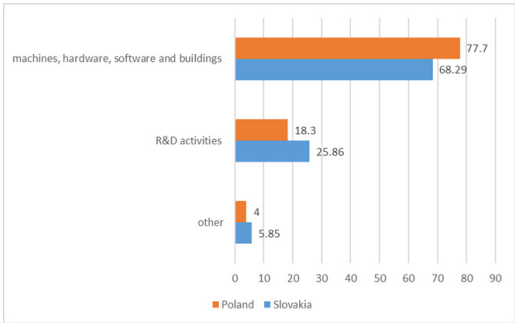

Fig. 7. Structure of expenditures on innovative activity in Polish and Slovak industrial enterprises in 2016, divided into three groups [%]. Source: Own study based on [24, 25]

Fig. 7. Struktura nakładów na działalność innowacyjną w przedsiębiorstwach przemysłowych w Polsce i Słowacji w 2016 roku w podziale na trzy grupy [%]. Źródło: opracowanie własne na podstawie [24, 25]

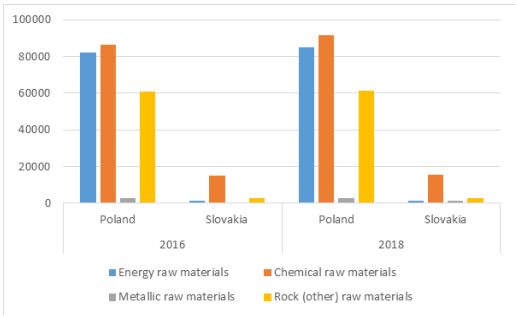

Fig. 8. Total geological resources of minerals from deposits in Poland and Slovakia in 2016 and 2018 [million tons]. Source: Own study based on [30, 31, 32]

Fig. 8. Całkowite zasoby geologiczne kopalin w złożach w Polsce i Słowacji w 2016 oraz 2018 roku [mln ton]. Źródło: opracowanie własne na podstawie [30, 31, 32]

mainly due to rock, energy and non-metallic raw materials [39]. Slovak industry still greatly influences the economy, while the metallurgy and the automotive industries possess significant importance.

Conclusion

A comparative analysis of the innovative activity of industrial, innovatively active businesses in Poland and Slovakia has revealed several challenges these countries encounter and need to overcome to remain in their position in the innovation ranking of the EU member states. The indicated in the study process of widening of the innovation gap, which includes mainly the organizational and marketing innovations, nowadays possesses significant importance. The presented structure of expenditures on industrial innovation among the analysed countries revealed the absence of such modifications.

Various types of innovation – technology-driven, digital and global megatrends, such as artificial intelligence and the closed-circuit economy, offer companies great opportunities on the one hand while leading to new challenges on the other. While the global competition intensifies and threatens the leading positions of key industries, Poland and Slovakia should undoubtedly increase their innovative potential, i.a. in the use of their mineral raw materials as non-renewable resources, by identifying the sources of innovation, as well as the opportunities and threats associated with their implementation in raw material enterprises. In the current situation of the pandemic, following the collapse of the markets, this may prove difficult. It does not change the fact that innovation and planned innovative activity of industrial businesses in Poland and Slovakia are crucial. Without a doubt, a deeper analysis of the innovative activities and expenditures, which require not only improvement or effectiveness, but above all, a change in the direction of their focus would prove to be beneficial. Such activities should be aided by the management support programs and financed by the industry, as well as the state.

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Działalność innowacyjna przedsiębiorstw branży surowcowej na przykładzie Polski i Słowacji – wybrane aspekty

W artykule przedstawiono wybrane aspekty działalności innowacyjnej firm w branży surowcowej. Analiza objęła dwa kraje z grupy Moderate Innovators (według Global Innovation Index, GII), czyli Polskę i Słowację. Ogólne porównanie poziomu innowacyjności Polski i Słowacji z krajami UE przeprowadzono za pomocą wskaźników, takich jak Innovation-friendly Environment (IFE) czy Summary Innovation Index (SII). Przedstawiona struktura wydatków na innowacje przedsiębiorstw przemysłowych wśród analizowanych krajów ujawniła brak koncentracji na innowacjach organizacyjnych i marketingowych, które obecnie mają istotne znaczenie. Z przeprowadzonych badań wynika, że Polska i Słowacja powinny niewątpliwie zwiększyć swój potencjał innowacyjny m.in. w wykorzystaniu swoich surowców mineralnych jako zasobów nieodnawialnych, poprzez identyfikację źródeł innowacji oraz szans i zagrożeń związanych z ich wdrażaniem w przedsiębiorstwach surowcowych.

Słowa kluczowe: *działalność innowacyjna, górnictwo i wydobywanie, Global Innovation Index, Innovation-friendly Environment, Summary Innovation Index, wydatki na innowacje, surowce mineralne*