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# RAW MATERIALS MARKET REPORT 2020

*ENTREPRENEURIAL OPPORTUNITIES IN  
THE RAW MATERIALS SECTOR IN HUNGARY, CZECH  
REPUBLIC, POLAND AND SLOVAK REPUBLIC*

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SECTOR IN HUNGARY, THE CZECH REPUBLIC, POLAND AND THE  
SLOVAK REPUBLIC

2020

LIMBRA

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LIMBRA Decreasing the negative outcomes of brain drain in the raw materials sector  
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# KEY FINDINGS

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**PREPARED BY**  
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TEKLA SZÉP

## Key findings

*There are considerable differences among the Visegrad countries (Hungary, the Czech Republic, Poland and Slovakia) regarding the size and the structure of the domestic raw materials sector, but some of the fundamental problems are very similar.*

*Managers and experts have reported considerable skill gaps, and the lack of available knowledge in such crucial auxiliary services like IT & Industry 4.0, life cycle analysis and recycling methods, industrial symbioses and support network.*

*The main reason of knowledge gap is the lack of proper entrepreneurial activity in the raw materials sectors. Although the sector is dominated by micro-enterprises (close to 90% of the active firms fall into this category), the number of new, innovative businesses is extremely low.*

*Barriers to entry in the sector are typically very high. Initial investment costs are significant, and the share of sunk cost is also high. This is one of the factors that discourages entrepreneurs.*

*Our interviews have also revealed that the stakeholders consider the regulatory and tax burden to be too high, creating another barrier to entry. Regulations, on the other hand, create new market niches as well, since government policies make it compulsory for firms to apply novel approaches and methods, which incumbent firms have very little experience with.*

*A final clear barrier is the low entrepreneurial intention among raw materials students, and raw materials graduates. Our survey revealed that students are discouraged by the high bureaucracy costs; academic programmes include entrepreneurship skills training, but respondents reported that these courses are too theoretical, and so they clearly do not contribute to the boosting of the entrepreneurial intentions of students.*

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*The training materials developed by LIMBRA, and the entrepreneurial skills training programmes based on these materials, the inclusion of real life business problems into the training are all novel approaches that go beyond the traditional curricula of entrepreneurial courses, and LIMBRA activities confirmed that these can be effective in boosting the entrepreneurial intentions.*

*The mentoring programme designed by LIMBRA will not only offer guidance to students, but it can also help them in overcoming some of the bureaucracy costs as well.*

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## Introduction – Entrepreneurship and the raw materials sector

Zoltán Bartha & Tekla Szép

We face many global challenges. The list is really long: climate change, global epidemics (COVID-19), poverty, environmental crisis, wildfires, etc. Innovation is essential for successful mitigation. The big economic centres (European Union, the United States and Japan, not to mention the new competitors, such as China or South Korea) continuously compete with each other for human capital, financial or venture capital, attracting new investors and companies, generating start-up companies or increasing the number of patents. A strong, viable and efficient innovation ecosystem is crucially important if the EU wants to keep up with them.

Innovation can be related to any small piece of the value chain: materials, processing, design, products and services etc. The raw materials sector is the deal-breaker, however in the Visegrad countries (the Czech Republic, Hungary, Poland and Slovakia) it has declined considerably following the political and economic transformation of the early 1990ies. Household-name companies were closed, jobs were lost, and universities specialised in raw materials education were also hit, since the young people chose trendier fields of study. These developments seem distant in the 2020ies, but they still have an effect on the stakeholders of the raw materials sector. On the one hand, the better paying jobs, especially the ones available in the Northern and Western parts of the European Union, act as a strong brain drain pull factor. Some of the best raw materials graduates seek jobs outside of their countries. On the other hand, the young people still fail to realise that the hottest social, technological and business trends are very closely connected to raw materials: one of the first large scale application of robotics and industry 4.0 technologies happened in the mining sector; innovations in nanotechnology and in other subsectors create new needs for raw materials; waste management issues and circular economy models are also connected to the sector. The need for new ideas and technological/business innovation has never been higher in this area, yet, many of the graduates seek secure jobs at large organisations, even it means that they get employed outside of the sector. A large

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proportion of the innovation potential is untapped because of low entrepreneurial intentions among raw materials graduates.

LIMBRA (LIMit the BRAin drain! – EIT Raw Materials project no. 18197) was designed to tackle these problems of the raw materials sector. We organise thematic events for young people to make them aware how strongly connected the sector is to the latest social, technological and business trends; we organise novel training programmes for raw materials student to help them acquire entrepreneurial skills; we discover the needs of the raw materials sector, and help entrepreneurial minded students to find the right business ideas; and we created a coaching/mentoring programme for our students to provide assistance in starting their own businesses. We detect niches in the raw materials market, suggest and select business ideas that could potentially exploit those niches, help students to create viable business plans, and encourage them to start their own businesses based the developed business plans. In so doing we motivate them to “Become stay-at-home entrepreneurs” who can contribute to the innovation activity of the raw materials industry.

This complex market report is a key part of LIMBRA activities. 20 colleagues were involved in the research process during 2019 and 2020 from the four Visegrad partners: Technical University of Kosice (Slovakia), Technical University of Ostrava (Czech Republic), University of Miskolc (Hungary) and AGH University of Science and Technology (Poland). The research focused on the raw materials sector of the four Visegrad countries, and the report devotes a separate chapter to each country. For doing innovation many times the idea what is missing. The report’s main purpose is to fill this gap: highlighting in all countries the underdeveloped areas with great innovation potentials, finding and identifying the niches. Secondary data sources (available at company or aggregated level) were used to provide a clear picture of the current state of the industry. The PESTEL analysis (describing the Political, Economic, Social, Technological, Environmental and Legal context) conducted provides a deeper insight into the problem, while the interviews and the surveys designed and conducted by the LIMBRA team allowed us to gain a unique understanding about the major challenges and the entrepreneurial opportunities of the raw materials sector.

One of the advantages of this report is that it uses a fairly broad definition for the raw materials sector. Traditionally the raw materials industry is defined as Section B of the NACE structure (Mining & Quarrying), however it is obvious that many other branches are also directly connected to it: some agricultural activities

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(Section A), industrial processing (Section C), electricity production (Section D), water and waste management (Section E), and construction (Section F). The report uses the broader definition, identifies the areas that have the greatest growth potential, and focuses on these high growth sectors. We also encouraged colleagues to make the reports country-specific. Although the socioeconomic environment of the Visegrad countries is very similar, there are obvious national differences and specific national characteristics. These are reflected in the high growth/high potential sectors selected by the four teams for further analysis. The Hungarian team focused on waste management, and such auxiliary services as life cycle analysis and promoting industrial symbiosis, the Czech report concentrated on mining, the Slovakian one on construction, while the Polish focus area was yet again an auxiliary service, the connection between IT, industry 4.0 and raw materials.

The report not only describes the high growth/high potential sectors; the interviews conducted with experts, business owners, managers and other stakeholders made it possible to our colleagues to point out the niches where there is the greatest need for innovation and entrepreneurial intervention. Industrial symbiosis, for example can clearly decrease the amount of waste, and allows us to recover some of the raw materials used, but most firms find it too cumbersome to invest into the creation of such networks. Some of the programming skills engineering students acquire in academia could clearly enhance efficiency in the raw materials sector, but the new solutions avoid the sector as most talented students either leave the country, or look for stable jobs instead of venturing into the unknown with their own business ideas. These market niches serve as inputs for the final stage of LIMBRA activities, undertaken in 2021: we help students generate actual business ideas, and then we guide them through the process of business plan generation within the framework of a coaching and mentoring programme developed with the help of our Bilbao partner, Tecnalia Ventures.

The stakeholder analysis also confirmed the need for training entrepreneurial skills for raw materials students. In cooperation with our second Bilbao partner, Fundacion Tecnalia Research & Innovation, LIMBRA developed training materials in 2019, and has been using them to train critical soft skills in summer schools and real life problem solving events. University students usually get some entrepreneurial training within the academic framework, but our surveys confirmed that they typically find these courses too theoretical and being of little help. Working in small team, focusing on problem solving, and engaging in solving real life

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problems – an approach adopted by LIMBRA training courses – are way more efficient in teaching entrepreneurial skills, and thus, are more likely to influence the entrepreneurial intentions of students.

The market report is not the last of the LIMBRA reports. In 2021 we release a catalogue of business ideas, and a whole conference will be devoted to the topic of entrepreneurship in the raw materials sector. We also created a video that is based on the market analysis, which can be used to promote the LIMBRA initiatives among university students and young people in general. The video is accessible on our YouTube channel at: <https://youtu.be/t737YyehKlk>.

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# CHAPTER 1

HUNGARY

---

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## 1. Overview of Hungarian Raw Materials Market

Throughout the project, 21 classes of the national economy sections were identified in the raw materials sector based on the NACE Rev. 2 statistical classification of economic activities in the European Community. Public statistics are not stated by classes; only at the level of sections of the national economy. The information on each section was compiled based on the data of a database of Hungarian companies purchased from OPTEN Ltd. The database contains data on the enterprises operating in the raw materials sector in December 2019, partly for the closed year 2018 and partly for the period of the last 5 years (2014–2018). The drawback of the database is that the 5-year data has been compiled from the data of currently operating enterprises and, therefore, they do not include the performance of the companies closed down in the meantime. Thus, we draw conclusions for the sector based on the data of the companies with 5 closed years (total number of companies: 1,951).

The most important characteristics of the Hungarian raw materials sector are summarized primarily on the basis of the aggregated data of companies. We examined the company demographic characteristics of the 21 NACE classes, employee turnover, the net sales revenues of currently operating enterprises, and the 2014-2018 profitability indicators. The length of this report period does not allow background data to be included for all of the filters we used. We only provide some data that we consider important for the entire raw materials sector. Thanks to this set of data, we could select the section we focused on in the further stages of the study.

Table 1 shows the list of NACE Rev. 2 groups focusing on raw materials that we included in the research:

Table 1 List of NACE rev. 2 groups included in the research

Section	Class	Content
Section A – Agriculture, Forestry and Fishing	02.20	Logging
Section B – Mining and quarrying	05.10	Mining of hard coal
	05.20	Mining of lignite
	06.10	Extraction of crude petroleum
	06.20	Extraction of natural gas
	07.10	Mining of iron ores
	07.21	Mining of uranium and thorium ores
	07.29	Mining of other non-ferrous metal ores
	08.11	Quarrying of ornamental and building stone, limestone, gypsum, chalk, and slate
	08.12	Operation of gravel and sand pits; mining of clays and kaolin
	08.91	Mining of chemical and fertilizer minerals
	08.92	Extraction of peat
08.93	Extraction of salt	
08.99	Other mining and quarrying n.e.c. <sup>1</sup>	
Section D – Electricity, gas, steam and air conditioning supply	35.11	Production of electricity
	35.21	Manufacture of gas
Section E – Water supply; sewerage; waste management and remediation activities	38.11	Collection of non-hazardous waste
	38.12	Collection of hazardous waste
	38.21	Treatment and disposal of non-hazardous waste
	38.22	Treatment and disposal of hazardous waste
	38.32	Recovery of sorted materials

Source: Selected from NACE rev.2 list

## 1.1. Business Demography

Table 2 shows the main business demographic characteristics of the Hungarian raw materials sector. In 2019, there were 3,746 companies operating in the raw materials sector. Of these, 46.5% were engaged in the Production of electricity class, 13.6% in the Logging class, 11.6% in the Collection of non-hazardous waste class, and 7.2 % in the Operation of gravel and sand pits; mining of clays and kaolin class. It can be seen that in the 2014-2018 period a number of new enterprises were

<sup>1</sup> not elsewhere classified

established (48% of the enterprises operating today have been established in the last 5 years). However, the number of enterprises closed down without a successor company is also high (34% in terms of the number of enterprises operating today). Looking at this data, Production of electricity can be highlighted, where 72% of the companies have been established in the last 5 years. This proportion is also similar for the Extraction of crude petroleum and natural gas division. Most of the companies that have ceased to exist without successor companies (compared to the number of companies operating today) can be found in the field of the Recovery of sorted materials and Logging classes. The percentage of companies with 5 closed business years in the examined sectors (apart from the sectors comprising only few companies) is the highest in Waste management and remediation activities, followed by Extraction of natural gas, Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate, Operation of gravel and sand pits; mining of clays and kaolin, and Extraction of peat. Having examined the size of the companies based on the number of their employees, we have found out that the raw materials sector is characterized by the dominance of microenterprises (89%) while the percentage of medium-sized and large enterprises (together 3.4%) is negligible. Of the 3,746 companies currently operating in the raw materials sector in total, only 15 can be considered large companies in terms of the number of their employees. The dominance of microenterprises can be seen in all the sectors, except Mining of uranium and thorium ores, Collection of non-hazardous waste, and Treatment and disposal of hazardous waste. It should also be noted that about 45% of companies do not employ any people.

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Table 2 Business demography of the raw materials sector in Hungary

NACE class	Number of enterprises						Share of total enterprises (%)			
	in 2019	with available 2018 data	change 2014-2019	closed without a successor company 2014-2018	with 5 closed business years	with 0 employees	micro	small	medium-sized	large
02.20	509	442	186	254	327	178	96.6	2.9	0.0	0.5
05.10	1	1	0	4	1	1	100.0	0.0	0.0	0.0
05.20	12	12	1	2	11	3	66.7	33.3	0.0	0.0
06.10	25	23	19	2	10	19	100.0	0.0	0.0	0.0
06.20	9	9	6	4	4	7	88.9	11.1	0.0	0.0
07.10	1	0	1	0	0	0				
07.21	2	2	0	1	2	0	50.0	0.0	50.0	0.0
07.29	5	4	3	10	2	4	100.0	0.0	0.0	0.0
08.11	63	57	11	28	52	19	75.4	17.5	7.0	0.0
08.12	271	248	49	108	214	105	87.1	10.9	1.6	0.4
08.92	11	10	2	5	8	3	70.0	30.0	0.0	0.0
08.93	2	2	0	0	2	1	100.0	0.0	0.0	0.0
08.99	22	19	8	5	15	7	89.5	5.3	5.3	0.0
35.11	1741	1531	1254	326	489	1106	98.1	1.3	0.4	0.2
35.21	16	15	1	10	15	4	93.3	6.7	0.0	0.0
38.11	433	409	76	200	356	71	66.3	20.0	12.2	1.5
38.12	43	43	4	16	38	8	79.1	18.6	2.3	0.0
38.21	212	190	71	90	138	53	76.3	15.3	6.8	1.6
38.22	57	54	10	23	46	16	55.6	31.5	13.0	0.0
38.32	311	277	95	196	221	82	78.7	16.2	5.1	0.0
	<b>3746</b>	<b>3348</b>	<b>1797</b>	<b>1284</b>	<b>1951</b>	<b>1687</b>	<b>88.7</b>	<b>7.8</b>	<b>3.0</b>	<b>0.4</b>

Source: own calculations based on OPTEN database

## 1.2. Net Sales Revenue, Profitability, and Employment in Raw Materials Sector

Table 3 provides an overview of the net sales revenue progress that is based on the aggregated data of the enterprises operating in each of the classes we have examined. It gives an overview of 3,348 companies whose data was available for the closed business year 2018.

Table 3 Information based on net sales revenue of classes of raw materials sector in Hungary

NACE Class	Net sales revenue Thousand HUF, 2018 n=3348	Average net sales revenue 2018	Percentage of SMEs from the net sales revenue perspective (%) 2018	Average net sales revenue of SMEs - 2018	Average net sales revenue of SMEs - 2018 excluding enterprises with no net sales revenue	Change in net sales revenue of enterprises with 5 closed business years 2014–2018 (%) n=1951
02.20	26 024 416	58 879	58.9	34 836	42 935	+49.9
05.20	1 778 081	148 173	100.0	148 173	254 012	-63.7
06.10	9 149 882	397 821	100.0	397 821	1 524 980	+225.9
06.20	27 116 411	3 012 935	100.0	3 012 935	5 423 282	-25.3
07.21	1 138 008	569 004	100.0	569 004	1 138 008	-69.9
07.29	1 692	423	100.0	423	1 692	-97.2
08.11	53 927 548	929 785	100.0	929 785	1 382 758	+38.8
08.12	47 030 440	190 407	74.4	142 273	198 859	+48.6
08.92	1 353 889	135 389	100.0	135 389	150 432	+39.5
08.93	393 536	196 768	100.0	196 768	393 536	+3365.1
08.99	2 938 633	154 665	100.0	154 665	293 863	+132.2
35.11	753 725 090	492 309	66.2	326 493	867 621	+37.8
35.21	1 122 170	74 811	100.0	74 811	112 217	-53.7
38.11	230 688 783	564 031	69.2	395 883	444 404	+36.6
38.12	6 327 755	147 157	100.0	147 157	166 520	+13.9
38.21	101 258 160	532 938	74.0	400 932	539 383	+60.8
38.22	29 221 176	541 133	100.0	541 133	649 359	+0.08
38.32	133 628 277	482 413	100.0	482 413	674 890	+21
	<b>1 426 823 947</b>	<b>426 172</b>	<b>73.7</b>	<b>315 578</b>	<b>532 298</b>	<b>+34.6</b>

Source: Own calculations based on OPTEN database

According to the data of the examined 3,348 enterprises, in 2018, the domestic raw materials sector made a net sales revenue of roughly HUF 1.427 trillion. About 53% of this was in the

Production of electricity class, 35% in the waste management sectors (primarily in Collection of non-hazardous waste, Treatment and disposal of non-hazardous waste, and Recovery of sorted materials) and about 7 percent in Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate, and in Operation of gravel and sand pits; mining of clays and kaolin. Other sectors account for the remaining 5%. The SME sector accounted for about 74% of the net sales revenue. The average net sales revenue in Extraction of crude petroleum and natural gas, Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate, Mining of uranium and thorium ores, most waste management sectors, and Production of electricity are higher than the average for the entire raw materials sector. We examined the progress of the 2014-2018 net sales revenue based on the data on the companies with 5 closed business years. This represents data for a total of 1,951 companies (the NACE classes by number of companies are shown in Table 2). Compared to 2014, there was an increase in the net sales revenue of most of the examined NACE classes by 2018. Apart from the remaining values and the classes with a small number of companies, a significant growth can be observed in Logging, Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate, Operation of gravel and sand pits; Mining of clays and kaolin, Production of electricity and some sectors of waste management. Table 4 shows the data concerning the employment and profitability of the examined NACE classes.

The domestic raw materials sector (based on the data from 3,348 enterprises) employed 31,240 people in 2018, with the SME sector totalling 63%. About 65% of the 31,240 people were employed in the Waste management, 21% in Production of electricity, and approximately 8 percent in Quarrying of ornamental and building stone, limestone, gypsum, chalk and Operation of gravel and sand pits; mining of clays and kaolin. The remaining sectors have created about 4% of jobs. According to the data of the 3,348 enterprises, less than half of the companies closed the year with a profit in 2018. The worst results were in Extraction of crude petroleum (17%), Production of electricity (28%), Extraction of natural gas (33%), and Manufacture of gas (40%). The highest percentage of profitable companies was in the waste management sectors. We quantified two of

the profitability indicators. The ratios of operating profit to total assets and to total net sales revenue were compared. Table 4 shows only class averages calculated on the basis of profitable SME data (a total of 1,441 companies). The highest profitability was achieved in Extraction of crude petroleum and Extraction of natural gas, followed by Quarrying of ornamental and building stone, limestone, gypsum, chalk and Operation of gravel and sand pits; mining of clays and kaolin. Moreover, the profitability of some Waste management sector classes was also slightly higher than the average. In 2018, 59% of the 1951 companies with closed 5 business years were profitable. Compared to the year 2014, there was a decrease in the 08.11 class, a slight increase in Production of electricity, and a larger increase in the number of profitable companies in the classes of the waste management sector (only enterprises having existed for 5 years).

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Table 4 Employment and profitability in NACE classes

NACE Class	Number of employees 2018	Number of employees in SMEs 2018	Number of enterprises 2018	Percentage of profitable enterprises % (2018)**	Percentage of loss-making enterprises % (2018)**	Operating profit /total assets (% 2018)***	Operating profit/net sales revenue (% 2018)***
02.20	1462	834	442	62	36	14	12
05.20	94	94	12	58	42	6	10
06.10	8	8	23	17	83	46	41
06.20	13	13	9	33	67	25	27
08.11	1050	1050	58	57	34	26	19
08.12	1431	1176	247	59	39	19	24
08.92	49	49	10	60	40	8	9
08.99	102	102	19	42	53	4	5
35.11	6495	1663	1531	28	66	8	8
35.21	42	42	15	40	60	8	44
38.11	12 521	7687	409	69	29	8	7
38.12	348	348	43	81	19	14	11
38.21	3670	2629	190	62	33	12	10
38.22	1150	1150	54	69	30	2	13
38.32	2678	2678	277	54	41	11	6
Total*	31 240	19 650	3348	46	50	10	10

\* Table 4 does not show the detailed data of NACE rev 2. classes 05.10, 07.21, 07.29, 08.93. These, however, are included in the total.

\*\*Table 4 does not show the percentage of enterprises with 0 net sales revenue. It can be calculated as the difference between 100% and the rate of profitable and loss-making enterprises.

\*\*\* The indicator is based on the data of profitable SMEs, excluding those with 0 net sales revenue or 0 total assets. It means 1,441 profitable enterprises in the raw materials sector.

Source: Own calculations based on OPTEN database

### 1.3. Aspects Used to Specify Priority of Raw Materials Industry under Research

The aspects we took into consideration for selecting a raw materials industry to prioritize in the research were i.e.:

- Business demography characteristics;
- Net sales revenue;

- Employment data;
- Profitability and;
- Barriers to entry.

According to these aspects Table 5 represents a summary of the NACE rev.2 classes that we focused on:

*Table 5 Importance of NACE Rev. 2 classes in Hungary's minerals industry from various perspectives*

Class	Content	Aspects			
		Business demography	Net sales revenue	Employment	Profitability
02.20	Logging	✓			
06.10	Extraction of crude petroleum				✓
06.20	Extraction of natural gas				✓
08.11	Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate		✓	✓	✓
08.12	Operation of gravel and sand pits; mining of clays and kaolin	✓	✓	✓	✓
35.11	Production of electricity	✓	✓	✓	
38.11	Collection of non-hazardous waste	✓	✓	✓	✓
38.12	Collection of hazardous waste	✓	✓	✓	✓
38.21	Treatment and disposal of non-hazardous waste	✓	✓	✓	✓
38.22	Treatment and disposal of hazardous waste	✓	✓	✓	✓
38.32	Recovery of sorted materials	✓	✓	✓	✓

Source: Own elaboration

As part of the other aspects of the selection, we analysed the opportunities for starting new businesses.

- **Class 02.20: Logging:** In the case of Logging, we see new business start-up opportunities primarily in the field of innovative energy use. In this regard, the UNECE forecast for 2030 outlines two scenarios: According to the optimistic version, if the EU treats the energy use of wood as a strategic area, there will be 170 million m<sup>3</sup> more wood for energy use (residues,

clippings) in the internal market. This scenario clearly offers favourable opportunities for new companies considering the energy use of wood. In Scenario 2, the expected demand is significantly lower than assumed in Scenario 1, in which case there is still room for selling timber for energy purposes or for successful business models linked to direct energy use. (UN, 2011)

- **Division 05: Mining of coal and lignite (05.10 Mining of hard coal and 05.20 Mining of lignite):** Coal mining is one of the most controversial activities in the field of energy recovery. Future coal mining raises a number of issues regarding the environmental and social sustainability. We can link coal mining to the past rather than offering young people any future business opportunities. Although technologies allowing more sustainable mining and processing are already available, they increase entry barriers due to the capital intensity of this division. Based on environmental considerations, high entry barriers, and low profit prospects, coal mining is not considered a viable alternative for young entrepreneurs.
- **Division 06: Extraction of crude petroleum and natural gas (06.10 Extraction of crude petroleum, 06.20 Extraction of natural gas):** In this sector, high entry barriers and high start-up costs are to be expected. New entrants are extremely rare in the market. Even entrepreneurs with high capital strength are put at a serious competitive disadvantage by patented technologies that are difficult to access. The technologies resulting from R&D and raising competitiveness are also difficult to develop without significant capital effort, although the research infrastructure available at the university may be of some help to students. In spite of the favourable profitability indicators of the sector, we do not consider it a suitable field for start-up companies due to the above-mentioned characteristics. (Investopedia, 2020)
- **Division 07: Mining of metal ores (07.10 Mining of iron ores, 07.21 Mining of uranium and thorium ores, 07.29 Mining of other non-ferrous metal ores):** In 2010, a total of 269 companies in the European Union were mining metal ores. There is also a small number of companies operating in this sector in Hungary. The extremely low number of enterprises is a good indication of the high barriers to enter the market. The country's limited supply of raw materials, strict

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mining regulations, bureaucracy and high capital requirements for extraction are the primary barriers to entry. We do not consider the sector attractive for start-ups.<sup>2</sup>

- **Group 08.1: Quarrying of stone, sand and clay (08.11 Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate, 08.12 Operation of gravel and sand pits; mining of clays and kaolin):** The construction minerals sector includes materials such as limestone, dolomite, gypsum, slate and building stone. The sector is one of the largest (excluding the extraction of energy raw materials) in the European Union, both in terms of volume and the number of companies operating in it. The sector is also significant in terms of employment and its profitability indicators are also favourable. Demand for products is strong. Most of the companies operating in the sector are small and medium-sized enterprises. Demand for construction minerals is determined by construction performance. Mining construction minerals can be a promising business area for start-ups. Compared to the previously mentioned mining sectors, it is possible to start operations with lower capital requirements, there is a relatively stable demand for the products and the sales are mainly conducted within smaller regions. It is no coincidence that many small and medium-sized enterprises are successful in this field of activity. In Hungary, there is also a strong increase in the price of construction minerals. However, in terms of the emergence of innovative start-up ideas, we see less opportunity in this sector compared to other sectors. (Carpi et al., 2019)
- **Class 35.11: Production of electricity:** Diversification processes in electricity production create a new situation for small and medium-sized enterprises in the sector. Technological alternatives represented by renewable energy production often no longer require the same investments and plant sizes as conventional units based mainly on the use of hydrocarbons. In the areas of solar and wind energy, for example, a number of local solutions have been implemented. Although licensing may be a constraint, governments are trying to encourage the spread of

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<sup>2</sup> [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Archive:Mining\\_of\\_metal\\_ores\\_statistics\\_-\\_NACE\\_Rev.\\_2&oldid=83674](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Archive:Mining_of_metal_ores_statistics_-_NACE_Rev._2&oldid=83674)

environmentally friendly technologies. In the electricity industry, a number of new alternative solutions, technologies and even energy sources offer new opportunities for energy production, storage, transmission, and utilization. Energy start-ups are likely to gain ground, and the sector offers many opportunities for innovation. With their innovation and flexibility along the entire value chain, SMEs can find opportunities to gain a competitive advantage over large players, as long as their business model and technology are adapted to new trends. However, due to the extreme volatility of energy prices, the payback period of investments is more difficult to calculate, and the profitability indicators of the sector are changing. We have seen that in 2018, only 28 percent of companies operating in the sector were profitable. That is why we did not choose this area. (Könighofer, 2019)<sup>3</sup>

- **Class 35.21: Manufacture of gas:** It is not usual to see small and medium sized enterprises in this field.
- **Division 38: Waste collection, treatment, and disposal activities; materials recovery** (38.11 Collection of non-hazardous waste, 38.12 Collection of hazardous waste, 38.21 Treatment and disposal of non-hazardous waste, 38.22 Treatment and disposal of hazardous waste, 38.32 Recovery of sorted materials). When breaking the classification by the main activity down, there are typically several company activity areas; that is why we have examined the five selected classes of the waste management division.

The waste management sector caught our attention in connection with all the examined aspects (business demography, net sales revenue, profitability aspects, employment). In addition, the problem of waste management is a burning issue nowadays. Tightening environmental regulations are predicting the growth of the sector, and all the segments of the waste hierarchy offer many opportunities for the implementation of innovative ideas.

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<sup>3</sup> <https://www.startus-insights.com/innovators-guide/disrupting-energy-industry-breakdown-startup-driven-innovation/>

Based on all of these factors, we consider the waste management division to be a priority area of the domestic raw materials sector. The rest of our research focuses on the potential of this sector.

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## 2. Priority Industry Market Report

### Importance of Waste Management Division in National Economy of Hungary

The waste management division (NACE rev. 2 division 38) belongs to NACE rev. 2 Section E - Water supply; sewerage; waste management and remediation activities. In the publicly available KSH (Central Statistical Office of Hungary) databases we find data only at the level of sections. The most important macroeconomic data on water supply, sewerage, waste management and remediation activities in Hungary (2014-2018) is summarized in Table 6.

*Table 6: Data on NACE rev. 2 Section E - Water supply; sewerage; waste management and remediation activities in Hungary (2014-2018)*

	2014	2015	2016	2017	2018
Gross Domestic Product (at current price, million HUF)	259,424	277,104	302,060	315,395	312,379
Number of full-time employees (thousands of people)	38.7	38.4	41.0	39.9	40.5
Average gross monthly income of full-time employees (HUF)	224,447	230,574	234,037	269,090	300,387
Average net monthly income of full-time employees (HUF)	151,959	154,583	161,091	184,663	204,083
Number of enterprises	1,734	1,689	1,877	1,812	1,717

Source: KSH (Central Statistical Office of Hungary)

Section E represents about 0.8% of the total gross added value of the national economy and about 1.5% of the number of employees. The average gross and net monthly incomes of full-time employees are lower than the average monthly earnings in Hungary (by about 8–10%). Of all the enterprises, 0.24% operate in this section. The value of gross fixed assets at the current prices was HUF 4,795 billion and the value of net fixed assets HUF 2,886 billion in 2016, which corresponded to about 2% of the total assets of the national economy. However, this data also includes information on water supply and wastewater collection and treatment.

We have not found separate data on the waste management sector in the Eurostat database either. Perhaps, the trend can be seen in the data on the three main sectors classified as circular economy we are presenting, namely the Recycling sector, the Repair and reuse sector and the Rental and leasing sector as shown in Table 7.

Table 7 Private investment, jobs, and gross added value related to circular economy sectors

	2014	2015	2016	2017
Value added at factor costs - million euro	873.9	856	1,040.2	1,224.8
Value added at factor costs - percentage of Gross Domestic Product (GDP)	0.83	0.76	0.9	0.98
Persons employed – number	73,497	78,494	85,943	85,672
Persons employed - percentage of total employment	1.74	1.82	1.92	1.88
Gross investment in tangible goods - million euro	161.9	151	194.6	181.2
Gross investment in tangible goods - percentage of Gross Domestic Product (GDP)	0.15	0.13	0.17	0.14

Source: Eurostat

The value added at factor cost of the three sectors increased by 40.2% from 2014 to 2017. This accounted for 0.98% of GDP in 2017, a proportion that increased slightly over the period under review. In the three sectors, there were 85,672 employees working according to the 2017 data, although this is a broadly interpreted employment figure based on Eurostat's description. This is a 16.6% increase over 2014. Based on 2017 data, 1.88% of all employees were tied to an area of the circular economy. The gross investment in tangible goods also shows an increase (11.9%) compared to 2014. However, based on most indicators it can be seen that 2016 was a stronger year.

In general, the performance and importance of the waste management sector cannot be judged solely on the performance of the companies with the given NACE Rev 2. code. The performance of the sector is underestimated in official statistics; its real performance could be interpreted along the industry value chain as many innovations and achievements related to waste management/recycling are reported in the user sectors under other NACE Rev 2. codes.

## 2.1. Role of Waste Management Division in Industry Value Chains

With ever growing consumer society, an unprecedented problem of huge amounts of waste has emerged. There are a lot of questions related to waste. One of the European Union's priorities is to create a circular economy. The idea behind this is to take minimal raw materials and minimal energy from nature and use circular materials to meet our needs and to place as little material in landfills

as possible. Another of European Union's fundamental thesis is to create a green economy through the use of biological raw materials, green energy and so on. If we want to create a circular economy, we need to understand that waste is a valuable a by-product that can be further used. Our demand for resources is growing and that is why waste has to be used as a secondary resource. Waste management itself encompasses a wide range of activities on different levels of waste hierarchy. These are prevention, re-use, recycling, energy recovery, and disposal. Regulators' liability is huge. However, there are also great opportunities for forming public opinion and actively influencing society. These can lead to significant changes not only in prevention but also in the remaining waste hierarchy levels. Prevention appears at the levels of both, the producers and consumers.

There is a growing number of international examples and good practices for organizing re-use. In Miskolc, the Miskolc Re-use Centre has been established where the inhabitants have the opportunity to dispose of used (second-hand) redundant but still usable objects, tools, and equipment for these objects to be used by others when possible. The products that have been thrown away by people but are still of value to others are sold at a symbolic price after their possible refurbishment. This extends the time of their use and saves the product from disposal.

Recycling affects both, the municipal and industrial wastes. Fortunately, waste sorting, which was an essential prerequisite for recycling, started in the country many years ago. By treating the collected and sorted waste separately, it can be achieved that only 5% of the material end up disposed. The rest of material, e.g. packaging, is taken from individual waste collections and recycled. Alternatively, secondary fuel called residual waste fraction (RWF) can be thus produced from municipal waste or valuable compost can be produced from bio-waste from which we can recycle and produce biogas.

Waste energy recovery has been emphasized since the introduction of the Kyoto Protocol. There is a great potential in energy recovery but there are also limitations. In Hungary there is a storage conditions system. The waste containing decomposing organic matter should not be disposed. That

is because we want to prevent the generation of harmful gases in landfills which not only damage the environment but also the landfill. That is why companies need to treat this waste in some way.

Waste is treated mechanically and biologically to stabilize the decomposing material and recover components that have some heating value (e.g., paper, cardboard, plastic). They cannot be recycled as part of their material because they are mixed and contaminated but have a heating value and can be used to produce a residual waste fraction (RWF) of 12-14 megajoules/g. This corresponds to the heating value of lignite. The problem is that waste treatment is mandatory in Hungary because it is required by law. And even though it is also convenient for RWF production, its financing has been of an issue. Moreover, it has been exceedingly difficult to sell RWF. Many businesses could be set up in this area, but there is a need for rethinking the possible profitability of such businesses at the state level. Another solution is to transfer the costs to the population, but the population cannot be charged indefinitely; if waste transportation became more expensive, there are fears that more people would give up on such waste treatment. Any well-thought-out strategy seeks to minimize disposal by implementing the above.

The waste management sector is seen as an intermediary that connects waste donors and acceptors. Figure 1 illustrates the possible emergence of circular economy and industrial symbiosis solutions based on the idea that material recycling is conceivable both within a given sector (even within a company/facility) and through collaboration between different industries. Our approach is based on the general approach of the industry value chain where after the raw materials production and raw materials processing sectors, different sectors produce a product for final consumption for final consumers. Some products find a new owner in the form of re-use and eventually end up in the waste sector in the form of waste.

We have highlighted the role of the waste sector in facilitating the implementation of the circular economy. The collection, treatment, disposal, and possible processing of waste contribute to the production of secondary raw materials. Ultimately, the energy recovery of waste also reduces the

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amount of materials transported to landfills. To ensure the circulation of materials and values created by networks it is necessary to expand the functions and the role of the waste management sector (Aid et al. 2017; Horváth & Bereczk 2019).

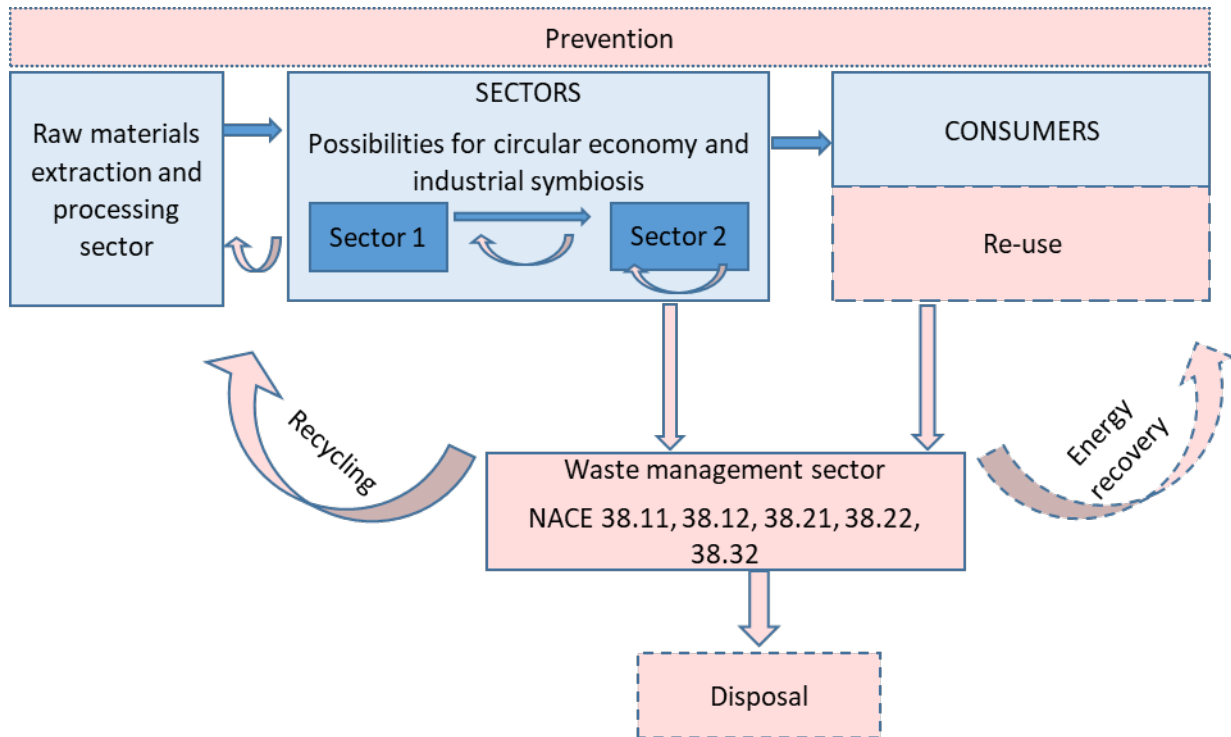


Figure 1 Role of the waste management sector in the industry value chain

Source: Own elaboration

According to Eurostat data, 15,938,077 tonnes of waste was generated in Hungary in 2016 in households and in economic sectors (NACE Rev. 2) in total. The composition of this waste generation is shown in Figure 2.

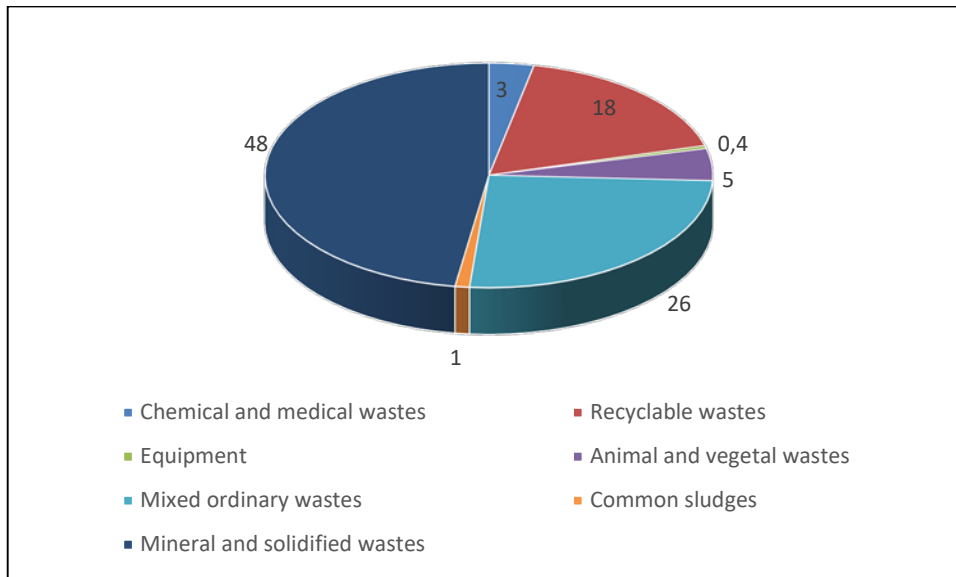


Figure 2 Generation of waste by waste category, Hungary, 2016

Source: Eurostat

## 2.2. PESTEL Analysis of Industry

The PESTEL analysis comprises six factor groups: political, economic, social, technological, environmental, and legal. In the following text, we examine the selected section considering all the above groups.

### 2.2.1. Political and Legal Environment

The waste sector is subject to strict European Union and domestic regulations.

EU regulations are based on three main pillars:

- Framework European Union legislation on waste - Directive 2008/98/EC;
- European Union legislation on waste management operations;
- European Union legislation on specific waste streams.

Waste management issues in the European Union are basically regulated by the European Commission Directive 2008/98/EC. The directive lays down measures to protect the environment and human health. It defines a number of relevant concepts, such as waste, hazardous waste, waste management, recovery, and recycling. Besides, it determines the levels of the waste hierarchy, which are:

- Prevention;
- Preparing for re-use;
- Recycling;
- Other recovery, e.g. energy recovery;
- Disposal.

It also meant the tightening of regulations concerning companies by introducing “polluter-pays principle” and “extended producer responsibility”.

The polluter-pays principle has become a guiding principle at both, the European Union and international levels. The aim is to make "the waste producer and the waste holder manage the waste in a way that guarantees a high level of protection of the environment and human health" (Directive 2008/98/EC, p. 4). Extended producer responsibility is designed to promote the efficient use of resources when designing and manufacturing products, taking into account the full life cycle of products, including their repair, reuse, disassembly, and recycling. (Directive 2008/98/EC)

*Table 8 Collection of relevant EU regulations in force since 2008*

<b>Regulation</b>	<b>Applicable from</b>
Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives	19/11/2008
Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)	24/11/2010

Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment	08/06/2011
Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE)	04/07/2012
Commission Regulation (EU) No 674/2012 of 23 July 2012 amending Regulation (EC) No 1418/2007 concerning the export for recovery of certain waste to certain non-OECD countries	23/07/2012

Source: Hungarian Waste Management Federation, <https://www.hosz.org/jogszabalyok>

Having seen the trends in EU legislation summarized in Table 8, it is clear that the Union has been continuously tightening legislation since the 2008 Directive (which itself had introduced stricter principles). The legislation focuses mainly on reducing industrial emissions, the hazardous substances used in electrical and electronic equipment and the treatment of the waste from such equipment.

The most relevant Hungarian regulations are<sup>4</sup>:

- Act LIII. of 1995 on general rules for the protection of the environment (1995. évi LIII. törvény a környezet védelmének általános szabályairól);
- Act LXI of 2009 on curbing minor offences related to the collection and sale of certain metals (2009. évi LXI. Törvény egyes fémek begyűjtésével és értékesítésével összefüggő visszaélések visszaszorításáról);
- Act LXI of 2009 on Metals (2009\_LXI\_Femtorveny\_MK891.doc);
- Act LXXXV of 2011 on environmental product charges (2011. évi LXXXV. törvény a környezetvédelmi termékdíjról);
- Act CLXXXV of 2012 on waste (2012. évi CLXXXV. törvény a hulladékról).

<sup>4</sup> Hungarian Waste Management Federation, <https://www.hosz.org/jogszabalyok>

### 2.2.2. Economic Environment

For the analysis of the economic environment, we firstly reviewed the research project funds available in the raw materials sector. In particular the waste sector, including Horizon 2020 resources at the European level, and the opportunities provided by domestic structural funds and government resources.

The supported H2020 projects were filtered out using the keywords “Raw material”, “Circular economy” and “SMEs”. This led to a list of 51 projects to be examined. Of these, 11 were coordinated by Hungarian coordinator organizations (UNEXIM, InnoPellet, reNEW (2016), reNEW (2017-2019), OpenHeritage, BrailleJet, START2ACT, CFMEBR, ULTIMATE, and OPTOFORCE) and the rest included a Hungarian participant. The project types are: Innovation (IA), Research & Innovation (RIA), Coordination & Support (CSA) and SME. The topics of the supported projects are extremely diverse within the raw materials sector; we have not found any common area of focus of related Hungarian projects. The topics include: highly automated deep mining, an international training centre for professionals in raw materials sectors, mapping and developing new cooperation opportunities related to raw materials, an EU databank for secondary raw materials, circular economy, recycling in the textile industry, food waste, agricultural waste, waste heat recovery, industrial symbiosis in the construction value chain, wastewater treatment, and sewage treatment.

The grants requested by the examined projects ranges from EUR 0 to 1,510,990.

We have not found any indication of a funded project related to Hungary and supporting specifically start-ups, either in the context of the waste management sector or circular economy. The reviewed projects can be linked to a total of 29 Hungarian organizations.<sup>5</sup>

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<sup>5</sup> CORDIS - EU research projects under Horizon 2020 (2014-2020) - <https://data.europa.eu/euodp/en/data/dataset/cordisH2020projects> - H2020 Projects and H2020 Project Publications tables; Horizon 2020 Environment and resources data hub - <https://sc5.easme-web.eu/?mode=7#> - filtered to Hungarian data

Reviewing the Hungarian funds, we highlighted the projects supported by the operational programs KEHOP (Environmental and Energy Efficiency Operational Program) and GINOP (Economic Development and Innovation Operational Program). We also reviewed EFOP (Human Resources Development Operational Program) projects, including those dealing with the raw materials sector, e.g. the EFOP-3.6.2-16-2017-00010 project named “Sustainable Raw Materials Management Thematic Network - RING 2017”. These, however, focus primarily on providing and educating researchers. Within KEHOP the following support schemes deal with the waste management sector:

- KEHOP-3.1.1-17 - Development of municipal waste collection, and transport and pre-treatment systems;
- KEHOP-3.1.2-17 - Diversion of biodegradable waste from landfills;
- KEHOP-3.1.3-17 – Forming attitude toward waste prevention;
- KEHOP-3.2.1-15 - Development of municipal waste pre-treatment, recovery, and disposal subsystems;
- KEHOP-3.2.2-15 - Systematic development of a network of municipal waste treatment facilities for phased projects.

Having evaluated 40 projects, it can be said that these primarily aim at supporting state-owned companies and local governments, with the development of landfills as their primary focus instead of decreasing the quantity of waste or using it as secondary raw materials.

As regards the GINOP operational program, a number of its projects focus on micro, small and medium-sized enterprise development; there is a sub-project related to start-ups (GINOP-2.1.5-15 - Building an innovation ecosystem (start-up and spinoff)) and to the supporting of young people’s ambition to become entrepreneurs (GINOP 5.2.2-14; GINOP 5.2.3.-16; GINOP 5.2.7.- 18.). However, these are not sector-specific, so applicants compete strongly for resources with other sectors.<sup>6</sup>

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<sup>6</sup> <https://www.palyazat.gov.hu/>

In addition to the EU and national funds, there is a number of other opportunities for funding start-ups, such as business angels or venture capitalists. However, it must also be said that most of them do not focus specifically on the raw materials sector or, more specifically, on the activities of the waste management sector, so new companies have to compete with companies in other sectors as well. However, there are some encouraging examples in this area, for example, when the Bonitas Investment Fund Manager (Bonitas Befektetési Alapkezelő) mentioned sustainable environment as a priority area to which waste management is also linked.<sup>7</sup> By the end of 2016, the companies in the Water Supply, Sewage and Waste Management sectors had contracted approximately HUF 2.5 billion in the form of the JEREMIE venture capital funds investments (EQUINOX, 2016). In the Széchenyi Capital Investment Fund (Széchenyi Tőkebefektetési Alap), we have not found any winning application focusing specifically on the waste management sector but they have supported two companies related to wastewater utilization, which may mean a shift in the circular economy (Biopolus Technológiák Zrt., Cyclator Kft.).<sup>8</sup> The Hiventures' portfolio includes Platoon Technologies Ltd which develops bio-plastic composting technology.<sup>9</sup> From the international point of view, Chivas Venture specialises in revitalizing the circular economy, supporting a number of start-ups dealing with anything from reducing food waste to recycling used tires.<sup>10</sup>

Low-interest, state-subsidized loan programs are available for SMEs, e.g. Growth Loan Program Refinancing loans disbursed as part of the “Hajrá” Program (Növekedési Hitelprogram Hajrá keretében folyósított refinanszírozási hitelek) or Széchenyi Card Program. However, the conditions of these are not necessarily suitable for start-up companies. For example, one of the requirements may be at least two closed business years, during which the company cannot make a loss.<sup>11</sup>

<sup>7</sup> <https://bonitasktk.hu/befektetesi-politika/>

<sup>8</sup> [https://www.szechenyi.szta.hu/befekteteseink/?fwp\\_paged=2](https://www.szechenyi.szta.hu/befekteteseink/?fwp_paged=2)

<sup>9</sup> <https://www.hiventures.hu/portfolionk?o=10>

<sup>10</sup> [https://www.chivas.com/en-EN/the-venture/alumni?fbclid=IwAR2pu2SLK6liMYwzVyuVL3UdOL2\\_hFvH39uV3S2kfzIX2VVdsN5e4JzwMcQ](https://www.chivas.com/en-EN/the-venture/alumni?fbclid=IwAR2pu2SLK6liMYwzVyuVL3UdOL2_hFvH39uV3S2kfzIX2VVdsN5e4JzwMcQ)

<sup>11</sup> <https://www.kavosz.hu/> ; <https://mnb.hu/nhphajra>

The Hungarian Waste Management Strategy is under preparation. The aim is to increase the economic policy role of the sector and to support the achievement of sustainability goals and the transition to a circular economy.<sup>12</sup> This is also important because the shareholders in the waste management sector expect more public support to fully exploit the potential of waste recovery.<sup>13</sup> (Héjja E.,2020)

### 2.2.3. Social Environment

Two levels of the waste management hierarchy, i. e. prevention and re-use are greatly influenced by consumer behaviour. People have a big impact on production processes, as their consumption habits are reflected in those. If we could achieve significant changes in the population's demand, it would also change production processes (the supply side). That is why it is important to give higher priority to the formation of social opinion on waste, which is still in its infancy in Hungary. Increasing public awareness through awareness-raising programs and initiatives could be the basis for that.

Unfortunately, there is still a lot of controversy in this area. For example, a number of good programs are being launched to change children's attitudes, such as drawing competitions (e. g. "My Environmentally Conscious School" drawing competition, Ministry of Innovation and Technology) and idea-supporting competitions ("Be creative from waste!", Ministry of Innovation and Technology, "Become Reuse Ambassador", Bay Zoltán Research Institute). At the same time, however, there is no support of waste collection at Hungarian schools. A large number of websites and information materials are being produced to shape public attitudes, yet the prices of goods do not reflect decision-makers' preferences for waste reduction and do not direct consumers towards

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<sup>12</sup> <https://www.dontwasteit.hu/2020/04/09/a-nemzeti-hulladegzaldalkodasi-strategia-kimunkalashoz-kapcsolodot-anulmanyra-ad-megbizast-az-emi/>

<sup>13</sup> <https://hosz.org/hirek/a-szelektiv-papirgyujtes-piakanak-osszeomlasa-magaval-sodorja-az-iskolai-gyujtest-is>

more sustainable consumption. There is currently the lack of a clear, central strategy in the areas of information, awareness-raising, and education.

Reuse is a good solution for avoiding waste. In this case, the given product or packaging can be reused for the same purpose as it was originally manufactured for, without any modification. This extends the time of use and saves the product from disposal. The most well-known example of such reuse in Hungary were returnable bottles. Unfortunately, manufacturers today make their products unique by making the world of glass increasingly diverse, thus making it impossible to economically recycle and reuse glass. In other areas, however, we are witnessing the emergence of new practices. There are already examples of recycling centres that are becoming more widespread in Western European countries. CERREC (Central Europe Repair & Re-use Centres and Networks) has set up re-use centres on an experimental basis. There are several of these in Hungary, such as the two Attitude Shaping and Reuse Centres in Budapest, the Miskolc Reuse Centre, and the Kaposvár Reuse Centre. The essence of the business model is that the population can take their used, redundant, but still usable objects, tools, and equipment to the centres for free. These then sell such objects, tools, and equipment further at a symbolic price. At present, however, there is no re-use centre in Hungary for consumer goods collected as part of industrial, commercial, service and office disposal, just because electronic items cannot be placed there.

Another good example of reuse are many auction portals and classifieds websites (Vatera, TeszVesz, Jófogás, etc.) which do a lot to extend the life of products by linking the demand and supply sides. Recycling stores (replacement of defective parts, repair shops) are also involved, including second-hand shops, charity shops, commission stores, and online second-hand stores of which there are many examples all over the country. Finally, we should mention public initiatives which are typically organized through social media (thematic give-and-take groups on Facebook) or in the form of traditional fairs, such as exchange fairs (books, clothes, antiques). In the case of these initiatives, quality control and renovation activities are largely lacking; the modern reuse

[www.limbra-project.eu](http://www.limbra-project.eu)

business has not yet developed in Hungary. However, according to surveys, there is 65% of Hungarians are willing to buy used products.<sup>14</sup>

#### 2.2.4. Technological Environment

An advanced technological environment plays an important role in the development of the sector. The demand for state-of-the-art technologies is emerging at all levels of the waste hierarchy pyramid both, within the sector and at the level of related industries.

Stricter environmental standards set increasingly ambitious energy efficiency, emission reduction and waste reduction targets for both, products, and production methods. Greater use of secondary raw materials in production processes is desirable. The need for processing long-lasting, repairable, modular, low-emission, energy-saving, etc. products will come into view. All this requires continuous technological development from manufacturers.

As far as recycling is concerned, the possibilities of material recovery should be analysed. In this case, the waste (or by-product) is recycled as a secondary raw material for use in production processes. There is a need for modern technologies both, on the part of the sectors that use recycled waste and of the waste management sector. The sectors that sell and use secondary raw materials need to recognize the potential of the circular economy and industrial symbiosis. The waste management sector, as a kind of accelerator, is involved in the process of efficient collection, sorting, and preparation. Waste collection systems, sorting, cleaning, shredding, and preparation for different waste types require different technologies. In Hungary, more than a hundred companies are engaged in waste recycling. Moreover, there has been serious research carried out in this field at universities. Table 9 demonstrates the quantity and share of recyclable waste categories and shows possibilities of their recycling.

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<sup>14</sup> <http://kornyezetbarat.hulladekboltermek.hu/hulladek/hulladekhierarchia/ujrahasznalat/>

Table 9 Volume of recyclable waste (2016) and options of its recycling in Hungary

Recyclable wastes	Quantity (tonnes)* 2016	Share (%)	Recycling options **
Metal wastes, ferrous	1,338,015	47.9	Steel industry, steel product manufacturing
Metal wastes, non-ferrous	125,720	4.5	Metallurgy, manufacture of metal cans
Metal wastes, mixed	23,949	0.9	Metallurgy, manufacture of metal cans
Glass wastes	131,618	4.7	Glass production, glass products, packaging
Paper and cardboard wastes	713,579	25.6	Manufacture of paper and paper products
Rubber wastes	54,113	1.9	Rubber sheets, automotive products, road foundation, energy recovery in a cement plant
Plastic wastes	221,334	7.9	Plastic products, packaging, film production, textile production, as fuel in cement industry, thermal power plants
Wood wastes	159,293	5.7	Production of furniture
Textile wastes	23,190	0.8	Textile industry, cloths, carpet
Recyclable wastes total	2,790,811	100.0	

Source: \*Eurostat, \*\*Hungarian Waste Management Federation

The handling and dismantling of electronic equipment, batteries and scrap cars is also a source of recycling tasks and opportunities. Energy recovery includes waste incineration and cement plant recovery. Incineration of waste as fuel is mainly used in cement plants. The more fuel is replaced by waste, the lower the cost of producing cement is. Incineration in waste incineration plants produces either heat or electricity. Most incinerators produce their combination (CHP/Combined Heat and Power). The central and eastern European countries are well behind Western Europe in the number of incinerators and their performance. Advanced flue gas purification technologies and processes can ensure emissions from incinerators to be well below extremely strict EU limit values. Even so, serious disadvantages of this solution are the air pollution caused by incineration, the loss of secondary raw materials, and other social damages.<sup>15</sup>

Landfilling is widespread as a cheap and simple, yet short-term solution. However, the construction and operation of modern landfills can no longer be considered cheap at all.

<sup>15</sup> <http://kornyezetbarat.hulladekboltermek.hu/hulladek/hulladekhierarchia/>

Most of the landfills in Hungary did not meet the requirements of the European Union. Therefore approximately 2,200 landfills had to be closed by July 1, 2009 and then “recultivated”. Instead of those we now use 74 EU-compatible landfills. In some cases, landfill gas (biogas) generated in landfills can be used for generating heat and electricity.<sup>16</sup>

According to the 2016 Eurostat data, the structure of waste treatment activities in Hungary is following: disposal - landfill 34.2%, disposal - incineration 0.6%, energy recovery - 7.4%, recycling - 54.1%, refilling - 3.7%.

An indicator of the sector innovation potential is the number of related patents registered in Hungary.

### 2.2.5. Environmental Factors

Through recycling, waste is converted into secondary raw materials and returned to industrial production, thus reducing the use of primary raw materials. This has a positive effect, as the Earth’s raw material reserves are finite. As the extraction and use of primary raw materials decreases the associated negative environmental and social impacts also decrease. The production from secondary raw materials results in an extremely significant reduction in energy consumption, CO<sub>2</sub> emissions, air pollution, water pollution, and water consumption compared to the production from primary raw materials. Waste recovery therefore plays a key role in the fight against climate changes and other environmental issues (EuRIC, Hungarian Waste Management Federation).<sup>17</sup> In Hungary, the waste management sector (including waste and wastewater treatment) contributes to the total

<sup>16</sup> <http://kornyezetbarat.hulladekboltermek.hu/hulladek/hulladekhierarchia/>

<sup>17</sup> <https://humusz.hu/hirek/vegleges-formaba-ontotte-az-euric-femhulladek-hasznositas-elonyeirol-szolo-uj-brosurajat/26607>

GHG emissions by 5%. Of that, the landfilling of solid waste amounts to 72%, waste-water treatment to 18% and waste incineration to 10%.<sup>18</sup>

### 2.3. Companies in Industry

The companies of the waste management sector and their characteristics were examined on the basis of the OPTEN database.

*Table 10 Business demography of the Hungarian enterprises operating in the waste management sector*

NACE Class	Activity	Number of enterprises in 2019	Data available for 2018	Number of companies successfully closing 5 <sup>th</sup> year of their existence	Change in number - 2014-2019	Closed without a successor company 2014-2018
38.11	Collection of non-hazardous waste	433	409	356	76	200
38.12	Collection of hazardous waste	43	43	38	4	16
38.21	Treatment and disposal of non-hazardous waste	212	190	138	71	90
38.22	Treatment and disposal of hazardous waste	57	54	46	10	23
38.32	Recovery of sorted materials	311	277	221	95	196
Division 38	Waste management total	1,056	973	799	256	525

Source: Own OPTEN data-based elaboration

*Table 11 Companies divided by size (based on the number of employees) (2018)*

NACE class	Enterprises with 0 employee	% of microenterprises	% of small enterprises	% of medium-sized enterprises	% of large enterprises
<b>38.11</b>	71	66.3	20.0	12.2	1.5
<b>38.12</b>	8	79.1	18.6	2.3	0.0
<b>38.21</b>	53	76.3	15.3	6.8	1.6
<b>38.22</b>	16	55.6	31.5	13.0	0.0
<b>38.32</b>	82	78.7	16.2	5.1	0.0
<b>Division 38 total</b>	230	71.7	18.6	8.7	0.9

Source: Own elaboration based on OPTEN database

<sup>18</sup> <http://kornyezetbarat.hulladekboltermek.hu/hulladek/hulladekhierarchia/artalmatlanitas/>

In 2019, there were 1,056 companies operating in the examined sector. The sector has been clearly dominated by micro-enterprises (72%). The medium-size companies can mainly be found in the field of waste collection and in the treatment and disposal of hazardous waste. This is the area for public utility companies that shows higher technological demands. There is a total of 9 large companies operating in the sector, providing activities related to non-hazardous waste.

The territorial structure of enterprises is more or less even, with the exception of their higher number in Budapest and the Pest County. Table 12 shows the structure of companies in Hungarian counties in 2018.

*Table 12 Structure of companies in Hungarian counties in 2018*

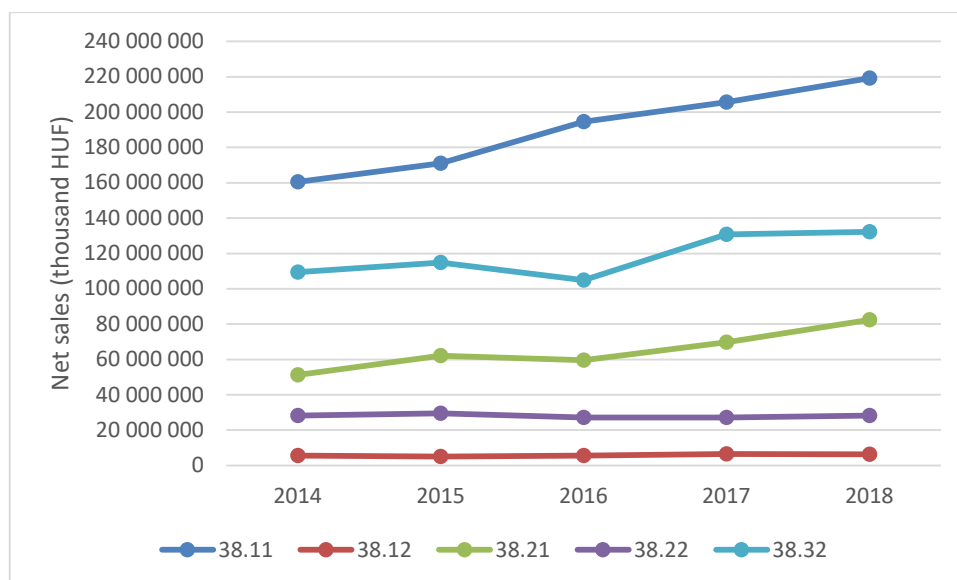
County	38.11	38.12	38.21	38.22	38.32	Division 38 total	Distribution concerning counties %
Bács-Kiskun County	18	5	10	5	10	48	4.93
Baranya County	15	3	6	1	4	29	2.98
Békés County	17	1	4		13	35	3.6
Borsod-Abaúj-Zemplén County	16	1	17	6	11	51	5.24
Csongrád County	20	1	7	4	9	41	4.21
Fejér County	23	3	7	1	14	48	4.93
Budapest	75	11	41	13	69	209	21.5
Győr-Moson-Sopron County	13	1	8	2	12	36	3.7
Hajdú-Bihar County	19	4	5	2	13	43	4.42
Heves County	8	3	5		4	20	2.06
Jász-Nagykun-Szolnok County	17		4		9	30	3.08
Komárom-Esztergom County	16		9	6	8	39	4.01
Nógrád County	8	1	1	1	8	19	1.95
Pest County	81	6	35	5	41	168	17.3
Somogy County	12		7		12	31	3.19
Szabolcs-Szatmár-Bereg County	12	2	6	1	12	33	3.39
Tolna County	5	1	1	1	4	12	1.23
Vas County	8		4	3	8	23	2.36
Veszprém County	16		7	3	6	32	3.29
Zala County	10		6		10	26	2.67
<b>Total</b>	<b>409</b>	<b>43</b>	<b>190</b>	<b>54</b>	<b>277</b>	<b>973</b>	<b>100</b>

Source: OPTEN data-based own elaboration

In terms of their legal form, out of 973 companies (2018), 855 companies operate as limited liability companies, 61 as limited partnerships, 41 as limited companies, 15 as co-operatives, and 1 as a general partnership.

The waste management sector employed 20,367 people in 2018, of which the SME sector accounts for 71%. There were 61.5% of employees engaged in the collection of non-hazardous waste, 18% in the treatment and disposal of non-hazardous waste and 13.1% in the recovery of sorted materials. The collection, treatment, and disposal of hazardous waste accounts for 7.4% of employment.

Our conclusions concerning the development of the net sales revenue of the sector are based on the data of 799 companies with 5 closed business years. The combined net sales revenue of these companies increased by 32% from 2014 to 2018. The largest increases were in the collection, treatment, and disposal of non-hazardous waste, but there was also an increase in the recovery of sorted materials. The collection, treatment, and disposal of hazardous waste accounts for a smaller share of the sector's net sales revenue, with the growth being also the smallest in these areas.



(38.11: 356 enterprises, 38.12: 38 enterprises, 38.21: 138 enterprises, 38.22: 46 enterprises, 38.32: 221 enterprises, Total 799 enterprises)

*Figure 3 Development of waste management sector's net sales within the companies with 5 closed business years*

Source: OPTEN data-based own elaboration

In the first three years, i. e. between 2014 and 2018, the profitability indicators for waste collection, treatment and disposal were usually better than those for the recovery of sorted materials. However, in the last two years, the profitability indicators of the latter sector also increased. In 2018, 64% of the companies in the sector were profitable (based on the data from 973 companies). The percentage of profitable companies in the field of recovery of sorted materials was lower. Profitability indicators were calculated on the basis of the aggregate data from 596 profitable SMEs and the results are shown in Table 13. It can be seen that profitability varies from class to class.

*Table 13 Profitability characteristics of the waste management sector of Hungary*

NACE class	% of profitable enterprises (2018)	Operating profit /total assets (% 2018)	Operating profit/net sales revenue (% 2018)
<b>38.11</b>	69	8	7
<b>38.12</b>	81	14	11
<b>38.21</b>	62	12	10
<b>38.22</b>	69	2	13
<b>38.32</b>	54	11	6
<b>Division 38 total</b>	64	-	-

Source: OPTEN data-based own calculations

Out of the top 50 companies with the highest turnover in the Hungarian waste management sector, 24 operate in the collection of non-hazardous waste and 11 in the field of treatment and disposal of non-hazardous waste. Eleven companies operating in the recovery of sorted materials are in the group of the largest companies (shown in bold in Table 14). The remaining 4 companies belong to the area of hazardous waste treatment and disposal. Half of the top 12 companies operate in the field of recovery of sorted materials. These companies are: INTER-METAL Recycling Kft., MÜ-

GU-Kft., Locker Hulladékhasznosító Kft., ERECO Zrt., GEOSOL Kft., and Hamburger Recycling Hungary Kft.

Table 14 Top 50 companies in the Hungarian waste management sector by net sales revenue (based on the 2018 data)

Rank	Company name	NACE class	Rank	Company name	NACE class
1.	FKF Nonprofit Zrt.	38.11	26.	Saubermacher-Magyarország Kft.	38.11
2.	<b>INTER-METAL Recycling Kft.</b>	<b>38.32</b>	27.	ÉBH Nonprofit Kft	38.21
3.	HARTMANN HUNGARY Kft.	38.11	28.	CONESTOGA Kft.	38.11
4.	<b>MŰ-GU-Kft.</b>	<b>38.32</b>	29.	<b>P.M.R. Kft.</b>	<b>38.32</b>
5.	ATEV ZRT.	38.21	30.	STKH Sopron és Térsége Nonprofit Kft.	38.11
6.	<b>Locker Hulladékhasznosító Kft.</b>	<b>38.32</b>	31.	MiReHu Nonprofit Kft.	38.21
7.	<b>ERECO Zrt.</b>	38.32	32.	SARPI Dorog Kft.	38.22
8.	BÜCHL HUNGARIA Kft.	38.21	33.	ENVIROTRADE Kft.	38.22
9.	BMH Nonprofit Kft.	38.21	34.	DEPÓNIA Nonprofit Kft.	38.11
10.	MENTO Kft.	38.21	35.	ÉTH Nonprofit Kft	38.11
11.	<b>GEOSOL Kft.</b>	38.32	36.	EWC-H Kft.	38.11
12.	<b>Hamburger Recycling Hungary Kft.</b>	38.32	37.	Szegedi Hulladékgazdálkodási Nonprofit Kft.	38.21
13.	FCC Magyarország Kft.	38.11	38.	DESIGN Kft.	38.22
14.	DTKH Nonprofit Kft.	38.11	39.	DBR Nonprofit Kft.	38.11
15.	Dél-Kom Nonprofit Kft.	38.11	40.	Zöld Híd B.I.G.G. NKft.	38.21
16.	FBH-NP Nonprofit KFT	38.21	41.	ZALA-MŰLLEX Kft.	38.11
17.	BIOKOM Nonprofit Kft.	38.11	42.	NHSZ Szolnok Közszolgáltató Nonprofit Kft.	38.11
18.	VERTIKÁL Nonprofit Zrt.	38.11	43.	<b>Zalai HUKÉ Kft.</b>	<b>38.32</b>
19.	Debreceni Hulladék Közszolgáltató Nonprofit Kft.	38.11	44.	GYHG Nonprofit Kft.	38.21
20.	Észak-Alföldi Környezetgazdálkodási Nonprofit Kft.	38.11	45.	NHSZ Észak-KOM Nonprofit Kft.	38.11
21.	A.K.S.D. Kft.	38.11	46.	ZV Nonprofit Kft.	38.11
22.	DAREH BÁZIS Nonprofit Zrt.	38.11	47.	ÉMK Kft.	38.22
23.	Green Collect Kft.	38.11	48.	<b>FE-GROUP INVEST Zrt.</b>	<b>38.32</b>
24.	<b>Sárvári HUKÉ Kft.</b>	<b>38.32</b>	49.	Zalai Közszolgáltató Nonprofit Kft	38.11
25.	<b>NHSZ Tatabánya Zrt.</b>	<b>38.32</b>	50.	Zempléni Z.H.K. Nonprofit Kft.	38.21

Source: OPTEN data-based own elaboration

Now, that the quantitative data of the waste management sector has been reviewed, we will supplement our analysis with a qualitative assessment stated in the section below that is based on interviews with sector stakeholders.

## 2.4. Stakeholder Analysis

In order to map the specifics of the waste management sector, we conducted semi-structured interviews with ten experts in the sector. The aim was to map the main opportunities and obstacles in doing business in the sector based on participants' experience and thus provide a foundation for a PESTEL analysis.

*Table 15 Main characteristics of the stakeholders*

	<b>Interviewee's position</b>	<b>Company main activity</b>	<b>Number of employees</b>
1	Manager	Treatment and disposal of non-hazardous waste	4
2	EMS leader	Quarrying of stone, plaster, and chalk	160
3	Colleague	Activities of other membership organisations n.e.c.	4
4	Research field leader	Other research and experimental development on natural sciences and engineering	223
5	Manager	Treatment and disposal of non-hazardous waste	282
6	Editor in chief	Engineering activities and related technical consultancy	0
7	Researcher	Other research and experimental development on natural sciences and engineering	210
8	University professor	Higher education	
9	University professor	Higher education	
10	University professor	Higher education	

Source: Own elaboration

First of all, it should be emphasized that the waste management sector is extremely diverse, with each level of the waste hierarchy (prevention, re-use, recycling, energy recovery and disposal) having a number of specific characteristics, while being closely interlinked. Secondly, it is really difficult to estimate the real weight of the sector, as, in many cases, innovations related to waste management and their results do not appear directly in the waste management sector.

Firstly, we addressed the challenges the sector is facing and the business opportunities that arise from them. We focused on the opportunities that the interviewed experts see for newly graduated engineering students planning to start their own business.

In the case of Hungary, compliance with EU directives on waste recycling is the major challenge. Fluctuations in material and primary raw material prices are of an issue and if the price of oil falls down so will the price of energy generated from waste.

The issue of municipal solid waste versus industrial waste needs to be addressed separately when discussing waste management issues, as they are subject to different frameworks and need to be treated differently. In the case of municipal solid waste, a strong state presence can be observed (collection is mostly concentrated in the hands of state and local governments) and its framework is determined by a government regulation. In the latter, however, market solutions predominate (resulting in highly volatile prices), but the secondary raw material market is expanding rapidly and there are plenty of opportunities in the long run. For the industrial waste, there is a huge potential for prevention. Operating costs are lower when less waste is generated, as waste has to be treated and this treatment is costly. One of the experts sees many business opportunities in this field.

Almost all market participants have emphasized that necessary technology is available in most areas, but it creates a high barrier to entry, even in the areas that are traditionally not in the regulator's hands. And where there is competition, such as in writing studies or grant applications, there are depressed prices in the market. At the same time, an engineer, if having a good overview of their field and examining the environmental issues in a system, can find a possibility of use where the disposal and transformation of waste can gain new meaning.

For students just after graduation, the respondents identified a number of market niches. It was felt that there was also an opportunity created by increased administrative burden due to state regulation as well as access to grant funds and the task of managing the funds. Environmental life cycle analyses, economic life cycle analyses and SLCA models examining social impacts are becoming increasingly of an aspect requiring the training and employment of professionals who are competent in these activities. Finally, climate protection was mentioned as a new option. At the same time, it is believed that past experience and social capital are still important, so it is crucially

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important that potential entrepreneurs in this area gain necessary experience during their university years.

There was no consensus among respondents as to whether there is a business opportunity for young people to promote industrial symbiosis (e.g. establishing an intermediary network that connects waste donors and recipients, software development, etc.). It is mainly the professionals who see that the market is already narrow, but those working in the academic line feel that the establishment of a nationwide network of intermediaries is a priority without which waste recovery cannot be efficient.

State intervention is needed in order to develop a business model that allows companies to operate profitably. And, if someone invents a new technology, the financing must also be solved, because the ultimate goal, working technology, is in the society's interest.

The innovation culture of Hungarian companies is not yet mature, the willingness to take risk is low. They are afraid of new solutions, and recycled material made from waste will only be incorporated into production if it is much cheaper than standard materials. Although many island-like innovations and development ideas emerge, they often die. There is a need for bringing together island-like initiatives. There has already been an example of this mentioned in connection with a grant: hundreds of local governments came together and reached a consensus quite easily and quickly in order to gain EU funds. This could work well in the entrepreneurial sphere, be it fundraising or R&D.

Paradoxically, EU and state grants are not conducive to innovative ideas because participants do not take risks and strive for mature technology. For example, in a state-funded project in which the employer of one of the respondents was also a consortium partner, the development of 16 marketable products was undertaken, with full product descriptions and patent applications. This is a big risk that companies in the market would not take. Instead, companies prefer ready-made, workable solutions (such as those already proven in Western Europe).

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As regards potential funds for young entrepreneurs, respondents feel that loans are mainly available to them in the market. The Economic Development and Innovation Operational Program (GINOP) and other asset grants are not tailored for start-ups. Respondents were unaware of the existence of incubation activities in this sector, but university colleagues emphasized that they were trying to help young people implement their ideas. However, this is still not enough for incubation. There are examples of the existence of venture capital, but not specifically focused on this area. There are young entrepreneurial competitions, but also not sector specific. Funders expect a complete, elaborate business plan, so young people need business, entrepreneurial knowledge, and credible action in addition to a professional idea.

As far as the importance of changing one's attitude is concerned, all respondents agreed on this point. At present, the Hungarian market participants are price sensitive, consumers have little knowledge of this area, they are hostile to planned projects (for example, the construction of a waste incinerator or landfill) while producing more waste. Companies prefer predictable, financially secure solutions, which delays the resolving of the issue of producer's liability. At the same time, it is not possible to rely on the fact that the environmentally conscious willingness to pay will develop on its own; the changes must be initiated through pricing; this means that the change of attitude is also a regulatory and financing issue.

The tasks related to the change of attitude will also be manifested in financial resources which may, at the same time, provide an opportunity for new companies to enter the market. There are a number of communications, information and education-related tasks that need to be pursued while following a central strategy but at the local level, considering the diversity of the target group and generational differences. If we want to create a circular economy, we need to make market participants aware of the fact that waste has value and it is not just rubbish. The change in attitude has begun, but it is still in its infancy. Information to residents is important because they see that waste is taken away once a week and they do not see the path of waste, and the opportunities of

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its recycling, or re-use. More demonstration activities would be needed, either by civilians or by state-owned companies. The marketing in this sector is particularly poor. This could be helped by young people – marketing activities could be carried out in this sector, which could also create entrepreneurial opportunities for young people.

We need to emphasize that work is now under way to prepare a waste management strategy that will determine the future focus of waste management and thus the direction of change in the sector.

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### 3. Case Studies of Companies

As part of the project, we prepared three case studies. When selecting the companies, we tried to have them as diverse as possible in terms of their scope of activities, applied solutions and size, while, at the same time, focusing on the companies that have been operating in the market for a long time, i. e. those that were able to implement a functioning business model. The main data of the selected enterprises are presented in the table below (table 16).

*Table 16 Main characteristics of the enterprises*

	<b>Company main activity (NACE code)</b>	<b>Year of foundation</b>	<b>Number of employees</b>
V1	S94.9.9 -Activities of other membership organisations n.e.c.	1989	2
V2	E38.3.2 -Recovery of sorted materials	1991	220
V3	E38.1.1 -Collection of non-hazardous waste	1995	200

Source: Own elaboration

#### 3.1. Operation and Activities

One of the three companies (V1) operates in the form of an association but also carries out profit-oriented activities. It works for sustainable natural and man-made environments with environmentally conscious society based on local natural, social, economic, and cultural resources living in it. Its mission is to conserve natural resources, and to ensure sustainable land use, food security, access to information, waste management and pollution prevention. The organization was founded in 1989, when these issues were great novelty in Hungary. It was under these circumstances that they launched their first programs designed with the help of primary and secondary school students as well as adults. When first grants appeared (for example, an energy efficiency grant) they enabled the organisation to develop an infrastructure (real estate, equipment) for creating operating conditions. The number of employees in the most active period when 30-40 projects were being implemented at the same time each year, was 25 people. Currently, they employ 2 people and get help of 20-25 volunteers taking part in the work.

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The company activities are remarkably diverse. The most important service is education. Due to the importance of environmental awareness, the greatest social benefits are also seen here. The “Forest School” project, the fee for which is typically below the market price, is organized for about 800–1,000 children a year. This activity is closely related to the mission of the organization and also generates regular net sales revenue. Moreover, Eco-Playground has been set up for children and a farm pedagogy program has been developed. Advisory Office provides the public with free assistance concerning environmental issues (environmental and energy saving practices and opportunities). It is mainly used by the people living in and around the settlement where the company is located. They provide advocacy and legal aid services for major industrial and municipal investments. The expert members of the association perform the expert and research activities in the framework of various ad hoc assignments (e.g. GIS, Land Registry orders, etc.). They run an eco-friendly product store, where they offer environmentally conscious products mainly produced by small businesses below the market price. With the help of their parcel delivery service, they have made the products available to a wider audience, but they also continue to take part in trade fairs.

The conservation of biodiversity is the aim of several of their programs, which, for example, monitor and document the development of the natural environment and forest wildlife, and deal with the distribution of native farm animals. Finally, various events are organized (local product festivals, folk art camps). The organization is part of an international group and maintains good relations with other market players.

Our second company (V2) is a domestically owned, medium-sized company. The company was established after the regime change and deals with waste management, recycling, and reuse. It also produces secondary raw materials from waste. It employs about 220 people. Due to the nature of its activities, it owns a significant amount of equipment. The value chain of their service is relatively simple, following a classic model. They buy waste from their partners and arrange its transportation to the company’s site where processing and recycling take place.

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The third company (V3) is a privately owned medium-sized company that has been operating for about 25 years. The number of its employees is around 200. Its field of activities is the recycling of plastic waste, mainly plastic film (thin plastic packaging material). Both, the industrial and municipal wastes are used as resources. Recycled waste is sold in the form of regranulate, primarily to medium-sized companies in Hungary, but the recycled plastic granules are also exported. Their utilisation is very particular as only a few products can be made from the film regranulate, mainly industrial films and garbage bags. The main suppliers are the agricultural and construction industries. Plenty of packaging film is also returned to the company from the trade sector. Stores are distinguished by quality, where there are many PET bottles and packaging foils, as they are clean and very much suitable for recycling. Municipal waste is treated separately, and the company receives it baled and separated for recycling. In the initial phase, the company had only one regranulating plant. Later, a sorting plant was installed. Bank loans were necessary to start the business, but funds from several grants were also used during the operation, mainly for capital expenditures.

### 3.2. Success Factors

The key to V1's success, according to the respondent, is that the company organizes its tasks within the community, in an innovative way, "issues" included, with the focus on protecting the environment and nature whatever the case. The biggest success for them has been the organization of events in the form of national meetings and green events. Another program they highlighted was the promotion of composting via lectures aimed at schools and municipalities. Their strength is their belonging to the community, which is based on common environmental values; they have found themselves surrounded by supporters and collaborators. They are perceived as a company performing useful activities and this usefulness also seems beneficial to those who join them, i.e. clients and volunteers. At the same time, they feel that there are not sufficient public support

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services despite the ever-lasting enthusiasm of the activists. The strength of the organization lies in teamwork and sharing the same values; they like to work together. They are strongly embedded in the local community and have a good network of contacts. One of the foundations of the organization's operation is free, self-fulfilling, innovative, and creative thinking and operation, which, however, without a systematic implementation background or a properly operated organization, would not bring the expected market results.

The key to V2's success is professional commitment. This domestic SME considers waste to be a valuable resource from which it can produce and sell secondary raw materials after its treatment. Innovative waste management solutions and a potential for continuous development are important for the success of the company, both, in terms of the continuous growth of the number of employees and the development of professional relations. The company is proud to operate in a transparent manner. V2 also highlighted the knowledge of foreign languages, proficiency in legal matters and the existence of engineering knowledge, i.e. the skills important at the time of its establishment and start-up.

Among its successes, the interviewees from V3 has primarily mentioned the firm's skilful procurement department which the company primarily depends on when determining the quality of the secondary raw material made from waste. Any company, whether public or private, needs a good leader who would manage its processes. They feel they have such a person. They also stressed out the need for suitable people in this sector, since a lot depends on the composition of human resources and workers' esteem. Since the waste sector does not represent a clean process it is not considered to be attractive by many. Dedicated people are therefore one of the company success factors; they feel that there are right people in the right places in the company.

### 3.3. Challenges and Difficulties

According to V1, engaging young people and students in community activities is really challenging. The declining social base is both, a difficulty and an operational risk for the organization. The type of public support that characterizes Western European countries has not yet been established in Hungary. There is a lack of coordinated, well-thought-out marketing activities that would be better at reaching the target group. Another challenge is funding. A significant part of the organization's revenue is determined by central budget resources and public service revenues. It means that its growth and operation depend to a large extent on the support environment of the given period. The percentage of private donations is low, and they are received very occasionally. Maintaining properties is a burden. The revenue generated by the company only covers maintenance costs and does not allow for expansion. It was also emphasized that there is a lack of the entrepreneurial spirit in the team, and that the range of products and services and the number of users should constantly expand.

In the case of V2, the main challenges include the legislative changes in the Hungarian Waste Act of 2012 (2012. évi hulladéktörvény). In some cases, it is easier for manufacturing companies to work with primary, non-recycled materials than with recycled ones as their production can be really costly.

According to V3, the biggest challenge is to find the right workforce. The key role of procurement colleagues lies in visiting sites with waste, measuring such waste and deciding if it is suitable for collection and processing. The waste is then sorted on the company's premises. With the lack of a good sorting team, this activity is not done properly, which signals a problem for further processing. According to our interviewee, typical for Hungary nowadays is that after sorting the remainder of the waste is placed in landfills. Obviously, this is not the right direction to go. According to the company, this may be partly due to the fact that the strategy of waste sorting is inconvenient and the framework it is performed in is inappropriate. Many places try to work with temporary workers

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or even prisoners. Unfortunately, the result is not necessarily positive as special knowledge is required to sort the right plastics. The sorting process can also be mechanized, but that would lead to high scrap cost and losses.

### 3.4. Conclusion

The importance of waste management is growing due to the constantly increasing amount of waste. Corporate case studies point out the need for widely diverse activities that affect all the waste hierarchy levels. Accordingly, there are many business opportunities available, although mostly to companies with large capital. All three companies have a long history and considerable knowledge and experience in the sector. Their cases are good examples of the potential for high-quality, profitable activities in the sector.

All three interviewed companies have highlighted the critical role of professional commitment and human resources in the processes, although in different contexts due to the scope of their activities. In addition to finding and retaining the right workforce, the availability of financing solutions is also crucial. All interviewees reported the use of external sources (loans, financial resources for grants). They operate in a transparent manner and comply with legal requirements.

As our V3 interviewee puts it, “Recycling waste is like burial services, it will always be necessary”. The waste generated should not be landfilled but recycled. This can also protect the environment, and those who do the job well can make a living from their business.

## 4. Potential Entrepreneurs' Reflection

We conducted semi-structured interviews to explore students' interest in the waste management sector as well as students' willingness to be entrepreneurs. We also discussed the mobility of our students, the main reasons for staying in the region or for deciding to leave.

At the beginning, it should be mentioned that the entrepreneurial intention is low in Hungary (Gubik, Farkas, 2019) and this also applies to the University of Miskolc. At the University of Miskolc, 8 percent of the surveyed students (764 students) are planning to start their own business or to take over their family business after graduation. In the case of engineers, this number is only 5 (3.2 percent of them would like to found a company), which represents only 15 of the 221 surveyed engineering students.<sup>19</sup> This data shows that it was not easy to find students with entrepreneurial intention among engineering students. Therefore, PhD students were also included in the interviews. The following table gives a brief overview of the participants.

*Table 17 Respondents' main characteristics*

	Education	Current studies	Work experience	Entrepreneurial experience / background	What stage is he or she in
1	Faculty of Earth Science and Engineering BSc	Faculty of Economics MSc	Technical preparation department engineer	Family entrepreneurial background (husband, husband's parents)	Brainstorming
2	Faculty of Earth Science and Engineering MSc, Faculty of Economics MSc	PhD	Project manager	Former own business	Brainstorming
3	Faculty of Earth Science and Engineering MSc	PhD	Student work, Research assistant	-	Brainstorming
4	Faculty of Natural Sciences MSc		Production Manager	Family entrepreneurial background (parents)	Brainstorming
5	Faculty of Earth Science and Engineering BSc	Faculty of Earth Science and Engineering MSc	Research / engineering field	-	Brainstorming

<sup>19</sup> Data taken from the GUESS 2018 database

6	Faculty of Earth Science and Engineering MSc	PhD	Participation in university projects	-	Brainstorming
7	Faculty of Earth Science and Engineering BSc	Faculty of Earth Science and Engineering MSc	trainee in design	-	brainstorming

Source: Own elaboration

## 4.1. Student's Entrepreneurial Intention

All of the students interviewed are more or less proficient in waste management. Due to their field of training, they have some knowledge about the sector. It is a completely different question, however, whether they feel they have the basis needed to start a business. The first part of our questions focused on whether they studied subjects related to entrepreneurship. All respondents answered yes, but it should be emphasized that in the framework of university education, these are not special entrepreneurial subjects related to the skills or knowledge required to start one's own business, but basic economics and business subjects (microeconomics, macroeconomics, statistics, business economics). This became clear later when we asked them about the nature of the external help needed to start a business. The topics highlighted by the respondents: the areas of accounting, economic consulting, legal advice, and other tasks related to starting a business (preparation of a business plan, market analysis) suggest that this is an area that could be improved. According to one of our respondents (H3), more practical examples are needed for teaching these subjects. Two students (H1 and H6) also mentioned that if they started a business, they would look for an accountant and a lawyer first. Student H6 also has a professional degree in business administration, at the National Training Registry where he studied all economics and business subjects; his reason for deciding to apply for this course was to have appropriate knowledge once running his business. Even though he has the right knowledge, he does not want to start any business right now as he does not have the confidence and sufficient financial capital to do so.

The interviewees were divided on the question of the usefulness of the business-related subjects they had taken. Two considered these not to play any role in their entrepreneurial decision (H3, H5),

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while the others felt that these subjects were decisive, either because of their entrepreneurial ideas or, generally speaking, from a professional's point of view.

The majority of the students have only dealt with starting a business at the level of brainstorming so far. Their plans are quite detailed and clear, especially the plans of those who have entrepreneurial family background and thus have an insight into how entrepreneurial processes take place and what it generally means to be an entrepreneur. According to one of our interviewees (H2), their career choice is already determined by their family background – many people choose their field of training to suit the family business or base it on their parents' work experience (where there is a demand for labour, what income can be earned). Of those who ended up in their field by chance, several left, unable to succeed in the profession.

It is also important how confident the students are in their decisions. The literature describes this confidence as self-efficacy which can be developed via special programs (Gubik, Farkas, 2019). For example, one of our respondents (H1) was not brave enough to start his own business, although he had contributed to the family business with several good ideas.

One interviewee has entrepreneurial experience. She emphasized two things. One was that she would not have dared to start a business if she had not studied at the Faculty of Economics in parallel; she did not consider her technical knowledge alone to be enough to start her own business. The other is that she had gained knowledge additional to her university study by having taken part in a student research society competition. The business opportunity itself had come from there. Eventually, she had closed down the company and had found a job in a multinational company. This was because she had not had enough orders and enough contacts to help her find business opportunities, so for a long time, she could only have been a subcontractor for a fraction of the real amount of the business available. She emphasized that although she had not really needed much capital to start her business, she had needed a relatively predictable income; having had no savings, she could not have borne the financial risk arising from the uncertainty of the orders. There was

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another interesting counter-argument on her part: as an entrepreneur, she had had to focus on one thing on a long-term basis, which she had found very tiring because she loved doing a variety of work and dealing with new tasks. She states that large companies have an advantage here, as one can also switch jobs within a company.

The interview with her confirmed one of the lessons learnt during the discussion with stakeholders: although there are areas where capital requirements are not high, there is still a barrier to entry due to the lack of social capital and awareness of those already in the market. This was also confirmed by H7, who said that in order for someone to start a business that would be profitable in the field of waste management, large start-up capital and political connections were needed.

It is important to emphasize that entrepreneurship is more than a good business idea. You need to be able to translate this idea into a good business plan and you have to be able to sell it to investors. The product, the service, yourself as an entrepreneur, all of these need to be advertised, the processes need to be organized, and so on. There are a number of professional tasks that require additional knowledge, to which administrative tasks (starting a business, tax, accounting tasks) are added.

The interviewed students are in the brainstorming phase; the ideas they come up with are truly diverse. Only the interviewee with entrepreneurial experience (H2) has a detailed business idea. They all agree that there is a great business potential in waste management: “I see a business opportunity in this field as waste is a big problem all over the world, so its management and prevention is not only important from the environmental point of view, but also brings promising business opportunities .... I see prevention as an attractive area from the entrepreneurial as well as environmental point of view” (H3). The business idea mentioned by respondent H6 was that “it would be worthwhile to start a business that deals with waste analyses, as it is mandatory to do a quarterly waste analysis in the waste management sector. If I had to start a business in the easiest manner possible that would be it. Obviously, this would require engineering qualifications and

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chamber membership. Maybe that would be the least complicated, but you need the right knowledge.”

H1 suggested “...especially in the field of recovery, to make something new out of something used, be it jewellery or everyday objects.... or the use of smart energy can be an area of interest”.

The interviewee (H2), who already has had entrepreneurial experience, only wants to do this business as her second job; in addition to waste management, she also has business plans for other areas.

The students interviewed gave very different answers to our mobility-related question<sup>20</sup>. The financial reasons, which we consider to be the main motivation, do not seem to be as important for students’ decisions as we previously thought. Several students mentioned the importance of family as a factor forcing them to stay (H1, H3). Other important aspects for the interviewees in general included those related to their job expectations, such as performing challenging tasks, diversity of work, and the opportunity for continuous improvement. There were also some motivations mentioned that a larger firm is more likely to provide, such as working in an international environment and the opportunity to use English on a daily basis (H2).

## 4.2. Findings

A good business idea is not enough. In order to raise capital, a ready-made business plan must be put on the table. Here, it is important to have economics/business background as well. Thus, not only should students be motivated to acquire well-founded, competitive knowledge related to their own profession, but they should also be able to identify independently their further training needs (business-related knowledge), organize their own learning accordingly and/or work with those who

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<sup>20</sup> “What are the most important considerations in connection with the decision to stay or leave the Northern Hungary region (or even Hungary) after completing your studies?”

already have those skills. The combination of economic and technical qualifications can lead to more competitive solutions. The institutional framework for this needs to be created at universities. This also requires stronger communication and collaboration amongst faculties.

Incorporating entrepreneurial knowledge into educational materials and promoting existing programs are important tasks but this is not enough to ensure the availability of the service. It would also be an important task to arouse students' interest in the topic, as without their participation the utilization of what they have learned will not take place.

Career opportunities should be addressed consciously, and students should be made aware of them so that they can consider those and adjust their plans accordingly. In addition to material knowledge, their self-efficacy should also improve. It is not enough to have the knowledge. One also needs to believe that they can be successful with it in the market.

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## 5. Executive Summary

In the course of our research, we examined which area of the Hungarian raw materials sector could be an attractive entrepreneurial target for young people participating in raw material-related education. By increasing students' interest in the topic as soon as possible and by raising awareness of career opportunities in the sector the chances that students will not leave the region and will try to become entrepreneurs after completing their studies instead might also increase.

Firstly, we examined 21 classes of the raw materials sector. We examined the business demographic characteristics of different classes, the trends in the number of employees and net sales revenue of the currently operating enterprises, profitability indicators, and barriers to entry in the period between 2014 and 2018. The domestic raw materials sector, as well as other sectors, are characterized by the dominance of micro-enterprises (89% of them). The 3,348 operating companies generated HUF 1.427 trillion in sales revenue and employed 31,240 people in 2018. Within the raw materials sector, based on a comparative analysis of the above data, we chose the waste management sector as a further goal of our analysis. It is important to note that the actual performance and importance of the waste management sector is higher than estimations from official statistics, as many innovations and achievements related to waste management/recycling in user sectors are reported under other NACE codes.

The role of the waste sector in industrial value chains has been defined as a kind of intermediary, which, through the collection, treatment, and processing of waste, contributes to the generation of secondary raw materials that can be sold to industries. In our analysis, we examined all the levels of waste hierarchy (prevention, reuse, recycling, energy recovery, landfilling) based on its potentials. The preparation of the Hungarian Waste Management Strategy is in progress. Its objectives – to increase the role of the sector in economic policy, to support the achievement of sustainability goals and the transition to a circular economy – will further increase the future potential of waste management.

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Our research comprising desk research, interviews, case studies and a content analysis provided an overly complex picture of the entrepreneurial opportunities inherent in waste management. The necessary technology is available in most areas, but it also creates a high barrier to entry. Even in the areas where power is not concentrated in the hands of regulatory bodies, smaller companies are being pushed out of the market. At the same time, increasing administrative burden due to strict regulatory requirements and conditions for grants for the waste sector, as well as environmental and economic life cycle analyses, SLCA models, etc. result in the expansion of the market for skilled professionals. Market gaps can also be identified in the field of promoting industrial symbioses (e.g. support network, software development, etc.). Moreover, in the regulation of manufacturing sectors, increasingly ambitious energy efficiency, emission reduction and waste reduction targets are encouraging a greater use of secondary raw materials in production processes. Product expectations (longevity, serviceability, modular design, energy saving, etc.) require continuous technological development. The demand for state-of-the-art technologies and continuous innovation are also reflected at all levels of the waste hierarchy as well as in related industries.

In terms of access to resources, a review of the opportunities offered by the European H2020 grants, domestic structural funds and government resources has led to the conclusion that the topics of the supported projects are extremely diverse in the raw materials sector and there are no specific resources for waste management available. Within the Hungarian Economic Development and Innovation Operational Programme (GINOP) projects, there are many sub-projects related to SME development, start-ups, and support for young people that would like to become entrepreneurs. However, they are not sector-specific, so applicants compete with other sectors for resources. As regards business angel or venture capital investments for start-ups, there are no opportunities to focus on the waste management sector. Finally, there are low-interest, state-subsidized loan schemes available to SMEs but their terms are not necessarily tailored to start-ups.

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The two levels of the waste management hierarchy, both prevention and re-use, are greatly influenced by the type of consumer behaviour developing within society. But significant changes in household demand also affect production processes (supply). The process of forming social opinion on waste, which is still in its infancy in Hungary, should therefore be given higher priority. The tasks related to the change in attitude will also be manifested in financial sources which may provide an opportunity for new companies to enter the market.

Having examined the supply side of becoming an entrepreneur, it can be generally stated that Hungarian student's intention to become entrepreneurs is low. It is even lower among technical students. Increasing this number requires comprehensive interventions. Career opportunities for students need to be addressed more intensively, and students need to be made aware of them so that they can consider those and adjust their plans accordingly. In order to be able to turn their business ideas into well-developed business plans, they also need economic/business/entrepreneurial knowledge or peers who can perform these tasks in the planned business. The institutional framework for this needs to be created at universities. This also requires stronger communication and collaboration amongst faculties.

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## Annexes

### Questions for stakeholders

1. What business opportunities do you see for waste management in the areas of prevention, re-use, recycling, energy recovery, and disposal?
2. At what level of the waste management hierarchy (prevention, re-use, recycling, energy recovery, and disposal) do you see the best chance for newly graduated students to become entrepreneurs?
3. What market challenges is the sector facing in these areas?
4. What barriers to entry can be identified in the sector? What are the main barriers for start-ups?
5. What characterizes the regulatory (and support) environment? Do they hinder or support business opportunities?
6. What are technology requirements of each activity? Is there a technology gap that makes it difficult for a start-up entrepreneur to enter the market?
7. Is the necessary infrastructure available for entrepreneurs to successfully manage business opportunities?
8. Are there incubators / business facilitators?
9. Are investor networks available to SMEs?
10. Are funding sources (public or private) available to entrepreneurs?
11. Do entrepreneurs receive support (public or private) for labour or job positions or do they get wage subsidies?

12. In many cases, innovations related to waste management and their results are not introduced in the waste management sector. What role can the waste sector play in achieving waste management goals?
13. Do you see an opportunity to create a network of intermediaries supporting the promotion of industrial symbiosis, e.g. between waste donors and acceptors?
14. How can the environmental and social benefits of effective waste management be measured?
15. Do you see a need to support a change in social attitudes? What role can actors in the sector play in this?
16. Do you have any other comments related to the topic?

### Questions for company representatives

1. What is the main activity of your company? How many people do you employ?
2. Who are the main consumers of your products / services? (end consumers, other companies, no need to name the companies, only the nature (scope of activity, size))
3. Who are their main suppliers? (it is not necessary to name the companies, only their nature (scope of activity, size))
4. How is the value chain of your product / service structured?
5. What motivated you to start and run the company?
6. What are the key success factors of the company?
7. What challenges do you face?
8. What skills and knowledge do you consider to be the most important for starting a company?  
How did you obtain them?

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9. What market knowledge was crucial for setting up the company? What other type of knowledge was important later?
10. What are the milestones of your operation / growth?
11. What failures have you experienced during your company operation?
12. Have you used the services of incubators or, more broadly, any business development services?
13. Did you use any of the following sources to start the company: loan, capital investment (business angels, venture capital), accelerator programs or grants?
14. What resources could you use during the operation of the company: credit, capital investment (business angels, venture capital), accelerator programs or tender resources? If you took several, which ones did you find most beneficial for your growth?

### Questions for students

1. Did you have any courses related to entrepreneurial knowledge? If so, could you characterize them? (List some strengths and weaknesses). Have you heard of the Agora program of the University of Miskolc? (Entrepreneurship Agora for Young People)
2. Have you ever considered becoming an entrepreneur? Have the economic / entrepreneurial subjects studied and the knowledge gained influenced your opinion?
3. Do you have any entrepreneurial experience (own business or family owned business)? If so, in what area?
4. Do you have work experience? If so, in what area?

5. At which faculty and which specialization do you study? Do you see a business opportunity in your field of study? Do you know the most crucial issues of waste management? If so, do you see a business opportunity in this area?
6. Can you imagine yourself as an entrepreneur in waste management? If so, which area of the hierarchy do you consider attractive from the entrepreneurial perspective? (prevention, re-use, recycling, energy recovery, and disposal)
7. If not, what is the reason for this?
8. Are you aware of the steps of starting a business and the tasks of the business process?
9. Are you familiar with the current grant opportunities? (in connection with starting a business in general or in a specific field)
10. Have you already taken steps to start your business? (e.g. inventing an entrepreneurial idea, finding peers, business plan, market analysis, etc.) What kind of outside help do you think you would need?
11. Where do you want to be located after your studies (scope of activity and geographical area)?
12. What are the most important aspects of the decision to stay in or leave the Northern Hungarian region (or even Hungary) after completing your studies?



# CHAPTER 2

CZECH REPUBLIC

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## 6. Raw materials in the Czech Republic

### 6.1. Macroeconomic Development of the Czech Economy

In the last two years, the Czech economy has been successful. According to the most recent data, the Gross Domestic Product (GDP) /1/ rose by 5.4 % in 2015. This revision moved the original result of 4.6 % significantly upward. However, the 2015 growth was supported by an extraordinary combination of unexpected favourable transient factors of varying intensity and duration. In addition to the delayed draw-down of EU funds, the fall in oil prices and other raw materials has also been a strong driving motive. After many extraordinary impulses, the Czech economy slightly moderated in 2016, as expected. According to the revised data, the growth of Gross Domestic Product was 2.5 %. The substantial 2015 increase set an extremely high benchmark for 2016 and, in this context, the performance of the domestic economy can be assessed positively. The good condition of the economy was confirmed by the result for the first half of 2017, which indicated the strengthening of the economic performance by over 3 %. In the first quarter, the year-on-year growth of the economy was 3 %, the preliminary second-quarter estimate talked about the growth exceeding 4.5 %. The quarterly and year-on-year growth rates of Gross Domestic Product are shown in Figure 4.

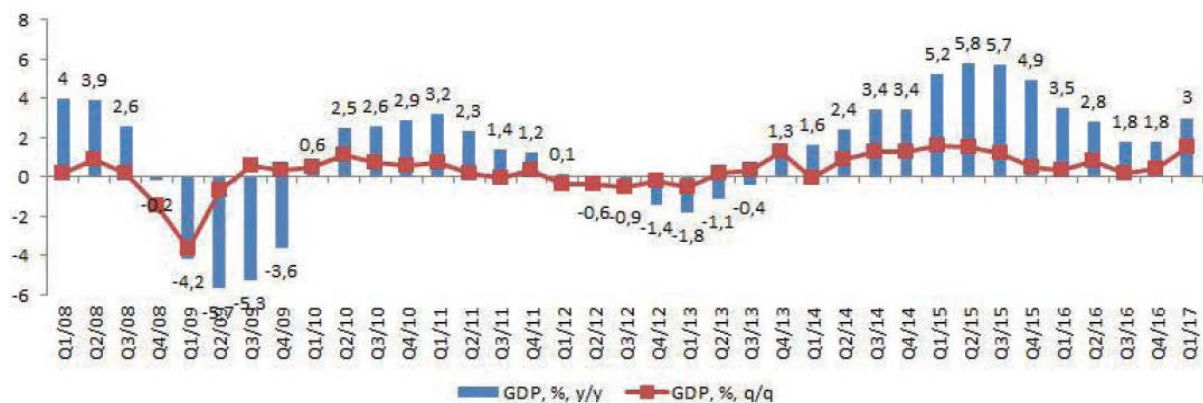


Figure 4 Actual GDP, annual and quarterly changes (in per cent)

Source: CZSO, National accounts (July 2017)

## 6.2. Selected Statistical Data on Exploration and Mining in Territory of Czech Republic

Table 18 Selected statistical data on exploration and mining in the Czech Republic

Statistical data/Year		2012	2013	2014	2015	2016
registered geological works <sup>a)</sup>	total	3 000	3 340	3 585	4 128	5 610
	economic geological	24	22	27	26	11
protected deposit areas – number		1 087	1 098	1 100	1 105	1 112
mining leases – total number		967	969	973	974	967
number of exploited reserved deposits		495	502	504	505	507
number of exploited non-reserved deposits		209	203	209	208	221
mine production of reserved deposits, mill t <sup>b)</sup>		114	107	109	114	110
mine production of non-reserved deposits, mill t <sup>b)</sup>		11	11	10	12	12
organizations managing reserved deposits		320	321	318	319	322
organizations mining reserved deposits		183	179	181	179	184
organizations mining non-reserved deposits		151	170	152	165	166

Source: Czech Statistical Office

Note: numbers of data in view are given unless otherwise indicated

<sup>a)</sup> engineering-geological and hydrogeological works prevail

<sup>b)</sup> conversions: natural gas 1 mill m<sup>3</sup> = 1 kt, dimension and crushed stones 1,000 m<sup>3</sup> = 2.7 kt, sand and gravel and brick clays and related minerals 1,000 m<sup>3</sup> = 1.8 kt

## 6.3. Significance of Mining in the Czech Economy

Table 19 Mining in the Czech economy

Ratio/Year	2012	2013	2014	2015	2016
Annual GDP * growth	-0.7	-0.5	2.7	4.6	2.5
Share of mining and quarrying in GDP, % of current prices	1.1	0.8	0.9	0.8	0.8
Share of mining and quarrying GVA in GVA of industrial production**, % of current prices	3.9	2.9	3.2	2.9	2.0

Source: Czech Statistical Office

Notes: \* GDP determined by production approach, volume indices, stable period of previous year = 100

\*\* Industrial production = mining and quarrying + manufacturing + electricity, gas, steam and air conditioning supply

## 6.4. Economic Instruments

Economic instruments, through which funds are obtained, are also used to achieve the goals of raw materials policy. These funds are used for certain purposes by the state, municipalities, and miners. An important role of economic instruments lies in their motivational character. The purpose of the fees for reserved minerals is to have a private entity carry out its activities for a fair remuneration while, at the same time, bearing in mind that the mineral wealth belongs to the state. The fees are also to secure the market for raw materials or motivate the state to prefer the use of a particular raw material or a group of raw materials.

## 6.5. Economic situation of Domestic Mining Companies

Analysing the economic situation of the enterprises extracting raw materials means considering certain facts. Enterprises extracting raw materials can mine more kinds of raw materials. Because of that it is necessary to include these companies in individual raw materials categories and, therefore, they appear multiple times in the analysis.

Table 20 Mining in total

Indicator	Unit	2012	2013	2014	2015	2016
Number of enterprises		191	241	242	251	240
Number of employees		53 298	57 146	55 895	63 427	54 959
Sales	mill. CZK	141 021	153 688	147 489	185 334	156 164
Value added	mill. CZK	60 765	57 054	57 473	74 260	38 105
Sales per employee	ths. CZK/ employee	2 646	2 689	2 639	2 922	2 841
Labour produktivity based value added	CZK/ employee	1 140 089	998 385	1 028 222	1 170 808	693 333
Hourly labour produktivity	CZK/ working hour	672	595	609	697	413
Average salary	CZK/ employee	30 388	29 736	29 847	30 462	31 137
(Value added - salaries) per employee	CZK/ employee	1 109 702	968 649	998 374	1 140 346	662 197
Indexes	16/12		13/12	14/13	15/14	16/15
Number of enterprises	25%		26%	0%	4%	-5%
Number of employees	3%		7%	-2%	13%	-13%
Sales	11%		9%	-4%	26%	-16%
Value added	-37%		-6%	1%	29%	-49%
Sales per employee	7%		2%	-2%	11%	-3%
Labour produktivity based value added	-39%		-12%	3%	14%	-41%
Hourly labour produktivity	-39%		-11%	2%	15%	-41%
Average salary	2%		-2%	0%	2%	2%
(Value added - salaries) per employee	-40%		-13%	3%	14%	-42%

Source: Data from CSO and MIT

It is not possible to separate business activities related to the extraction of raw materials from other activities. Raw materials are also extracted by a lot of enterprises that, in addition to the extraction, process brick-clay, produce ceramic tiles or have construction as their main business i. For these enterprises, data does not only relate to the extraction of raw materials but also other activities. For the purpose of the analysis, enterprises represent a basic unit. A huge quantity of economic data on large enterprises is available. For small enterprises, however, the data is only limited or missing completely. For this reason, certain indicators have been adapted. For the enterprises extracting raw materials absolute indicators are characteristic. These are their number, the recalculated number of employees (e.g. when someone works half-time, he/she is only one half), sales and the added value. Moreover, they are also evaluated by selected relative indicators such as sales per employee, value added labour productivity, hourly labour productivity, average wage and the difference between the added value and the wage per employee (see Table 20).

As we proceed from the statistical data in which individual business data is subject to confidentiality, it is not possible to state raw materials with fewer than three enterprises in a group. The period covers the years 2012 to 2016. The time series indicators are provided by chain indices and by average growth for a given period. Comparable indices for individual minerals are compared with the Mining Total values equalling 100%.

*Table 21 Sales in 2016 (mil. CZK)*

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Mineral raw material	Total	CZ-NACE B	Other CZ-NACE
Bituminous coal	37 711	37 711	0
Brown coal and lignite	7 740	3 584	4 156
Kaolin	6 520	5 214	1 306
Clays and betonite	7 786	3 180	4 606
Feldspar	2 879	2 450	429
Glass sand	5 837	3 846	1 991
Foundry sand	9 325	3 975	5 350
Limestones and correlative silic additives for cement production and dolomite	3 017	2 920	97
Dimension stone	23 170	22 464	706
Crushed stone	14 364	12 367	1 997
Sand and gravel	7 219	1 108	6 111
Brick clays and related minerals	30 595	16 272	14 324
Other minerals	156 164	115 091	41 073
Mining total			
		75 762	
Firm classified one time into data processing		77 524	
CZ-NACE B			
		39 329	
Firm classified more times into data processing			

Source: Data from CSO and MIT

The specifics of the selection of enterprises extracting raw materials (Fig. 5) can be demonstrated through sales (Table 21). Total Mining Sales (selected enterprises extracting the surveyed raw materials) amounted to CZK 156.164 million in 2016. In the sectoral breakdown of enterprises by CZ-NACE, the selected enterprises should theoretically belong to CZ-NACE B Mining and Quarrying. This, however, is not the case. In 2016, CZ-NACE showed sales amounting to CZK 77.524 million. In our selection however, it amounts to CZK 115.091 million.

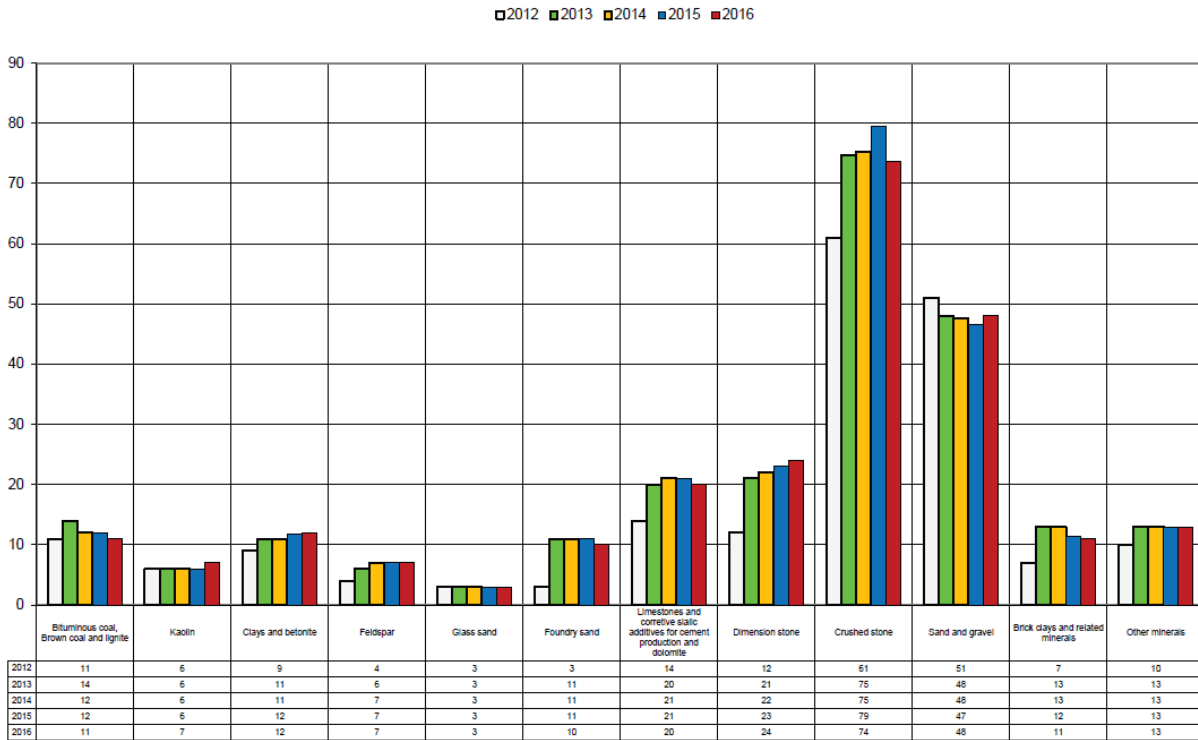


Figure 5 Number of companies in various raw material fields

Source: Data from CSO and MIT

Some enterprises extract more raw materials. This means that they are included in every raw material that they extract. The enterprises extracting more raw materials are included in Mining Total more times. The enterprises included once in Mining Total have sales of CZK 75.762 million. This is quite comparable to CZ-NACE B. However, the difference of  $115.091 - 75.762 = \text{CZK } 39.329$  million means that the selected enterprises were repeatedly included in the figure.

Almost 50% of the enterprises and their sales, are repeatedly included. In addition, a lot of enterprises from other CZ-NACEs are also included in the selection amounting to CZK 41.073 million of sales. These are mainly the enterprises from CZ-NACE 23 Manufacture of Other Non-Metallic

Mineral Products and CZ-NACE F Construction. There is a high share of other CZ-NACE in some raw materials.

The highest number of enterprises have crushed stone, sand, and gravel as their raw materials (Fig. 5). In reality, however, this number will be probably significantly higher as these mineral industries cover many small companies which have not been recorded. Unlike the mineral industries, in the bituminous and lignite industry, all the companies were recorded due as there are only big companies processing these commodities. The smallest number of companies has been recorded for the glass sand industry.

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## 7. Market Report for Mining Industry

Mining and quarrying have had very long history in the Czech Republic for many centuries. The products of the mining industry still serve as input raw materials for a number of very important industries, such as energy, construction and building materials, ceramics, glass, chemical, rubber production, pharmaceutical and many other specific fields.

The raw materials industry has a significant multiplier effect on the national economy, so its real importance is substantially higher compared to the net contribution of the sector itself.

The following graph documents the total domestic extraction of raw materials by groups (energetic materials – blue, industrial minerals except ores – green, building materials – purple).

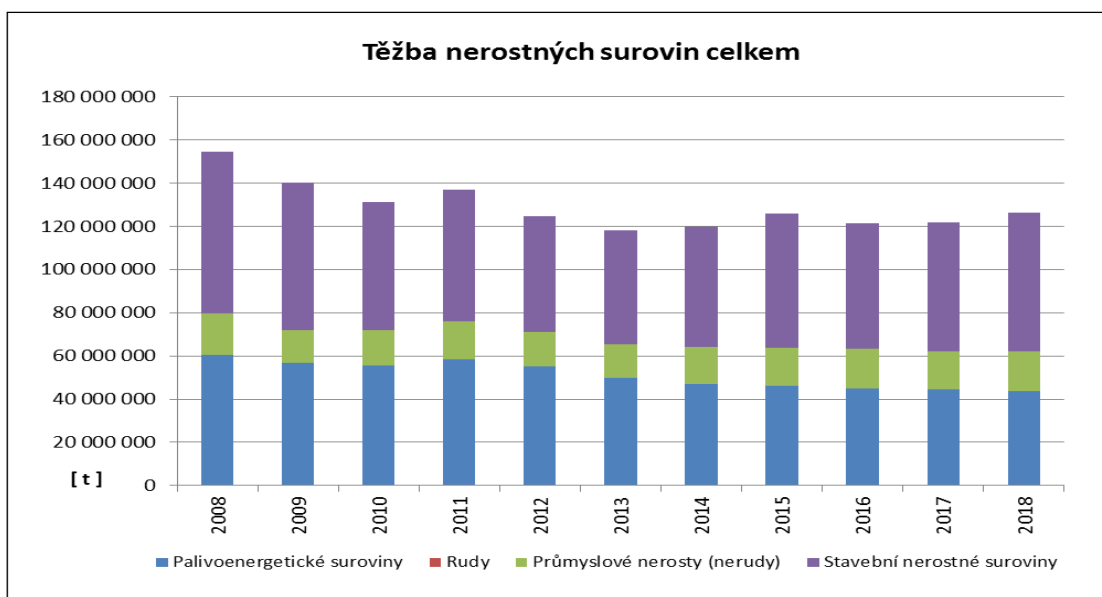


Figure 6 Mining of raw materials

Source: Czech Statistical Office

More detailed background data on the extraction of raw materials in the Czech Republic is stated in the following table.

Table 22 Mining of raw materials in the Czech Republic 2014-2018

	Unit	2014	2015	2016	2017	2018
<b>1. Fuel and energy raw materials</b>						
Black coal	1,000 t	8,341	7,640	6,074	4 870	4 110
Brown coal	1,000 t	38,348	38,251	38,646	39,310	39,187
Lignite	1,000 t	0	0	0	0	0
Oxihumolite	1,000 t	7	6	6	6	4
Petroleum	1,000 t	148	126	116	106	109
Natural gas	mil. m <sup>3</sup>	198	200	168	171	179
Uranium ore	1,000 t	137	91	73	12	0
Uranium metal	t	165	134	128	56	34
<b>2. Non-energy raw m.</b>						
<b>2.1. Industrial minerals (except ores)</b>						
Pyroponous rock	1,000 t	18	17	8	34	13
Moldavite rock	1,000 m <sup>3</sup>	45	67	71	54	61
Kaolins	1,000 t	3,281	3,454	3,540	3,669	3,622
Clays	1,000 t	518	569	538	537	469
Bentonite	1,000 t	301	369	374	254	277
Feldspar (felds. raw mat.)	1,000 t	422	433	454	368	449
Feldspar replacement	1,000 t	17	21	31	34	31
Quartz raw materials	1,000 t	16	14	18	17	16
Glass and foundry sands	1,000 t	1,337	1,347	1,322	1,311	1,302
Wolastonite	1,000 t	2	1	2	2	1
Fusible basalt (fusible rocks)	1,000 t	2	15	14	14	12
Diatomite	1,000 t	34	15	26	34	31
Limestone	1,000 t	10,041	10,277	10,995	10,398	11,077
Dolomite	1,000 t	449	451	440	450	451
Cement corrective raw materials	1,000 t	302	291	417	388	650
<b>2.3. Construction min.</b>						
<b>2.3.1. Exclusive deposits</b>						
Decorative stone (rough and noble stone prod.)	1,000 m <sup>3</sup>	145	187	156	112	116
Building stone	1,000 m <sup>3</sup>	12,341	13,740	12,385	12,776	14,140
Gravel sands	1,000 m <sup>3</sup>	5,753	6,063	6,143	6,199	6,499
Brick raw materials	1,000 m <sup>3</sup>	677	736	877	678	825

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<b>2.3.2. Non-exclusive deposits</b>						
Decorative stone (rough and noble stone prod.)	1,000 m <sup>3</sup>	58	55	48	33	18
building stone	1,000 m <sup>3</sup>	982	1,171	1,408	1,251	1,151
Gravel sands	1,000 m <sup>3</sup>	4,063	4,796	4,045	4,829	4,875
Brick raw materials	1,000 m <sup>3</sup>	161	165	225	251	298

Source: Czech Statistical Office

This sector consists of five groups corresponding to the international classification NACE Rev.2 at the second level of breakdown. The largest of them is the group Mining and Processing of Hard Coal and Lignite (NACE 05) which covers about 68% of all the employees in this group of occupations. The remaining staff are employed in (stated in the descending order of the number of employees) Other Mining and Quarrying (NACE 08), Mining and Quarrying (NACE 07), Extraction of Crude Petroleum and Natural Gas (NACE 06) and Support Activities for Mining (NACE 09).

Based on a detailed level 4 NACE breakdown, a total of 14 different subsectors fall into this industry. The major subsectors are the following (stated in the descending order of the number of employees):

- Mining of hard coal (NACE 0510);
- Mining of lignite (NACE 0520);
- Quarrying of stone for artistic or building purposes, limestone, gypsum, chalk, and slate (NACE 0811);
- Operation of sand and gravel pits; mining of clays and kaolin (NACE 0812);
- Mining of uranium and thorium ores (NACE 0721);
- Oil extraction (NACE 0610);
- Mining of other non-ferrous metal ores (NACE 0729);
- Support activities for petroleum and natural gas extraction (NACE 0910);

- Extraction of natural gas (NACE 0620);
- Support activities for other mining and quarrying (NACE 0990).

## 7.1. Fuel and Energy Raw Materials Mining Industries

The fuel and energy raw materials are both fossil fuels and uranium ore. Mined fossil fuels include hard coal, lignite, oil, and natural gas. The mining of lignite in the South Moravian Lignite Basin (*Jihomoravská lignitová pánev*) was terminated in 2009.

The Czech Republic still has the reserves of lignite and hard coal. Unfortunately, it does not have sufficient reserves of oil or natural gas. The domestic production of these two strategic mineral fuels is of little economic significance. The potential of unconventional fuel and energy raw materials in the Czech Republic (e.g. shale gas) is currently unknown.

### 7.1.1. Hard Coal

The hard coal, both coking and energetic, is mined in our territory in the Upper Silesian Basin (*Hornoslezská pánev*) - the Czech part is operationally called the Ostrava-Karviná Region. The coal reserves in the Upper Silesian Basin are divided into two areas by the state border, with about 30% of the reserves located in the Czech Republic and 70% in Poland.

The company Ostravsko-karvinské doly a.s. (OKD), which is currently the only one to mine hard coal (HC), operates the Darkov and Karviná mines (Mining plant / *Důlní závod 1*) and ČSM Stonava mine (Mining Plant / *Důlní závod 2*). On 31<sup>st</sup> March 2017, OKD terminated mining at the loss-making Paskov Mine in the Frýdek-Místek Region (*Útlum-Jih Mining Plant*). At present, the backfilling of the open pits of the Paskov mine has been ongoing.

Our hard coal deposits traditionally supply the input raw material not only to power engineering but, above all, to the metallurgical industry represented by Czech smelters and some metallurgical plants in the Central European region.

### 7.1.2. Lignite

Lignite is mined from the deposits located in the area of the Ore Mountains lignite basins (*Rudohorské hnědouhelné pánve*) (North Bohemian and Sokolovská).

The largest North Bohemian lignite basin is further divided into three parts (Chomutov, Most and Teplice).

Coal is mined by Severní energetická a.s. (SevEn) in the ČSA quarry, by Vršanská uhelná a.s. (VU) in the Vršany quarry and by Severočeské doly a.s. (SD) in the Bílina and Libouš quarries. Characteristic for this area is open-cast mining. Deep mining at the last mine called Centrum was stopped in April 2016 and, on 21 December 2016, the mine was closed with an airtight concrete plug. Considering the location of the reserves, these have to be currently deep mined in the side slopes of the ČSA quarry (Severní energetická a.s.). Miners were transferred from the Centrum Mine to work on this section.

Another source of lignite is the Sokolovská basin with Sokolovská uhelná a.s. (SU) as the local mining company. The coal is mined in the Jiří quarry there exclusively by surface mining.

The Mining of coal graph shows a decrease in the amount mined in both commodities the hard coal and lignite.

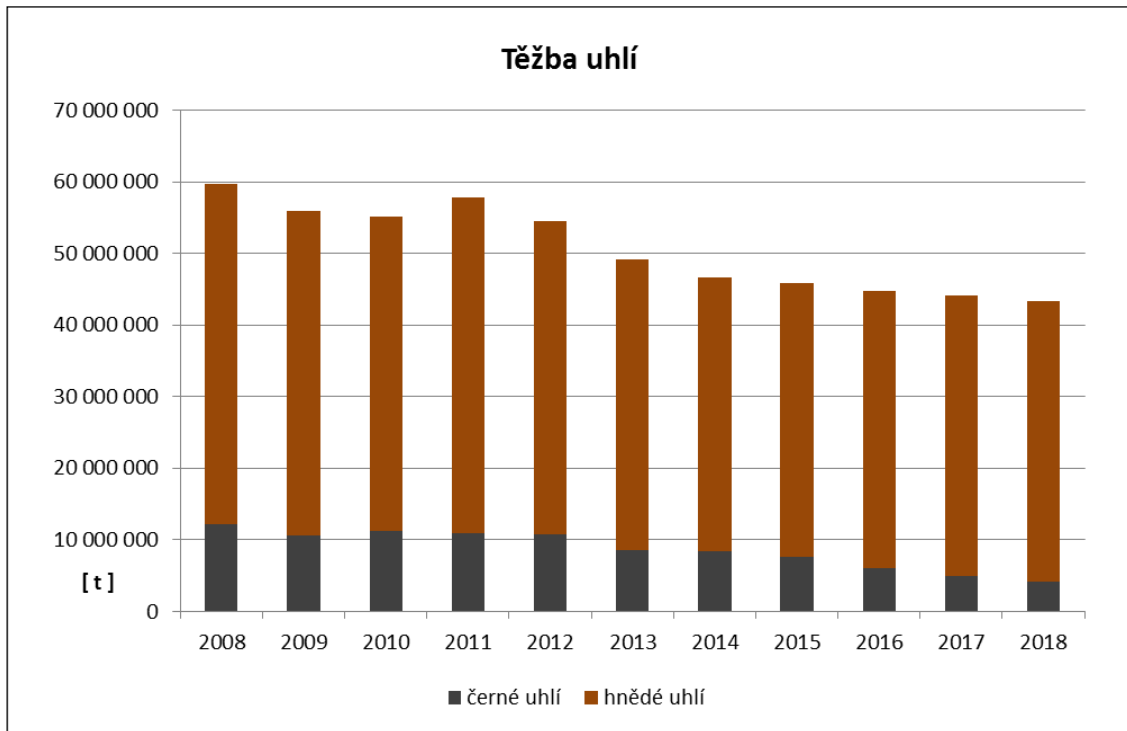


Figure 7 Mining of coal

Source: Ministry of Industry and Trade

In our country, hard coal is mined by the mining company OKD a.s. and, just like the other parts of the world, it has also been affected by the unfavourable situation in this market. The priority nowadays is to keep at least a part of the mining sites in operation even though there is a general reduction of activities in the field. The effort to fully use the mined reserves in the Moravian-Silesian Region also has a significant social dimension.

Lignite is primarily connected with the domestic supply of energy to households. In this consumption sector, the gradual restructuring of large and commercial energy consumption as well as the gradual change in household heating (e.g. replacement with natural gas) is particularly evident.

## 7.2. Outline of Future Hard Coal and Lignite Mining

The mission of the mining industry is to mine minerals for the Czech economy, i.e. for supplying energy and for providing industry and agriculture with the necessary input raw materials.

The topic number one is currently the energy use of coal, i.e. its use in coal (steam) power plants, heating plants and households. The issue of coal in relation to other methods of energy production (nuclear power plants, gas, and renewable energy sources) is to be dealt with by a recently established Coal Commission. Before this commission achieves any results in its work, we present here the current views of possible coal mining.

### 7.2.1. Outlook for Lignite Mining

The life outlooks and possible changes in the fuel base are based on a questionnaire survey from 2017 that starts with the year 2016. The mining outlooks correspond (or corresponded at the time of their compilation - mid-2017) to the intentions of the mining companies. Mining companies often work with a minimum and maximum outlook.

In August 2019, the Coal Commission began to perform its activities the result of which will probably be a new plan for solving coal-related issues in the Czech Republic, including the updating of mining at individual lignite quarries and OKD mines.

The current lignite mining figures are just below the level of 40 million tons. According to its prospects, mining it will gradually decline.

Shortly after 2020, mining at the Czechoslovak Army Quarry (*Lom Československej armády*) will end (Severní energetická a.s., SevEn).

Table 23 Outlook for lignite mining [mil.t]

	2018	2020	2025	2030	2035	2040	2045	2050
Vršany (VU) Quarry	7.77	7.50	6.00	6.00	6.00	5.40	5.40	5.40
Libouš (SD) Quarry	11.45	12.00	9.50	9.50	5.00	0.00	0.00	0.00
Jiří and Družba (SU) Quarries	6.85	6.30	5.50	5.50	5.00	0.00	0.00	0.00
Bílina (SD) Quarry	9.45	9.60	8.50	8.50	7.00	4.50	4.50	4.50
ČSA (SevEn) Quarry	3.67	3.60	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>39.19</b>	<b>39.00</b>	<b>29.50</b>	<b>29.50</b>	<b>23.00</b>	<b>9.90</b>	<b>9.90</b>	<b>9.90</b>

Source: Ministry of Industry and Trade

Around 2040, the mining at the Jiří and Družba Quarries (Sokolovská uhelná, legal successor, a.s., SU) and the Libouš Quarry (Severočeské doly a.s., SD) will be terminated. After 2040, mining will only take place at the Bílina Quarry (Severočeské doly a.s., SD) and the Vršany Quarry (Vršanská uhelná a.s., VU).

However, mining in these quarries is also questionable. The Bílina Quarry is still in the process of obtaining a permit for mining until 2035, and the life of the Vršany Quarry depends, among other things, on sufficient demand for coal from this quarry.

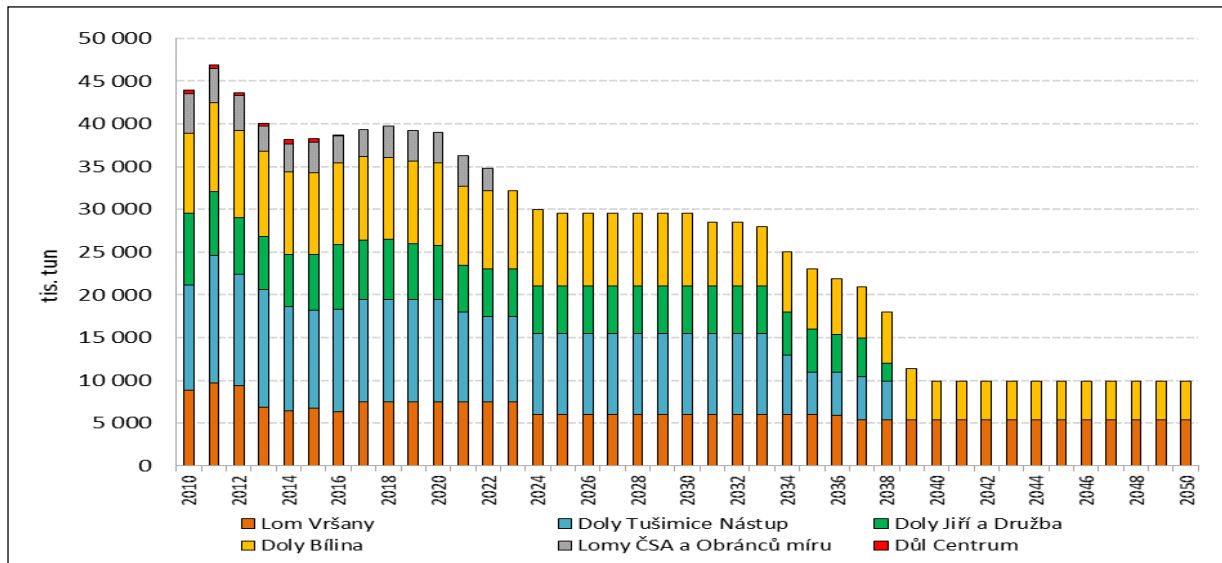


Figure 8 Outlook for lignite mining by individual quarries [thousand tonnes]

Source: Ministry of Industry and Trade

### 7.3. Outlook for Hard Coal Mining

The expected hard coal outlook is based on the OKD, a.s. restructuring / reorganization plan. According to this plan, hard coal mining should be completely stopped as early as in 2023.

However, according to some forecasts the mining in OKD should continue until 2030. This is, however, possible under the assumption of favourable economic results.

Table 24 Outlook hard coal mining [mil.t]

	2016	2017	2018	2019	2020	2021	2022	2023
Karviná Quarry	2.10	1.50	1.95	1.70	1.60	1.00	0.00	0.00
Darkov Quarry	1.30	1.00	0.00	0.00	0.00	0.00	0.00	0.00
ČSM Quarry	2.40	2.70	2.60	2.60	2.65	2.50	1.85	1.45
Paskov Quarry	0.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>6.57</b>	<b>5.20</b>	<b>4.55</b>	<b>4.30</b>	<b>4.25</b>	<b>3.50</b>	<b>1.85</b>	<b>1.45</b>

Source: Ministry of Industry and Trade

Even so, this does not necessarily mean the end of the use of hard coal in the Czech Republic as a certain volume of such coal can be purchased from abroad.

The table and graph show the original overview of mining according to the Restructuring Plan.

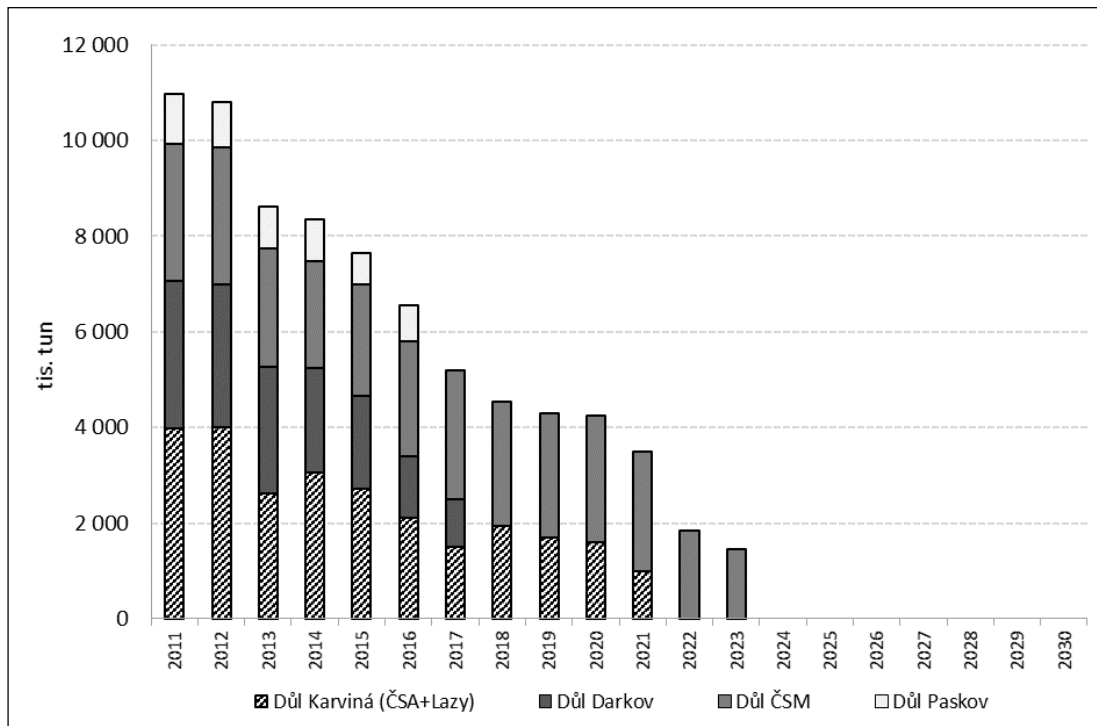


Figure 9 Outlook hard coal mining [thousand tonnes]

Source: Ministry of Industry and Trade

## 7.4. PESTEL Analysis of Industry

The PESTEL analysis includes six factors: political, economic, social, technological, environmental, and legal. In the following text, the selected part of the factors is being examined.

### 7.4.1. Political and Legal Factors

#### Influence of Political Decisions

The decisions made as a result of a current political situation influencing such a situation in the long run have a great effect on the mining industry. In many cases, these are irreversible steps, for example, when closing a mine or stopping using a deposit before its mineral is fully recovered. Another typical feature of the mining industry is that many strategic decisions need to be made well in advance, as their implementation is very time consuming. Therefore, the willingness of political elites to deal with the decisions the implementation of which exceeds one election period in advance needs to be strengthened.

### **Reserved and Non-Reserved Minerals and Their Deposits**

The minerals defined in Act No. 44/1988 Coll. on the protection and use of mineral resources (Mining Act) as amended can be classified as reserved and non-reserved. Natural accumulations of reserved minerals form reserved mineral deposits which constitute the mineral wealth of the country and are owned by the Czech Republic. The deposits of non-reserved minerals (especially sand and gravel, crushed stone, and brick clay) are a constituent part of the land as stipulated in paragraph 7 of the Mining Act. It is no longer possible to reclassify significant non-reserved mineral deposits as reserved, due to the 1991 amendment to Mining Act. The decisions of administrative agencies in this matter issued and effective before the amendment came into force remain valid as per the transitional provisions of Act (Section 43 and 43a thereof). The deposits specified by these decisions are still reserved deposits, i.e. owned by the state and are considered to be separated from the land itself.

### **Legislative Instruments**

#### **Mining Law**

The basic legislative instrument of the raw materials policy is the mining law, namely the acts concerning the use of mineral resources, i.e. Act No. 44/1988 Coll. on the protection and use of mineral wealth (Mining Act) as amended and related legislation; Act No. 61/1988 Coll., on mining activities, explosives and sState Mining Administration as amended and related legal regulations;

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Act No. 157/2009 Coll. on the management of mining waste and on the amendment to certain acts as amended by Act No. 168/2013 Coll. and Act No. 62/1988 Coll. on geological works.

### **Building Law**

Another important legislative instrument concerning the use of mineral wealth is Act No. 183/2006 Coll. on spatial planning and building regulations as amended (Building Act).

### **Environmental Legislation**

The environmental legislation is extremely important for the raw materials industry. The adherence to the applicable environmental protection standards is a prerequisite for the successful and socially acceptable use of mineral wealth. At the same time, it is desirable from the perspective of those standards to set realistic and long-term conditions for the extraction and processing of minerals and to promote the prudent use of mineral wealth using the latest methods and technologies available.

An important phenomenon that significantly affects the use of minerals is the growing importance of a wide range of ecological criteria, both at the European and national levels. It is necessary to strictly supervise this aspect of mining. At the same time it should be noted that there are many cases on the global scale, in the EU and in the Czech Republic where the use of minerals has a very small negative impact on the environment although it is evident that the extent of the mining impact on the environment varies from case to case. These "best practices" need to be promoted and their maximum use has to be ensured. In other cases, it is desirable to take appropriate measures to eliminate or minimize the negative effects of mining on the environment.

Below is a summary of selected legal regulations on mineral prospecting and exploration effective as of June 30, 2017:

### **Acts**

- Act No. 44/1988 Coll. on mineral protection and use (Mining Act);

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- Act No. 61/1988 Coll. on mining operations, explosives, and State Mining Administration;
- Act No. 62/1988 Coll. on geological works;
  - Act No. 157/2009 Coll. on mining waste treatment and on amendment to certain acts;
  - Act No. 85/2012 Coll., on capturing carbon dioxide into natural rock textures and on amendment to certain acts,

## Other Legal Regulations

### Mineral Deposit Exploitation

- Decree of Czech Mining Authority No. 104/1988 Coll., on the efficient use of reserved deposits, permits and notification of mining activities and other activities using mining methods;
- Decree of Czech Mining Authority No. 415/1991 Coll. on construction, the elaboration of documentation and the determination of safety pillars, rods and zones for the protection of underground and open-cast sites in the wording of Decree of Czech Mining Authority No. 340/1992 Coll. and Act No. 331/2002 Coll.;
- Decree of Czech Mining Authority No. 172/1992 Coll. on mining claims in the wording of Decree No. 351/2000 Coll.;
- Decree of Czech Mining Authority No. 175/1992 Coll. on the conditions of non-reserved mineral deposit exploitation in the wording of the Decree No. 298/2005 Coll.;
- Decree of the Ministry of Environment of the Czech Republic No. 363/1992 Coll. on the survey and registry of old mine workings in the wording of the Decree of the Ministry of Environment No. 368/2004 Coll.;

- Decree of the Ministry of Environment of the Czech Republic No. 364/1992 Coll. on protected deposit areas;
- Decree of Czech Mining Authority No. 435/1992 Coll. on mine surveying documentation during mining and during some operations employing mining methods in the wording of
- Decree of Czech Mining Authority No. 158/1997 Coll., Decree No. 298/2005 Coll. and Decree No. 382/2012 Coll.;
- Decree of the Ministry of Economic Policies and Development No. 497/1992 Coll., on the inventory of reserves of reserved mineral deposits;
- Ordinance No. 98/2016 Coll. on royalty tariffs (of mined out minerals).

### Geological Activities

- Decree of the Ministry of Environment No. 282/2001 Coll. on the registration of geological activities in the wording of Decree of the Ministry of Environment No. 368/2004 Coll.;
- Decree of the Ministry of Environment No. 368/2004 Coll. on geological documentation;
- Decree of the Ministry of Environment No. 369/2004 Coll. on the planning, execution and evaluation of geological activities , announcing geohazards, and on the procedure for estimating reserves of reserved deposits as amended by Decree of the Ministry of Environment No.18/2009 Coll.;
- Decree of Czech Mining Authority No. 298/2005 Coll. on the requirements for professional qualification and competence in mining or in the activities employing mining methods and on amendments to certain acts in the wording of Decree No. 240/2006 Coll. and Decree No. 378/2012 Coll.;
- Decree of Czech Mining Authority No. 15/1995 Coll. on the licensing of mining activities and the activities employing mining methods as well as on designing sites and installations

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forming part of such activities in the wording of Decree No. 298/2005 Coll. and Decree No. 380/2012 Coll.;

- Decree of the Ministry of Environment of the Czech Republic No. 206/2001 Coll. on the certificate of qualification for planning, executing, and evaluating geological work.

### **Foreign Policy - Raw Materials Diplomacy**

The exploration, mining and processing companies can be supported through the promotion of participation in mining fairs and international diplomacy in the sector , all that by, for example, including the topic of minerals in the agenda of Joint Intergovernmental Commissions for

### **Economic Cooperation**

It is desirable to strengthen this "diplomacy" mainly in producer or transit countries, the traditional target countries of our industry and in the developing countries with great market potential for raw materials, especially for mining and raw material processing technologies.

It is also important to focus on raising the awareness of Czech companies, and actively searching for business opportunities and political support at the local level and to support Czech entities in their involvement in foreign projects in the field of research, exploration, geological exploration and the use of minerals.

#### **7.4.2. Economic Factors**

##### **Macroeconomic Indicators of Sector**

In the Mining Industry sector, approximately 1.2% of the total added value of the entire Czech economy is produced. From this point of view, it is the 3<sup>rd</sup> smallest industry in the Czech Republic. As regards the exported volumes, it is the 9<sup>th</sup> smallest industry. It is, however, the 10<sup>th</sup> largest industry in the Czech Republic considering its imported volumes.

The labour productivity of the Mining Industry sector is the 4<sup>th</sup> largest of all branches of the Czech economy. It is at the level of 178% of the average labour productivity in the Czech Republic. In

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comparison with the labour productivity in the EU28 sector, the labour productivity in the Czech Republic is, nevertheless, lower (which applies to all but one sector). The labour productivity in this sector in the Czech Republic is at the level of 34% of the labour productivity in the same sector in EU28. This is 18 percentage points less than the total labour productivity of the Czech economy compared to the labour productivity of EU28.

### **Number of Employees**

The increase in labour productivity, which was higher in the Czech Mining Industry sector than the growth in total production, caused a decrease in the number of employees between the years 2000 and 2014. Since 2000, their number has decreased by almost 35,000, i.e. by about 49.3%. In 2014, less than 36,000 people were employed in this sector in the Czech Republic. The sector's share in total employment in the Czech Republic decreased from 1.5% to 0.7% between the years 2000 and 2014. When considering the share of the Mining Industry sector in total employment and when compared to its share in EU28, its share is higher in the Czech Republic (in EU28, it represents as little as 0.3% of total employment). The following graph compares the share of this sector in total employment in individual EU28 countries.

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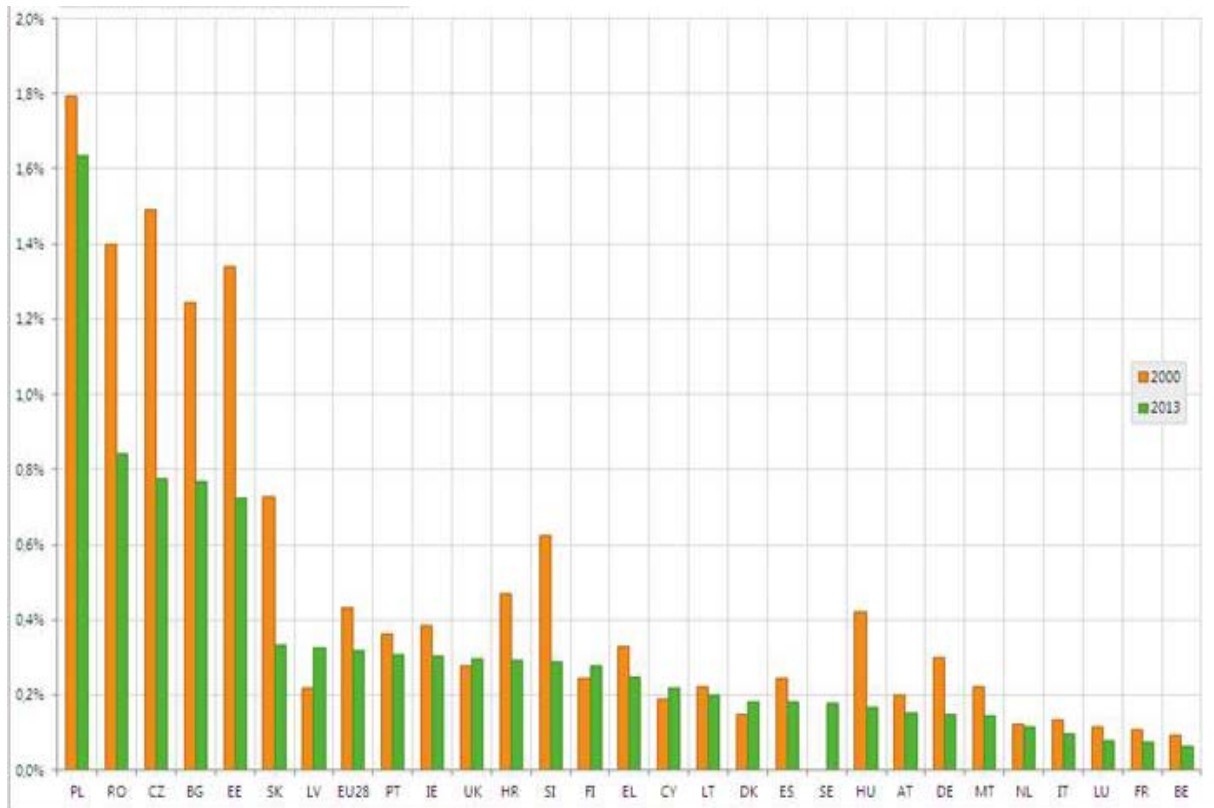


Figure 10 Share of mining sector in total employment in individual EU28 countries"

The number of jobs in the Mining Industry is expected to be reduced by 2025. Their number should fall by about 2,000 between the years 2014 and 2025, i.e. by about 6%. However, this does not mean that there will be no need to fill any new job positions in this sector by 2025. By 2025, around 7,000 people should have left their jobs in this sector (mainly due to their retirement). Overall, it can be expected that by 2025, the Mining Industry sector will need to fill some 5,000 new job positions.

### 7.4.3. Social Factors

#### Social Perception of Mining Industry and Raw Materials Sector in General

The social perception of the mining sector is burdened by many stereotypes, such as the fact that the extraction of raw materials is inherently destructive. However, there are mining methods that are environmentally friendly and projects that have a minimal impact on the environment.

Moreover, many of today's extremely valuable nature reserves were created in the sites of former quarries. Such cases need to be supported and the projects for the mutually beneficial coexistence of the use of minerals and the environment should be mediated. At the same time, it is necessary to draw on appropriate experience from abroad, for example, from Austria or from the Nordic countries, which shows that the use of minerals and an advanced society can coexist very advantageously.

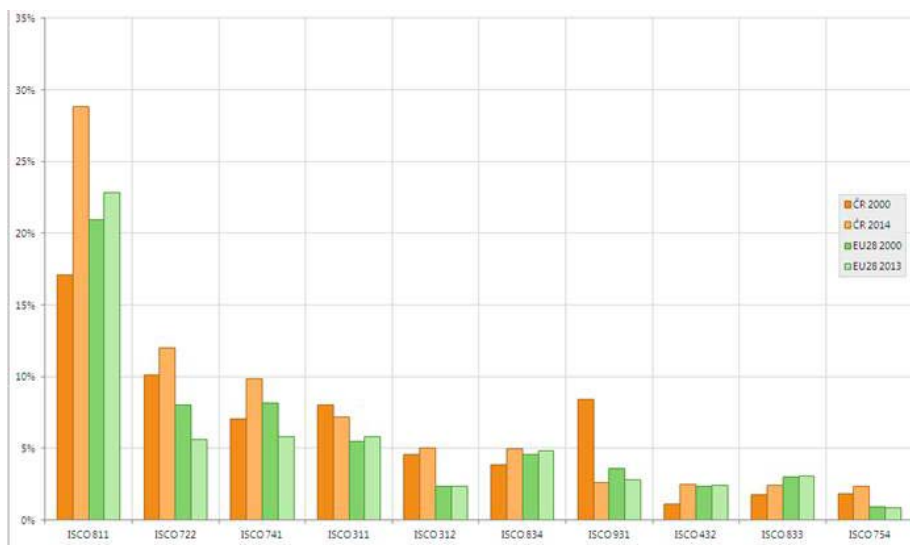


Figure 11 Largest groups of occupations

### Structure of Occupational Groups

In the Mining Industry sector, there were five groups of occupations in the Czech Republic in 2014, which accounted for at least 5% of the total number of employees in this sector. The largest group of occupations is the operator of mining and processing equipment (ISCO 811), which has a share of about 29% of those employed in this sector. The concentration of occupations is high in this sector. The comparison of the share of the largest groups of occupations in this sector in the Czech Republic and in EU28 can be seen in the following graph.

Asi tu chýba graf

## Regional Distribution

The largest number of those working in the Mining Industry sector is employed in the Moravian-Silesian Region (*Moravskoslezský kraj*). Almost 44% of all employees in this sector work in this region. Other more than 16% work in the Ústí Region, more than 12% in the Karlovy Vary Region, more than 6% in the South Moravian Region (*Jihomoravský kraj*) and also in the Central Bohemian Region (*Středočeský kraj*). In comparison with other industries, there is a clear pattern of this industry's geographical concentration in the Czech Republic.

The geographical exclusivity of this sector is very low in the Czech Republic. This sector has the largest share in the total regional number of employees in the Karlovy Vary region where the Mining Industry makes up more than 3% of all employees in the region.

The vast majority of people in this sector work, as is the case in the whole Czech Republic, in the same region where they live. Only 1.9% of people work in another region, which is 4.1 percentage points less than the average in the whole Czech Republic.

## Educational Structure

The largest proportion of people in this sector have a high school graduation education. Persons for whom this level of education as highest account for almost 61% of all the employed in the Mining Industry. The second largest group in this branch consists of people. Their employment share in this sector is almost 25%. Almost 9% of people with tertiary education are in this sector. Among persons with tertiary education, the largest part, 73%, comprises persons with a master's degree and 15% of them have a bachelor's degree.

On average, all those employed in this sector have 11.3 years of education. This is 1.1 years less than the average of all the employed in the Czech Republic. Compared to other sectors, the average years of education in this sector is the 4<sup>th</sup> lowest.

When focusing not only on the level of education but also on the field of study, it can be seen that most people in this branch have secondary school education in Mechanical Engineering, Metal Production and Metallurgy. These people account for more than 17% of the industry. The second largest group in this sector are people who have high school non-secondary education with a degree in Mining and Extraction. They account for more than 14% of the industry. Other significantly represented educational groups are as follows:

- Secondary school non-graduate education in the field of Electrical Engineering and Power Engineering;
- Secondary school non-graduate education in the field of Civil Engineering; ,
- High school diploma in the field of Electrical Engineering and Power Engineering;
- Secondary school non-secondary education in the field of Motor Vehicles, Ships and Aircraft;
- Elementary general education;
- High school diploma in the field of Mechanical Engineering, Metal Production and Metallurgy;
- High school diploma in the field of Mining and Extraction;
- Tertiary education in the field of Mining and Extraction.

### **Gender and Age Characteristics**

In the Czech Mining Industry sector, men represent the dominant group of employees. They account for almost 90% of all employees in this group of occupations. It represents 33 percentage points more than the share of men in the number of all employees in the Czech Republic.

The average age of the employed in this sector is 45.3 years. This is 2.8 years more than the average age of all employees in the Czech Republic. The mining industry is the 2<sup>nd</sup> oldest of all the industries in the Czech Republic.

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Of all the employed in the sector, 5% are recent graduates, i.e. those who left the education system in the last five years. This is four percentage points less than their share in the number of all the employees in the Czech Republic. Compared to other industries, the attractiveness of this industry for recent graduates is below average.

### Job Qualification Required

Job qualification intensity is an indicator that includes not only the education needed for the job but also further training in the form of practical experience. The higher the degree, the higher the qualification requirements for a given job. The total level of job qualification intensity (requirements) in the Czech Mining Industry sector in 2013 was 3.32 points (on an eight-point scale). This is 0.75 points less than the qualification intensity of all the jobs in the Czech Republic. In EU28, the level of job qualification requirements in this sector was 3.07 points in 2013. It was 0.25 points lower than the qualification intensity of jobs in this sector in the Czech Republic. Compared to all the jobs in EU28, the job skills intensity in the Mining sector is by 1.88 points lower than the job skills intensity in EU28. **Chyba! Nenašel sa žiaden zdroj odkazov.** shows the total number of jobs in the occupational groups with the degree of qualification intensity (1-8) for the Czech mining industry (orange), for the Czech Republic in total (hatched orange) and for EU28 (hatched green).

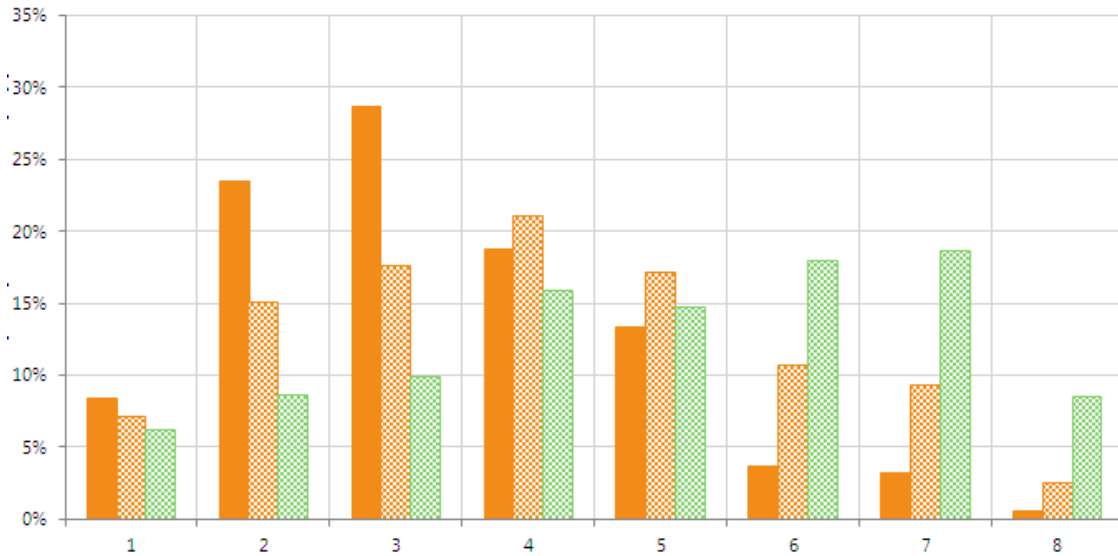


Figure 12 Job structure by the degree of qualification intensity, 2013, Czech Republic

#### 7.4.4. Technological Factors

##### Positive Influence of New and Advanced Technologies, Especially Material-Saving Ones

The maturity of a company can also be measured by material efficiency, i.e. the real use of material-saving technologies. The development of recycling and reuse of the maximum possible part of primary resources saves these non-renewable resources. In the field of material-saving technologies, the world's most developed countries (Japan, South Korea, and Finland) whose solutions in this area are very inspiring are at the top. In addition to taking over the “best practices” in this area, the support of science and research projects in the field of raw material utilization, waste-free technologies, efficient and smart recycling, etc. are being discussed intensely these days

The raw materials sector all over the world underwent a fundamental change in the first decade of the new century. Many countries, which used to be known as producers and exporters of minerals, have become their consumers or even importers in some cases. New consumption centres have been formed and new mining methods and raw material processing technologies have been developed. The foreign policy tactics for accessing minerals in producer countries and territories have changed. There is a shift to active raw materials diplomacy and cooperation. New raw material

alliances are currently being formed around the world, and many global players are gaining their sovereign access to mineral deposits in other countries, for example in exchange for building infrastructure or in the form of shares in joint ventures. The vast majority of global players pay great attention to the issue of raw materials diplomacy. Asian countries, especially Japan, South Korea, and China, are extremely active in this area worldwide.

### **Mining and Processing of High-Tech Raw Materials**

With the development of modern technologies, such as computers, mobile phones, LCD screens, optics and in connection with completely new production fields, such as nanotechnology, there is a gradual shift of interest from traditional mineral commodities to special commodities that were not previously used or were even considered undesirable admixtures of "main" raw materials. These are mainly various strategic metals or minor metals, and critical raw materials of the EU, some special non-metals included. Many of these commodities are present in economically interesting concentrations in, for instance, sludge ponds or in other former raw material mining and processing relics. These concentrations are mostly seen as unwanted material and environmental burdens. In some cases, however, they may be a secondary deposit of extremely valuable raw materials. The demand for these commodities is not based on their volumes but on their value resulting in their products being of extremely high added value. Given the fact that these surveys have not focused on such new commodities, the government does not have relevant information on domestic potential in this highly promising segment of mineral resources.

The time (approx. 25 to 30 years) gained should be devoted to the scientific research of mining and processing technologies which would enable a comprehensive use of indispensable uranium ore reserves in the North Bohemian Cretaceous (*Severočeská křída*) in the future in the way that would not permanently damage the environment, in order to obtain a scientifically based response to the question of whether these reserves might be of use in the future or not.

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## **Intentions Concerning Use of Raw Materials from Past Mining As waste**

With the advent of new technologies, the use of raw materials from dumps and sludge ponds, which have not yet been subject to further use, is becoming economically interesting. These are mainly critical raw materials and metals. The intention is to define and evaluate these sources of raw materials and analyse the technological possibilities of their obtaining. On the basis of the survey conducted so far, the selected sources are to be placed in the existing mining waste category and promising areas of them as sources are to be defined. The methods of their technological processing, of the possibility of using innovative mining methods and methods of ecological monitoring of processing and mining are to be analysed. New recycling technologies, the output of which are substances of comparable quality with the starting raw materials (extraction of accompanying / critical metals from sludge ponds and dumps), should be monitored. The selected sites should be also classified based on the extent of their exploration.

### **7.4.5. Environmental Factors**

The last major trend that significantly affects the use of minerals is an increased importance of a wide range of environmental restrictions. From the past, i.e. from the period of an extensive use of mineral wealth, the view persists that the mining industry as such is inherently destructive to the environment. However, there has been a significant change in this area in the last two decades. The interventions in the environment are, in many cases, very well compensated in the Czech Republic. This is thanks to the set remediation and reclamation mechanism, the creation of financial reserves, supervision, etc. Mining companies are also feeling increasingly responsible for the scale of the impact of their activities and for minimising such a scale. There are a number of cases, especially from the last two decades, showing that the way of solving the environmental side of the project or the use of latest mining or processing technologies is on a high technical level. Such a condition is desirable and should become a common practice. On the other hand, the cases where the extraction of minerals is of provable harm to the environment must be strictly assessed according to the applicable environmental legislation.

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An important phenomenon that significantly affects the use of minerals is the growing importance of a wide range of ecological criteria, both at the European and national levels. The strict ecological supervision of mining is necessary. It is also to mention that there are many cases in the world, in the EU and in the Czech Republic where the use of minerals has a very small negative impact on the environment, although it is evident that the extent into which mining affects the environment varies from case to case. These "best practices" need to be promoted and their maximum use must be ensured. In other cases, it is desirable to take appropriate measures to eliminate or minimize the negative effects of mining on the environment.

The financial reserve for remediation, reclamation and elimination of damages caused by mining companies during the use of deposits of reserved minerals is an important source for solving the elimination of damages caused by mining activities. Legislatively, the need to create financial reserves for remediation, reclamation and elimination of mining damages is regulated by Act No. 44/1988 Coll. on the protection and use of mineral wealth (Mining Act) and Act No. 593/1992 Coll. on reserves for determining the income tax base as amended.

The reserves are part of the costs of the organization and the quantification of the estimated costs of remediation and reclamation is part of the plan for the opening, preparation and mining of exclusive deposits and the application for mining area classification. The funds for the remediation and reclamation of exclusive deposits are deposited in an escrow account and, with the consent of the Mining Authority, it is possible to draw them from such an account for the purposes intended for the site. However, the obligation to create a financial reserve for remediation and reclamation is not enshrined in legislation for non-exclusive deposits, and thus these deposits fall into a different legal and financial regime.

Mining companies perform both technical and nature-friendly reclamation, with the latter of which being logically cheaper. There are a number of cases of successful quality remediation and

reclamation projects when, upon mining termination, mining works have become unique natural monuments. These "best practices" should also be encouraged.

The financial reserve for mining damages is used to settle such damages. The mining company is obliged to create a reserve of funds and the amount of the reserve created to cover the related expenses must correspond to the needs of the settlement of mining damages in the time course of their occurrence, or in advance, i.e. before their occurrence. The creation of reserves based on a mining company's proposal is subject to approval by the relevant district mining authority, which approves the updating of the amount of reserves and the drawing from them in agreement with the Ministry of the Environment. The District Mining Authority shall request the opinion of the municipality concerned before issuing a decision on drawing from these reserves. The organization's request for drawing from the financial reserve for mining damages must be substantiated by a list of mining damages, an estimate of the costs of their elimination and stages of drawing funds for the elimination of mining damages. Moreover, the District Mining Authority checks the above drawing. It is also necessary to continue performing thorough checks concerning the maintenance of reserves and ensuring their enforcement.

### **Mining and Nature Protection**

As of December 31<sup>st</sup>, 2015, there have been 1,504 reserved and 875 non-reserved mineral deposits registered in the Czech Republic. The number of the exploited deposits has been significantly lower – 507 reserved and 221 non-reserved ones. Only 39 reserved and 11 non-reserved deposits have been mined in special nature conservation areas; these represent 2.59 % and 1.25 % of the total number, respectively.

### **Programmes Dealing with Ecological Damages in Moravian-Silesian and South Moravian Regions**

After the privatisation of mining companies, the financial settlement of related ecological damages was not resolved in an appropriate manner within the scope of privatisation projects. However, within the scope given, the companies took over from the state not only mining localities but also

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extensive areas which were designated for revitalisation and for which a required financial reserve had not been generated in the past.

Mining companies have only been obliged to generate a financial reserve for the remediation and reclamation of the areas affected by mining since 1994, all that on the basis of an amendment (No. 168/1993 Coll.) to Mining Act.

In 2010, the Government approved the use of CZK 1 billion for the revitalisation of the Moravian-Silesian Region in order to finance the environmental activities performed by a state enterprise DIAMO. In 2017, the Government approved the amount of CZK 250 million from the same source for the implementation of measures designed to prevent the spread of pollution from old environmental burdens present in mine water caused by past metallurgical activities on the premises of Poldi Kladno Steelworks. Thus, the programme of revitalisation of the Moravian-Silesian Region and the liquidation of oil-gas wells in the South Moravian Region have not allocated with CZK 21 billion but only 19.750.

### **Revitalisation of Moravian-Silesian and South Moravian Region**

Currently, the revitalisation of the Moravian-Silesian Region is aimed primarily at the elimination of consequences of the ecological burden caused by bituminous coal mining and, in the case of the South Bohemian Region, at the elimination of the ecological burdens caused by the exploration for and extraction of crude oil and natural gas.

As of 31<sup>st</sup> December 2016, the funds actually spent on **134** finished projects amount to about **5.442 billion CZK** and the funds for **46** on-going projects to about **CZK 2.275 billion**.

## 8. Case Study of Selected Company Associated with Mining and Raw Materials

### 8.1. DIAMO, state enterprise

The main reason for describing DIAMO in our study is to present a typical company in the field of raw materials, which currently employs over 2,000 workers. This company is also one of the typical companies where students from the fields of mining and geology of the College of Mining, Technical University of Ostrava (*VŠB TUO*) continue their professional career. Coal mining tends to slow down across Europe. The reason we chose this company was its post-mining activities as the main scope of business.

### 8.2. Company Introduction

**DIAMO**, state enterprise, with its registered seat at Stráž pod Ralskem, is an organisation dealing with elimination of consequences of mining activities after uranium, ore, and partially also coal mining in the Czech Republic.

The attenuation and remediation programme follow the state policy for progressive improvement of the quality of environment and elimination of old environmental burdens with state funding. The programme consists of:

- Implementation of an attenuation programme in uranium industry with the elimination of consequences of the survey, mining, treatment, and processing of uranium from uranium deposits, commenced in 1989;
- Completion of the process of elimination of consequences of mining and processing of ores in the context of attenuation of ore mining, commenced by the Czech Government in 1990 and taken over from a wound-up state enterprise Ore Mines of Příbram (Rudné doly Příbram) in 2001;

- The liquidation and remediation work after coal mining in the Rosice-Oslavany Basin and in the area of lignite mines around Hodonín, commenced in the context of attenuation of coal mining in the years 1990 and 1991 and taken over by a state enterprise Ore Mines of Příbram in 2001;
- Liquidation and remediation work after hard coal mining in the attenuated part of the Ostrava-Karviná District, commenced in 1991 and taken over from OKD, a.s., Ostrava in 2002;
- Elimination of the environmental burden of former refinery production of a state enterprise OSTRAMO in Ostrava, taken over in 1997.



*Figure 13 Historical activities, DIAMO company*

The concept of the performed liquidation and remediation work is based on individual resolutions of the Government of the Czech Republic; for the individual localities, the concept is

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described in the technical projects of liquidation and remediation. The elimination of consequences of the survey, mining and processing of the above-mentioned raw materials is performed in compliance with strict requirements for environmental protection and its development.

The remediation of mining activity consequences also covers the payment of social and health benefits to the former and current employees of DIAMO, s.p., including all the organizations the successor company of which DIAMO, s.p., became.

### 8.3. Current Activities

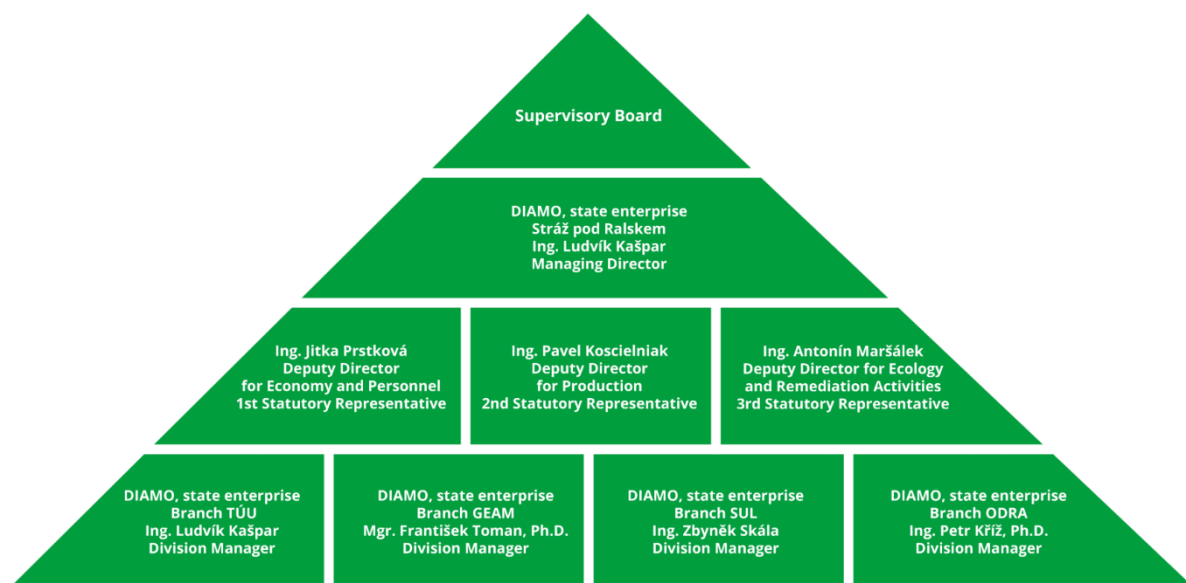


Figure 14 Management hierarchy, DIAMO Company

#### 8.3.1. SUL – Uranium Deposit Management

The Uranium Deposits Management branch is responsible for the liquidated uranium mining and processing capacities and other ore deposits in the territory of Bohemia, outside the North Bohemian and East Bohemian regions. Altogether, there are 19 uranium and other ore post-mining sub-areas with more than five thousand registered burdens.

In recent years, work has continued on the burdens formed by uranium ore mining and processing, all that in accordance with the updated attenuation projects for individual regions and within the scope of the allocated state budget funds.

A significant phenomenon in the branch plant activities is the treatment of mine water in the Příbram area. This is ensured primarily through the newly built large-capacity mine water treatment plant in the area of former shaft No. 19. Considering the possibility of extreme water inflows into the deposit, its capacity has been strengthened by the reconstruction of the older ČDV-1 Bytíz (*Mining Water Treatment Plant*).

The process of eliminating consequences of the activities of the MAPE Mydlovary chemical treatment plant also covers the remediation of sludge fields K I - 4, K III, and K IV / D. DIAMO received funds from the Operational Program Environment of the Czech Republic, co-financed from the EU and designed for the rehabilitation and reclamation of the chemical treatment plant and sludge pond K IV / D.

The mitigation of the consequences of mining activities and the elimination of emergency situations take place mainly in the localities of Horní Slavkov, Jáchymov, and Příbram.

A continuous activity performed is the technical monitoring of abandoned mining works and of the selected components of the environment in all problem areas.

### **8.3.2. TÚU – Uranium Mining and Processing**

The Uranium Mining and Processing (TÚU) branch plant (*Těžba a úprava uranu, odštěpný závod*) in Stráž pod Ralskem has been performing mining activities since 1993. Moreover, it has been terminating deep and chemical uranium mining (i.e. underground uranium leaching through surface drilling) since 1996.

It is crucial to mitigate the consequences of deep and chemical uranium mining in the Česká Lípa region. Uranium mining had been significantly affecting the character of the landscape in this area by building plants and equipment for uranium ore mining and processing for more than thirty

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years. This, in turn, affected the groundwater and employment in the region and thousands of human destinies.

The beginnings of mining development date back to 1962 when several rich uranium deposits were discovered and confirmed in the following years in the area of operation of today's TÚU branch plant in Stráž pod Ralskem. The beginnings of deep mining date back to 1965, when the excavation of the first pit began (unsuccessfully). The beginnings of chemical mining date back to 1967, when the first leaching experiments were carried out and the first kilograms of uranium concentrate were produced.

The dramatic decline in the price of uranium on free markets in the late 1980s, the slowdown in the construction of nuclear power plants, the termination of arms plants activities and a change in the society's view of uranium mining, especially in terms of its environmental impact, led to the termination of deep and chemical mining and subsequent liquidation of its facilities.

Nowadays, the underground of the mine is safely closed down, the surface objects of the mine, including mine water decontamination technologies, and for the most part the chemical treatment plant, have been removed. The contaminated soil was removed, and the premises became subject to maintenance. Its tailings pond is used as part of the rehabilitation of chemical uranium mining in Stráž pod Ralskem.

At present, the main activity of the TÚU University is the mitigation of the consequences of chemical uranium mining, which is undoubtedly one of the most extensive environmental burdens in the Czech Republic. The basis for "smoothing out" the consequences of chemical mining is the remediation of the rock environment, the elimination of non-operating and unnecessary boreholes and the revitalization of the areas affected by mining activities.

For the purpose of remediation of the rock environment, a complex of unique remediation technologies has been built; it ensures the removal of contaminants from depleted locations. The extensive pumping of locations and the operation of remediation technologies guarantees that the

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underground contamination will not spread in the direction of the natural flow of groundwater outside the existing remediation area. Mathematical models are used to control the pumping of the locations and to optimize the remediation process; they process the results of complete monitoring. In a year, more than 2.9 million m<sup>3</sup> are pumped out of the remediated rock environment, more than 3.1 million m<sup>3</sup> from other locations and process water, more than 140,000 tons of contaminants are discharged from under the ground and about 1.0 million m<sup>3</sup> of mine water is discharged into watercourses.

The comprehensive revitalization of the landscape is then the culmination of restoration of the area affected by uranium mining. It includes surface reclamation and the revitalization of watercourses and works. It is a comprehensive modification of living and non-living components of the environment in order to integrate the areas affected by uranium mining in the Stráž pod Ralskem area into the surrounding landscape. This creates the preconditions for the restoration of ecosystems close to nature and for the restoration of their non-productive (ecological stabilization) and productive functions.

The size of recultivated areas in the conditions of the TÚU ranges from very small areas to tens of hectares. In the conditions of the TÚU, it usually includes a technical part and a biological part.

The basis of the technical part is landscaping. In the planning and implementation phases, the emphasis is placed on a harmonious integration into the surrounding landscape. The basis is to model the surface into the shapes typical for the surrounding landscape that ensure a seamless connection to the surrounding terrain.

The purpose of the biological part of revitalization is to create preconditions for the emergence of richly structured communities. An irreplaceable role in this respect is played by the ecology of restoration, which uses spontaneous or partially controlled succession of vegetation to the maximum extent to restore man-disturbed places. Based on over twenty years of experience, such an approach appears to be the most effective from the material and financial points of view.

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The actual revitalization of watercourses and works represents the restoration of natural water regime of the landscape. In addition to the revitalization of small watercourses, other measures are being taken to retain water in the landscape to decelerate surface runoff. Small ponds, wetlands, or the modification of drainage routes in the form of manholes with meanders and without fortifications, etc. are purposefully created in revitalized areas.

Quality human resources, i.e. teams of educated experts and professionally qualified persons, are used for all activities. O. z. TÚU Stráž pod Ralskem is at a high professional level in this respect and has something to offer other organizations dealing with this issue.

### **8.3.3. GEAM – Mitigation of Consequences of Uranium Mining Activities**

The GEAM Dolní Rožínka branch plant (*odštěpný závod*) performs liquidation work as part of their mitigation of consequences of mining activities. The mitigation includes the remediation of the rock environment affected by deep uranium mining, the removal of unused buildings and technologies and the subsequent revitalization of the landscape.

Mining started in 1957. Since 1968, the Chemical Treatment plant (*Chemická úpravna*) with two currently used sludge ponds has been in operation. There were 11 pits formed when opening the deposit and there are now about 509 km of underground mining tunnels there. The depth of mining has been in the range of 950 to 1,200 m below the surface since 2005. The mining area is 8.76 km<sup>2</sup>. By 2016, 20,220 tons of uranium were mined there.

The GEAM Dolní Rožínka branch plant continued with the selective mining of uranium ore reserves in accordance with Government Resolution No. 1316/2005 of 12<sup>th</sup> October 2005, which approved the continuation of uranium mining and processing at the Rožná deposit until the end of 2008. By Government Resolution No. 565/2007 of 23<sup>rd</sup> May 2007, uranium mining and processing at the Rožná deposit in the Dolní Rožínka locality was extended for the period of the mine's economic profitability without the entitlement to the financial resources of the Czech state budget.

Under Government Resolution No. 50 of 25<sup>th</sup> January 2016, active mining at the Rožná deposit was terminated on 31<sup>st</sup> December 2016.

The mined uranium ore was subsequently processed in the Chemical Treatment plant. The resulting product was a chemical concentrate of uranium - ammonium diuranate. At the Chemical Treatment plant, the elution of U-metal absorbed on the ion exchangers of decontamination stations is also performed during the treatment of mine water. Sodium sulphate is obtained as an accompanying product of the technological process of sewage treatment.

As part of mining activity mitigation, mine water treatment takes place in the localities with terminated mining activities. In recent years, the main GEAM outlet profiles have discharged approximately 6.5 million m<sup>2</sup> of water per year into watercourses, including the treated sludge water from both sludge ponds of the Chemical Treatment Plant (*Chemická úpravná*). The mouths of the abandoned main mining works managed by GEAM in the past and liquidated after the completion of exploration and mining of uranium, polymetallic ores, coal, and lignite, are regularly inspected. Cultivation activities are carried out on recultivated dumps. These include the replanting of damaged forest crops and repairing fencing. Part of the mining, liquidation, and remediation activities is the monitoring of their impact on the environment.

The branch plant has a design department, a construction department and mechanical production, which it uses, among other things, for the production and construction of mine water treatment technology. The plant also operates an accredited centre of testing laboratories, ensures the transport of radioactive substances, the mining rescue service and geological and mining surveying work.

#### **8.3.4. ODRA – Mitigation of Consequences of Other Mining Activities**

The ODRA branch plant (*odštepňý závod*) in Ostrava takes care of the closed mine areas, mitigates the consequences of mining activities in the Ostrava region, remediation and reclamation included, maintains the mine water level by controlled pumping, pays social and health benefits to former

miners, provides anti-methane protection for the entire region and manages the "OSTRAMO Lagoon", the operation of the lagoon water treatment plant included.

The ODRA branch plant was established as a successor company of the closed mines Šverma, Heřmanice, Ostrava and Odra, i.e. mines from the Ostrava part of the district. Incorporated organisationally to the branch plant were the J. Fučík Mine on 1<sup>st</sup> January 1998 and František plants on 1<sup>st</sup> July 1999 and Paskov from the Karviná and southern parts of the district. As of 1<sup>st</sup> January 2002, the ODRA branch plant was transferred to DIAMO, a state-owned enterprise, in accordance with Government Resolution No. 453/2001, through the sale of a part of OKD, a. s. As of 1<sup>st</sup> January 2004, the Barbora site started to fall under . the ODRA branch plant based on the sale of a part of OKD a.s.. in accordance with Government Resolution No. 1128/2003.

As a result of an organizational change, the Rehabilitation Work branch plant (*Odštěpný závod SAP/Sanační práce*) was abolished on 1<sup>st</sup> February 2007 and incorporated into the organizational structure of the ODRA branch plant as Lagoons Centre (*Středisko Laguny*). As of 1<sup>st</sup> January 2011, the Lagoons Centre was organizationally integrated into the Surface Centre (*Středisko Povrch*). As of 1<sup>st</sup> March 2019, the Lagoon Water Treatment Plant (*Čistírna lagunových vod*) was transferred to the administration of the ODRA branch plant. The ODRA branch plant is in the stage of advanced mining decline and organizationally consists of the Mine and Surface Centres (*Středisko Důl a středisko Povrch*) and special management departments headed by the Deputy Head of the Department of Production, Technology and Ecology (*Výroba, technika a ekologie*) and the Deputy Head for Economics and Human Resources (*Ekonomika a presonalistika*).

The Surface Centre manages all areas of the former mines in the Ostrava and Petřvald sub-basins (hereinafter ODP and PDP), in the southern part of the district it is the former Paskov Mine and in the Karviná part it is the former Barbora Mine with completed " technical liquidation of the mine". Furthermore, the Surface Centre manages the landfill complex, comprising OSTRAMO lagoons and the Lagoon Water Treatment Plant. The Mine Centre manages the mining parts of the Jeremenko

and Žofie areas (i.e. water pits, dumps, degassing wells, liquidated main mining works and old mining works).

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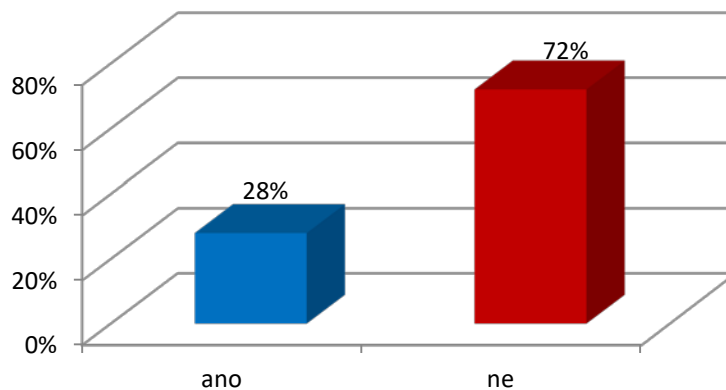
## 9. Questionnaire

### Research Evaluation

- Total number of 204 respondents, namely HGF (*Hornicko-geologická fakulta / Faculty of Mining and Geology*) students;
- Of these, 51% are women, and 49% men;
- They are all aged 20-26, with 53% being aged 20-23 and 47% being aged 24-26.

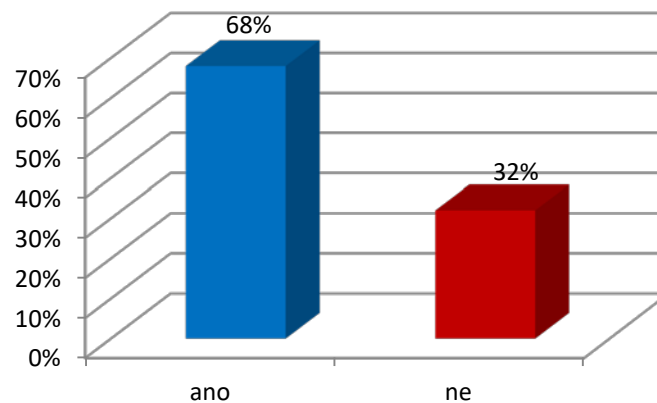
#### 1. Do you know the internships that the school offers?

The school puts quite a lot of effort into creating good working conditions for students in private companies within the offered internships. They have the opportunity to gain much-needed practical experience and earn money. It is therefore striking that 72% are not aware of such offers.



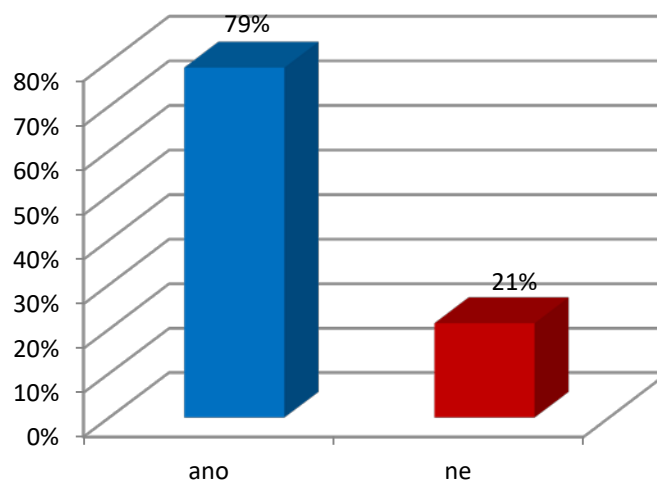
#### 2. Would you be willing to gain experience from an internship without being paid?

This issue is relatively closely related to the previous one concerning internships. The survey shows that 68% of respondents are interested in getting in touch with a local company, even without any remuneration for their work.



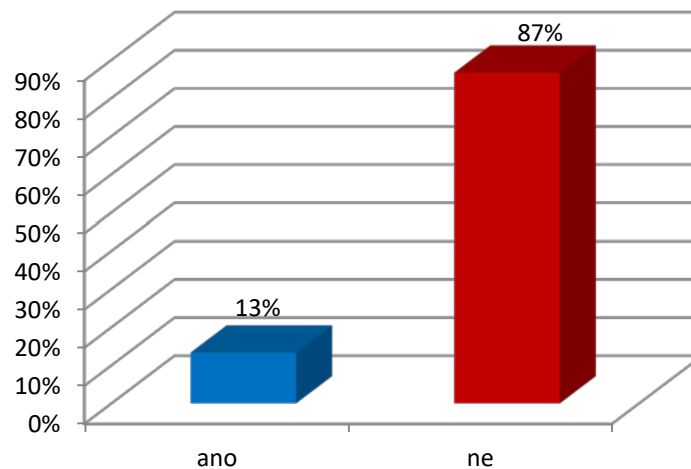
**3. In your free time, would you take part in debates with interesting personalities, entrepreneurs, and experts?**

It arises from discussions with many students that one of the greatest values a teacher can offer them is practical experience. 79% are interested in hearing about successful entrepreneurs in their area of residence and many of these people also want to share their successes with the public and motivate others. These may also be graduates of the faculty who are satisfied with the position they have achieved thanks to their education.



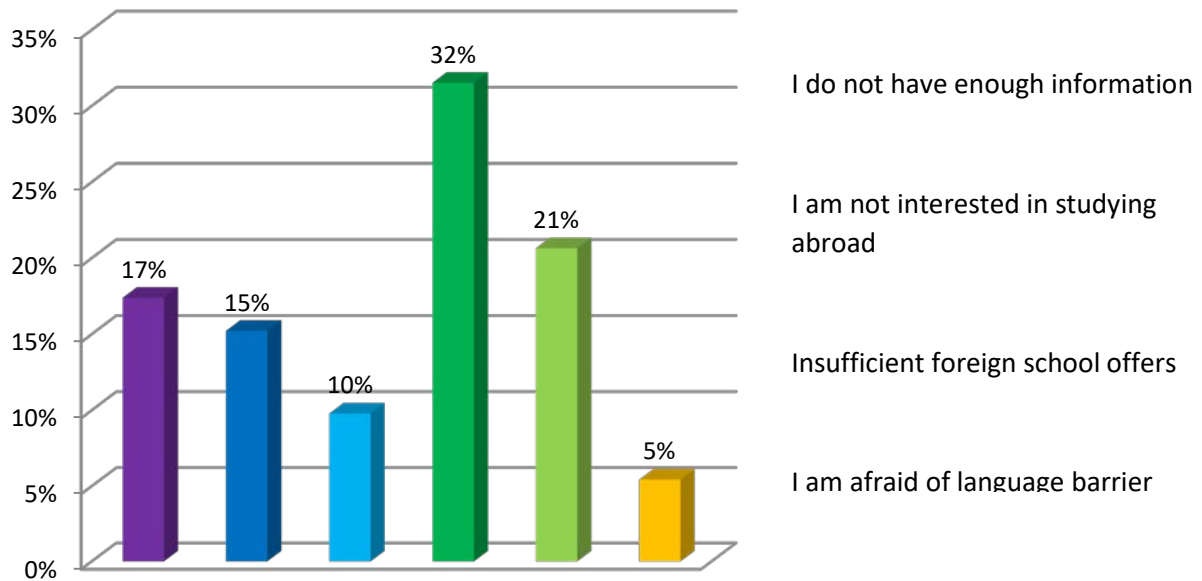
#### 4. Have you ever participated in the Erasmus program?

13% of respondents answered “Yes” (Ano) and this is mainly because most students use the Erasmus program in their bachelor’s studies and in the first semester of the follow-up program. The fact that the faculty managed to provide 13% of students with experience abroad can be viewed positively.



#### 5. If not, give a reason.

If we want more and more students to take advantage of this opportunity to study and travel every year, we need to find out what their main obstacles are. For 32% of respondents, the biggest is the fear of a language barrier. The second major obstacle is the lack of funds. 17% do not have enough information about this program, which can be perceived as their insufficient interest in studying abroad, as all the necessary information is freely and clearly available on the Internet and school website.



**6. How do you rate online teaching during university closure due to anti-coronavirus measures (grade as in school - 1 best, 5 – worst)?**

The 204 students rate online teaching as follows:

- 1 (the best mark) 45 % students;
- 2 - 31 % students;
- 3 - 15 % students;
- 4 - 8 % students;
- 5 - 1 % student.

**7. Did you have any courses related to entrepreneurial knowledge?**

61% of students answered that they had attended courses of this type, the rest (39 %) had not; of those 33 % state that it was because they had not known about the courses at the university, the remaining students (6 %) were simply not interested.

**8. Have you ever considered becoming an entrepreneur?**

Most students (65 %) had not thought about it yet, others (24 %) were still considering such an option, the remaining students (11 %) answered yes.

**9. Can you imagine yourself as an entrepreneur in waste management?**

Most students (72 %) did not know it yet, another part said yes (17 %) and the remaining students answered no (Ne) (11 %).

**10. Do you have any entrepreneurial experience (own business or family-owned business)?**

Most students said no (77 %), the rest answered yes (23 %).

**11. Do you want to stay in the Northern Moravia region (or even the Czech Republic) after completing your studies?**

Answers to this question were not so clear; 36 % answered that they wanted to stay, 34 % that they wanted to leave, the rest (30 %) did not know yet as it would depend on the opportunities and possibilities they would be given.



# CHAPTER 3

POLAND

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**PREPARED BY**  
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## 10. Overview of Polish Raw Materials Market

### 10.1. Description of Raw Materials Sector in Poland

The Raw Materials (RM) sector includes the mining of minerals from natural deposits and their initial processing. Poland is located on the border of 3 tectonic units: Proterozoic Crust, Od Variscan Orogeny zone and Young Alpine orogeny zone, which makes the region rich in natural deposits. Key and strategic resources include the following raw material deposits:

- Energy raw resources, such as hard coal, brown coal, and conventional and unconventional form of gas and oil;
- Metalliferous minerals;
- Chemical raw resources;
- Natural stones (including medicinal and thermal waters).

Despite plentiful coal, gas and oil deposits, the segment faces the issue of being unprofitable, which is mainly due to the unavailability of advanced technologies; the technologies that would allow the mining of less accessible sites on one hand and would ensure cost-competitiveness in the world market on the other.

The construction and pottery industries report a growing need for raw materials used in the manufacture of construction materials and aggregates. Considering the growing costs of construction work, an access to cheap raw materials will be necessary for dynamic infrastructure development.

The metals such as zinc, lead, copper, cobalt, germanium, are widely used in various industrial branches as, for example, part of important alloys and superalloys used in power industry and aviation. The metal segment also requires the support of new, reasonably priced technologies. Plentiful thermal water deposits in the country create an opportunity to strengthen the unconventional energy sector due to the high-power heat pump technology. (www.pmgconsulting.eu, 2019).

### 10.2. NACE Classification-Based Definition of Sector

The identification of the key area, where potential entrepreneurs, who want to open start-ups or companies in Poland, shall operate, was prepared on the basis of the PKD statistical classification of economic activities.

It is harmonized with the European NACE classification. Based on an internal analysis, the sectors directly related to the RM field in Poland were defined.

*Table 25 Selected areas of PKD classification for RMs sector in Poland (part of Appendix 1 table)*

Division	Group	Class	Sub-class	Content
<b>Section B - MINING AND EXTRACTION</b>				
5	05.1	05.10	05.10.Z	Mining of hard coal
5	05.2	05.20	05.20.Z	Mining of lignite
6	06.1	06.10	06.10.Z	Extraction of crude petroleum
6	06.2	06.20	06.20.Z	Extraction of natural gas
7	07.1	07.10	07.10.Z	Mining of iron ores
7	07.2	07.21	07.21.Z	Mining of uranium and thorium ores
7	07.2	07.29	07.29.Z	Mining of other non-ferrous metal ores
8	08.1	08.11	08.11.Z	Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate
8	08.1	08.12	08.12.Z	Operation of gravel and sand pits; mining of clays and kaolin
8	08.9	08.91	08.91.Z	Mining of minerals for chemical industry and for production of fertilizers
8	08.9	08.92	08.92.Z	Extraction of peat
8	08.9	08.93	08.93.Z	Extraction of salt
8	08.9	08.99	08.99.Z	Other mining and quarrying not elsewhere classified
9	09.1	09.10	09.10.Z	Support activities for petroleum and natural gas extraction
9	09.9	09.90	09.90.Z	Support activities for other mining and quarrying
<b>Section C - INDUSTRIAL PROCESSING</b>				
19	19.1	19.10	19.10.Z	Manufacture and processing of coke
19	19.2	19.20	19.20.Z	Manufacture and processing of refined petroleum products
20	20.1	20.11	20.11.Z	Manufacture of industrial gases

Source: Own elaboration

### 10.3. Leading Industrial Branches in RMs sector in Poland

The leading industrial branches in the RMs sector in Poland are:

1. Hard coal mining:
  - a. Coking (8<sup>th</sup> place in the world);
  - b. Energy sector (10<sup>th</sup> place in the world);
2. Hard coal mining (5<sup>th</sup> place in the world);
3. Silver extraction (8<sup>th</sup> place in the world).

## 10.4. Development Trends

According to literature, the Polish RMs sector comprises the following most innovative segments of the mineral raw materials branch [9]:

- Methods of locating deposits and analysing its parameters in accordance with technological solutions more precise than those currently used;
- Technologies of researching, locating, drilling, and exploiting the conventional and unconventional oil and gas deposits;
- Modern tools for numerical modelling of each component of newly built opencast mines;
- Technologies that decrease the consumption of the work and energy needed for mining clastic raw materials from flooded mine seams, including robotisation;
- Extraction of metals from deeper seams without installing underground infrastructure – e. g. bioleaching;
- Innovative technologies of extraction of rocks that are difficult to quarry in coal mining;
- Process of underground gasification of coal and manufacturing of fuels,
- Reclamation of excavations;
- New methods of improving the calorific value of raw materials;
- Coal drying technology for co-incineration, gasification, and transport;
- Technologies of oil processing;
- New technological solutions that allow for the improvement of the technology of quarrying rocks by blasting;
- Technologies that allow to improve the quality of extracted natural stones;
- Innovative technologies of extraction, processing and forwarding natural stones directed at limiting the impact on the environment;
- Diagnostics tools and systems that allow for limiting the failure frequency of the used machinery and equipment;
- Systems improving safety of workers;
- Innovative solutions improving the efficiency and industrial safety of basic machinery in mining.

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In order to identify the most popular areas of operation in the RMs sector, innovative projects, implemented in the 2010-2019 period by Polish research units (independently or in partnership) were analysed. A detailed report on these projects, along with the key words and the time in which they were implemented are included in Appendix 2 and a fragment of the table is presented below.

*Table 26 Part of table stating international and national projects implemented in the RMs sector in which Poland participated*

NO.	Subject	Acronym	Start date	Finish date	Field of study
1	Towards Indium free TCOs	INREP	1 <sup>st</sup> February 2015	31 <sup>st</sup> January 2018	Engineering and technology, environmental engineering, waste management, electrical conductivity
2	M4ShaleGas: Measuring, monitoring, mitigating, and managing the environmental impact of shale gas	M4ShaleGas	1 <sup>st</sup> June 2015	30 <sup>th</sup> November 2017	Gas, renewable, energy, governance, sustainable economy
3	Management of Municipal Water Waste Treatment Plants Potential by-Products of Sewage Sludge Ash type, as Active or non-Active Additions to Portland Cement-based Binders	Sewage Sludge in PC	1 <sup>st</sup> March 2017	28 <sup>th</sup> February 2019	energy and fuels, renewable energy, social sciences, commerce
4	Research Coordination for a Low-Cost Biomethane Production at Small and Medium Scale Applications	Record Biomap	1 <sup>st</sup> April 2016	30 <sup>th</sup> September 2018	gas, commerce
5	Immersive Experiences around TV, an integrated toolset for the production and distribution of immersive and interactive content across devices.	ImmersiaTV	1 <sup>st</sup> 2016	30 <sup>th</sup> June 2018	Economics, business, management, commerce, languages - general

*Source: Own elaboration*

## 10.5. Determining Key area for Potential Entrepreneurs in Poland

In this section, the A frequency of using the key words (application: [www.kwfinder.com](http://www.kwfinder.com)) has been determined; it demonstrates the attractiveness of a given key word that comes from and represents each one of the projects that were implemented in the RMs sector in Poland between the years 2011 and 2019. The table representing compilation of the projects, along with their key words and frequency of appearing, is presented in Appendix 26.

Based on the Appendix 26 table, for each of the PKD sectors, key words were selected from those that are the most popular and may be explored by potential entrepreneurs. In Figure 15, there are particular key words on the X-axis and particular activities from PKD classification on the Y-axis. The size of individual bubbles reflects the term attractiveness.

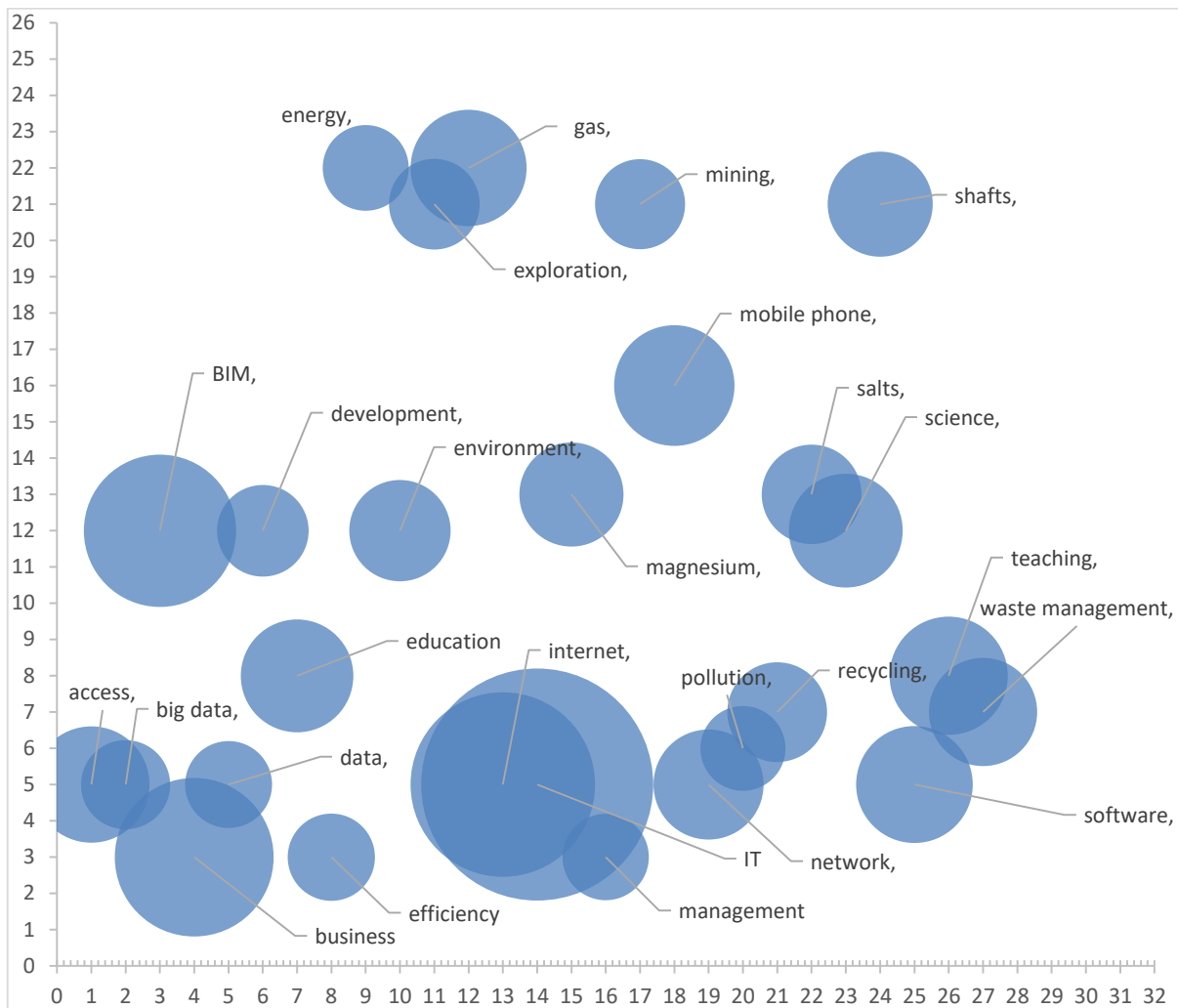


Figure 15 . Attractiveness of selected subjects on basis of the key word analysis performed in RMs sector

Source: Own elaboration

Respective designations on the X-axis:

1 - Access, 3 - Big data, 4 - BIM, 8 – Business, 20 - Data, 21 - Development, 24 – Education, 25 – Efficiency, 28 - Energy, 29 - Environment, 33 - Exploration, 35 - Gas, 38 - Internet, 39 – IT, 42 - Magnesium, 43 – Management, 45 - Mining, 46 - Mobile phone, 49 - Network, 54 - Pollution, 56 - Recycling, 59 - Salts, 60 - Science, 61 - Shafts, 63 - Software, 67 - Teaching, 70 - Waste management.

There are activities from PKD classification on the Y-axis, to be more precise:

- 3 - Head offices activity; management consulting services;
- 5 - Activity related to IT software and consulting services and associated activities;
- 6 - Activity related to the reclamation and other service activities related to waste management;
- 7 - Activity related to waste collection, processing, and disposal; raw materials recovery;
- 8 - Education;
- 12 - Other professional, scientific, and technical activity;
- 13 - Other mining and extraction;
- 16 - Manufacture of computers, electronic and optical products;
- 21 - Distinguishing hard coal and brown coal (lignite);
- 22 - Manufacturing and supplying electricity, gas, water steam, hot water and air for air conditioning systems.

The largest bubble belongs to the IT key word, followed by the Internet and business key words. Figure 15 does not include all the key words. Only those of higher frequency than 500 thousand given in the *Key word analysis* were used for analytical purposes.

As a result of the performed research and analysis the following activity of the PKD classification was specified for further research of the RMs sector: activity related to IT software and consulting services and associated activities. It is closely related to Industry 4.0 that is entering the Polish market and to widely understood ICT technologies.

The most innovative areas in the ICT sector, which have or may have a potential in the RMs sector, in Poland are the following:

- Intelligent sensor network technologies;
- Spatial navigations systems;
- Observation and identification systems using the ranges of electromagnetic waves different from any visible and infrared light;
- Cyberspace protection systems eradicating risks by developing IT infrastructure;
- Infrastructure and technologies of the distributed systems for e-business;
- Systems of logistic support and supply chain management;
- Intelligent control traffic system;
- RFID (radio-frequency identification) technologies;
- Semantic network technologies;
- Technologies of artificial intelligence for manufacture systems.

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## 11. Market report

### 11.1. National Raw Materials Policy Framework

The activities in the field of geology and mining in Poland is regulated by the Geological and Mining Act (GMA) adopted on 9<sup>th</sup> June 2011. It concerns the following issues: geological works, extracting minerals from deposits, underground tankless storage of substances, underground landfilling of waste, underground carbon dioxide storage.

The current binding legal system in Poland recognises two types of ownership: state ownership - deposits that are also called mineral rights and land ownership. Mineral rights include the following deposits: hydrocarbons, hard coal, methane occurring as an accompanying mineral, brown coal, metal ores, excluding iron ores from peat bogs, native metals, ores of radioactive elements, native sulphur, rock salt, potassium salt, potassium-magnesium salt, gypsum and anhydrite and precious stones, and medicinal thermal and saline water deposits. These rights are independent from the location of the minerals. The deposits of the minerals listed above, however, are considered to fall under the ownership of land.

### 11.2. Groups of Polish Mineral Raw Materials

Poland is a country rich in mineral raw materials. The mineral raw materials that can be found in Poland can be divided into four main groups, namely energy raw materials, metalliferous minerals, chemical raw materials, and natural stones. Figure 16 a detailed composition of each group of mineral raw materials.

Energy raw materials	Metalliferous raw materials	Chemical raw materials	Natural rocks
<ul style="list-style-type: none"> <li>• Hard coal</li> <li>• Brown coal</li> <li>• Oil</li> <li>• Methan from coal seams</li> <li>• Helium</li> <li>• Natural gas</li> <li>• Nitrogenous natural gas (HNNG)</li> </ul>	<ul style="list-style-type: none"> <li>• Arsenic ore</li> <li>• Zinc and lead ores</li> <li>• Tin ore</li> <li>• Copper and silver ores</li> <li>• Molybdenum-wolfram-copper ores</li> <li>• Nickel ores</li> <li>• Native gold and silver ores</li> <li>• Iron, titanium and vanadium ores</li> <li>• Accompanying elements in ores</li> <li>• Other metalliferous raw materials</li> </ul>	<ul style="list-style-type: none"> <li>• Barite and fluorite</li> <li>• Phosphorite s</li> <li>• Sulphur</li> <li>• Diatomite rock</li> <li>• Magnesium-potassium salts</li> <li>• Rock salt</li> <li>• Argillaceous raw materials , silicate mineral paint</li> <li>• Flinty earth</li> </ul>	<ul style="list-style-type: none"> <li>• Bentonites and bentonite clays</li> <li>• Aluminiums</li> <li>• Argillaceous raw materials</li> <li>• Kaolin raw materials</li> <li>• Glauconiteic sediments</li> <li>• Sands and gravels</li> <li>• Raw materials for glass-making</li> <li>• Filter gravels</li> <li>• Dolomites</li> <li>• Gypsums and anthracites</li> <li>• Calcite</li> <li>• Crashed rock gravel and stone blocks</li> <li>• Chalk</li> <li>• Flints</li> <li>• Quartz</li> <li>• Slate</li> <li>• Magnesites</li> <li>• Limestone and marls</li> <li>• Ambers</li> <li>• Peat</li> <li>• Saline, medicinal and thermal waters</li> </ul>

Figure 16 Groups of mineral raw materials in Poland

Source: Own elaboration

### 11.3. Geographical Concentration of Extraction

However, different is the distribution and quantity of deposits of raw materials. The occurrence of natural resources is related to the geological past and phenomena that lasted millions of years. The mineral raw materials are included in the group of finite resources, which means they are non-renewable. On one hand, it is important to use them rationally due to the above stated. On the other hand, their replacement with renewable resources needs to be pursued. This issue concerns energy raw materials the most. Therefore, we have a growing number of wind farms, solar and hydro power stations. The manufacture of biofuels is also increasing, which contributes to the improvement of the environmental cleanliness.

Figure 17 presents the distribution or breakdown of the main groups of mineral raw materials in Poland. In Poland, the biggest deposits of mineral raw materials are those of hard coal, brown coal, rock salt, copper, zinc, and lead ore.

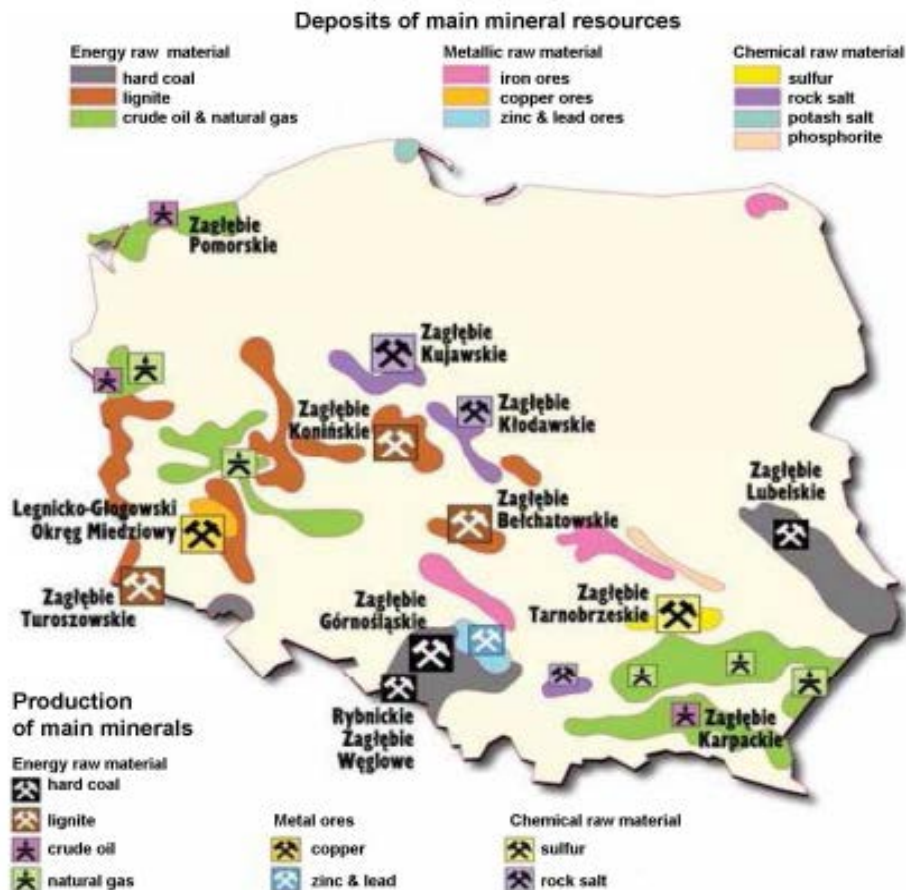


Figure 17 The distribution of main groups of mineral raw materials in Poland

Source: [2]

The most important raw materials in Poland are energy raw materials.

Hard coal is the most important energy raw material extracted in Poland. Its estimated economic resources are 60,496 Mt in total of which steam coal represents 70% and coking coal the rest (less than 30%).

In Poland, coal deposits are located in Upper Silesian Coal Basin (USCB), Lublin Coal Basin (LCB), and Lower Silesian Coal Basin (LSCB). Currently, coal is only exploited in USCB and in LCB.

Brown coal, the second main important Polish raw material, is almost entirely used in power industry (98% of large power plants are fuelled by it). Its most important deposits are located in Bełchatów (57% of the domestic production) and in Turów near Bogatynia.

In Poland, there are also oil deposits, which are located mainly in the Carpathians and on Polish plains.

As an example of metalliferous minerals, copper ores should be mentioned in the first place. Their deposits stretch from Lublin to Bytom Odrzański, which is a 60 km long and 20 km wide area. Zinc and lead ores that occur in the Silesian-Cracovian area (north-eastern skirts of the Upper Silesian Coal Basin) also belong to this group of minerals.

Among the chemical raw materials, the following should be mentioned:

- Sulphur, occurring in the northern part of the Carpathian Depression;
- Rock salt, located in the central part of our country (Kłodawa, Mogilno, Góra).

In Poland, there are also the deposits of natural stones, such as granite or dolomite, that are used in the construction sector.

## 11.4. Technology and Its Presence in Industry

The raw materials representing the largest deposits in Poland shaped the industry development and the presence of the applied technologies, especially in the power industry. In Poland, there is significantly more coal deposits than the deposits of oil and natural gas, which are mostly imported due to their scarcity in the country. In addition to energy raw materials, metalliferous minerals also play an extremely important role in our country. Here, primarily the deposits of iron ore, copper, zinc, and lead should be listed.

The possession of its own natural resources gives Poland a significant independence and it also reduces the costs of developing those industry branches that use mineral raw materials. Such an independence of Poland is possible especially with the use of hard coal and brown coal deposits supplying the **power and metallurgy industries**.

## 11.5. Poland as Producer of Selected Raw Materials

According to the *World Mining Data 2018* data [3], Poland is in the 5<sup>th</sup> place in the world in hard coal production (60,273,000 Mg t), in 8<sup>th</sup> place in silver extraction (1,264,659 kg) and coking coal extraction (13,082,000 Mg t) and in 10<sup>th</sup> place in steam coal extraction (57,213,000 Mg t). Figure 18 presents the leading world ranking positions of selected minerals.

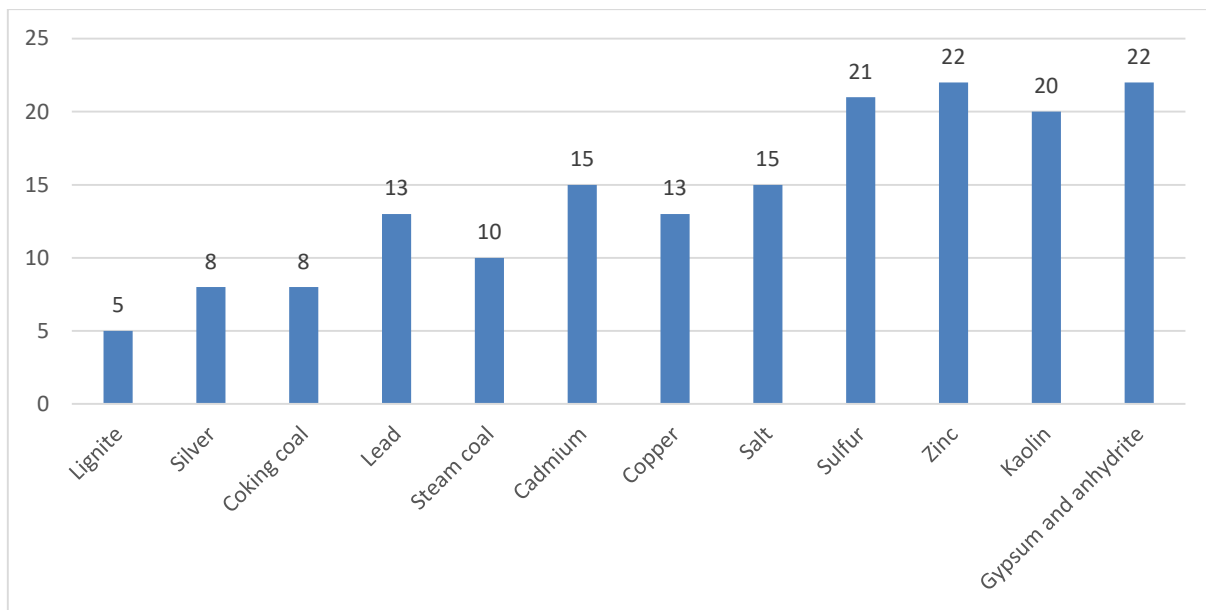


Figure 18. Poland's rank in world's output of selected minerals

Source: Own elaboration based on [1]

Taking into account the leading industries in Poland, which are the power and mining industries, the hard coal output decreased over the last 5 years (2015-2017) (Figure 19), and as of 2017, its level has been relatively similar, with a slight downward tendency (2018-2019), which is shown in Figure 17. Similarly, the sales volume in this period also decreased (Figure 20). This situation is mainly related to the widely understood restructuring processes of the mining industry, which also resulted in coal mines and decreasing its workforce size (Figure 21).

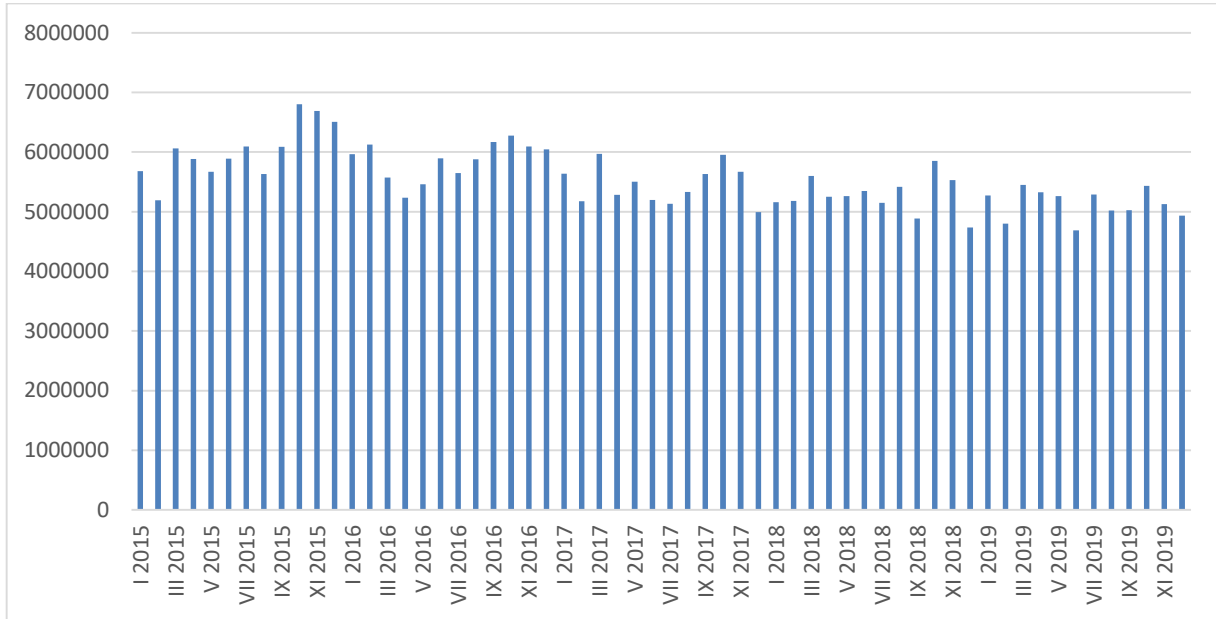


Figure 19. Hard coal total output in Poland

Source: Own elaboration based on [10]

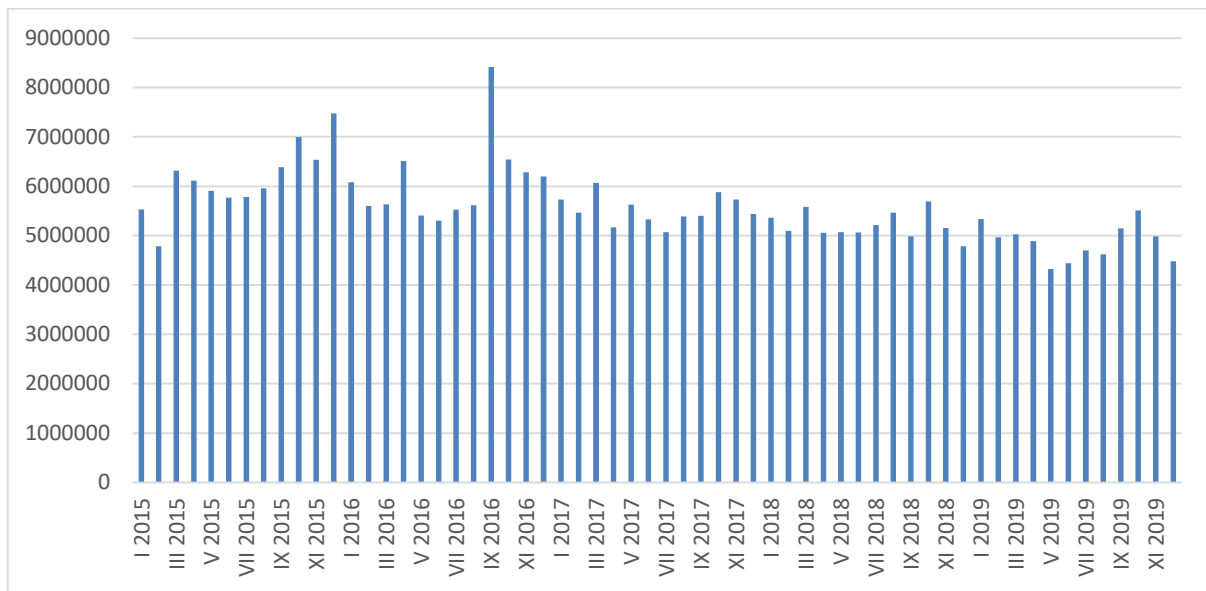


Figure 20. Total hard coal sales

Source: Own elaboration based on [10]

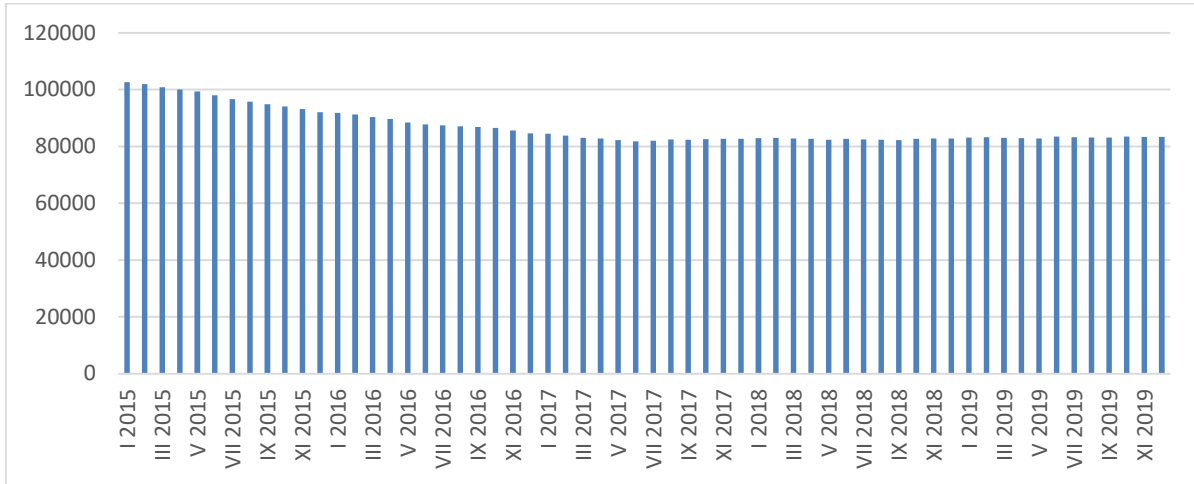


Figure 21. Hard coal mining workforce size in Poland

Source: Own elaboration based on [10]

The analysis of **Balance of Mineral Resources Deposits in Poland** for the 2014-2018 period shows that the number of deposits from which minerals can be extracted is quite large compared to the number of developed deposits, which is considerably smaller. Figure 22 shows the above values; the following designations were used: RRs – Recoverable Reserves and DRs – Developed Reserves. Significant differences between RRs and DRs mean that only a part of the recoverable reserves of particular resources is developed.

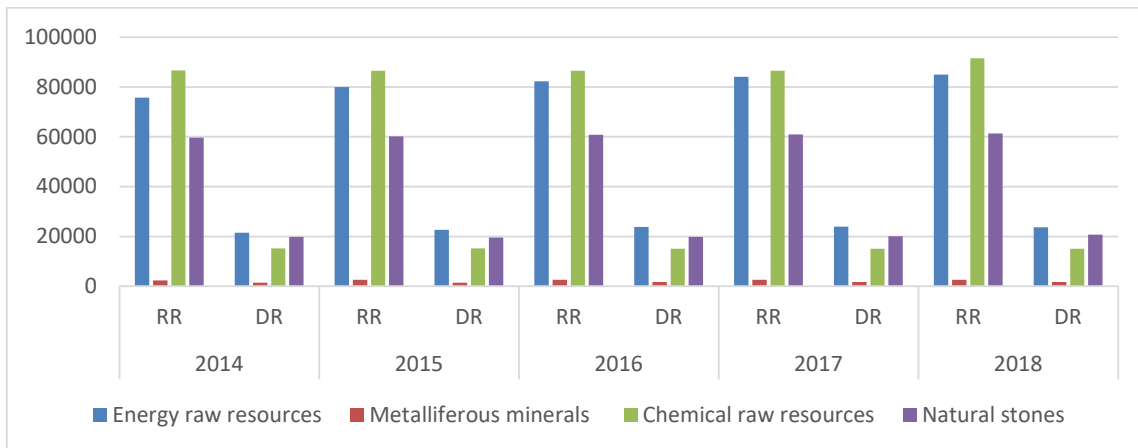


Figure 22. Amount of recoverable reserves and developed reserves in Poland in 2014-2018 period, divided into groups of minerals

Source: Own elaboration based on [4], [5], [6], [7], [8].

Figure 23 shows the average amount of deposits of minerals, divided into the gas, solid and liquid categories in a 5-year period (2014-2019). The amount varied slightly amongst the years. However, it is clear that the greatest amount of deposits is represented by energy gas minerals (above 50%) followed by energy solid minerals (36%) and energy liquid minerals (12%).

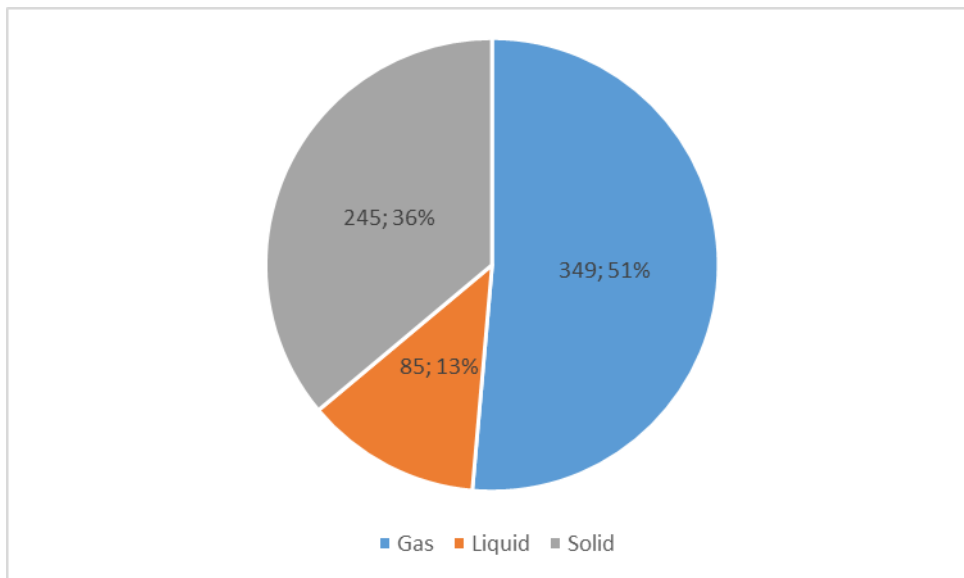


Figure 23. Average amount of deposits of energy minerals in Poland in 2014-2018 period

Source: Own elaboration based on [4], [5], [6], [7], [8].

Table 27 and Figure 24 show the details of the above development and of the utilisation of available deposits of minerals.

Table 27 Degree of use of deposits of particular minerals in 2014-2018 period

Groups of minerals	2014	2015	2016	2017	2018
Energy raw resources	28%	28%	29%	28%	28%
Metalliferous minerals	61%	54%	67%	66%	66%
Chemical raw resources	18%	17%	17%	17%	16%
Natural stones	33%	32%	33%	33%	34%

Source: Own elaboration based on [4], [5], [6], [7], [8].

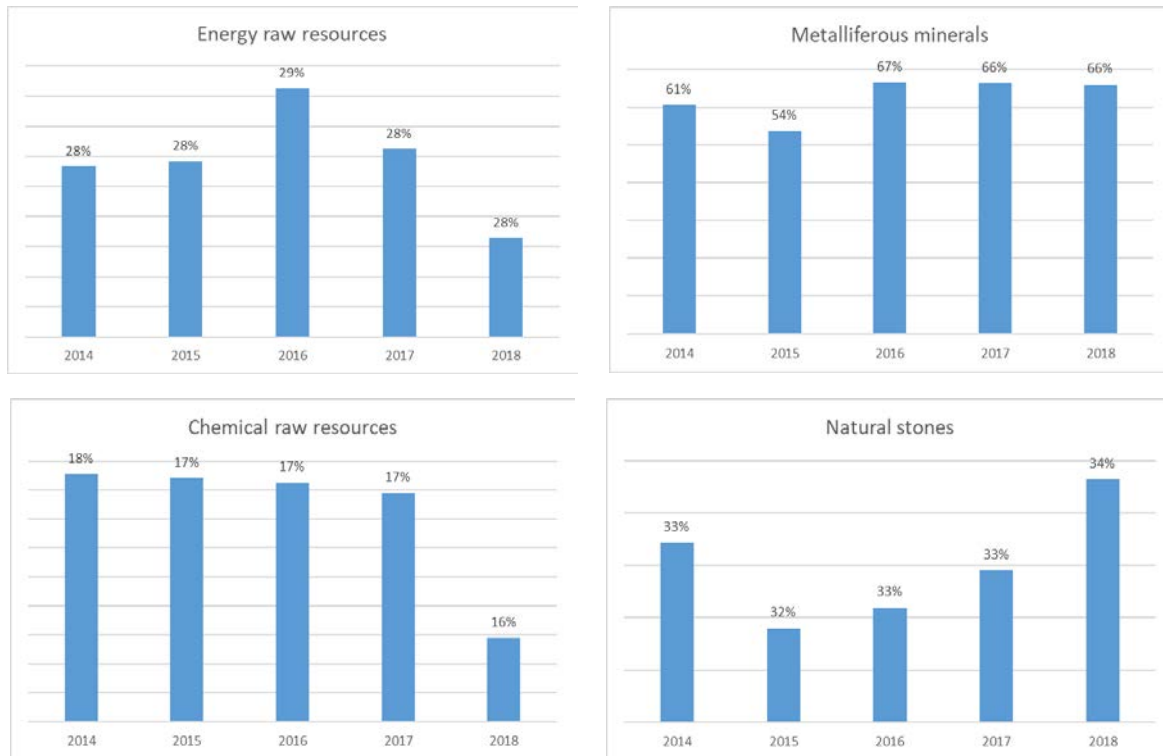


Figure 24. Degree of use of deposits of particular minerals in 2014-2018 period

Source: own elaboration based on [4], [5], [6], [7], [8].

In the analysed period, the use of all minerals in relation to the amount of their recoverable deposits is at a comparable level. However, the level of their use might be puzzling. Only 30% of energy minerals, less than 20% of chemical minerals and more than 30% of natural rocks are used. Metalliferous minerals have the highest level of use – from 54% to as much as 67%.

Figure 25 shows the average amount of deposits of minerals, divided into the gas, solid and liquid categories in a 5-year period (2014-2018). It can be seen that, among the deposits available in Poland, the deposits of energy gas minerals are most often developed (their use reaches 66%). The amount of developed deposits of the energy solid and liquid minerals is about four times smaller and reaches 16% and 18% respectively.

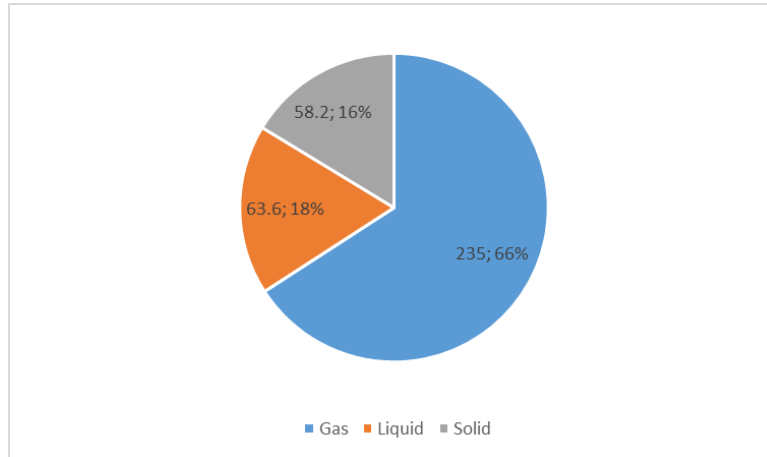


Figure 25. Average amount of developed deposits of energy minerals in Poland in 2014-2018 period

Source: Own elaboration based on [4], [5], [6], [7], [8].

Figure 26 shows the output of particular minerals in Poland in the 2014-2018 period. of all the extracted minerals, natural stones are of the highest amount (64%) followed by the energy (28%), metalliferous (7%) and chemical (1%) minerals.

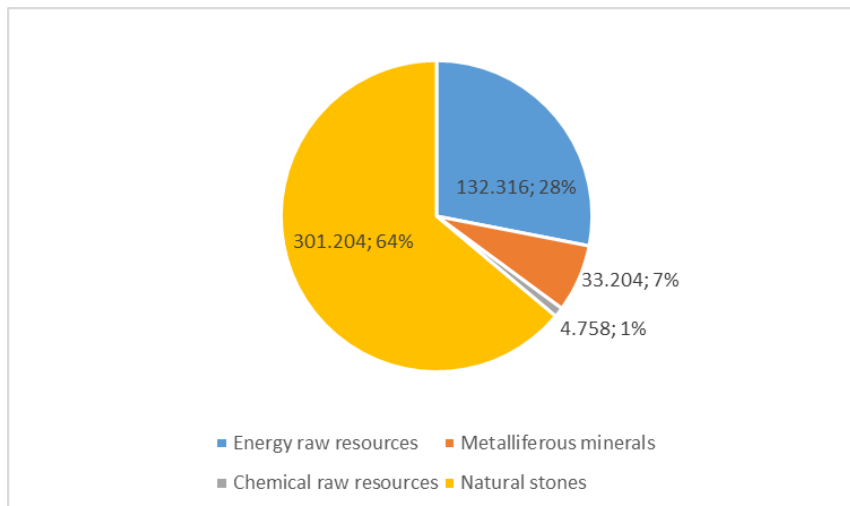


Figure 26. Average output of energy minerals in Poland in 2014-2018 period

Source: Own elaboration based on [4], [5], [6], [7], [8].

Figure 27 shows the pattern in the output of particular groups of minerals in the analysed period.

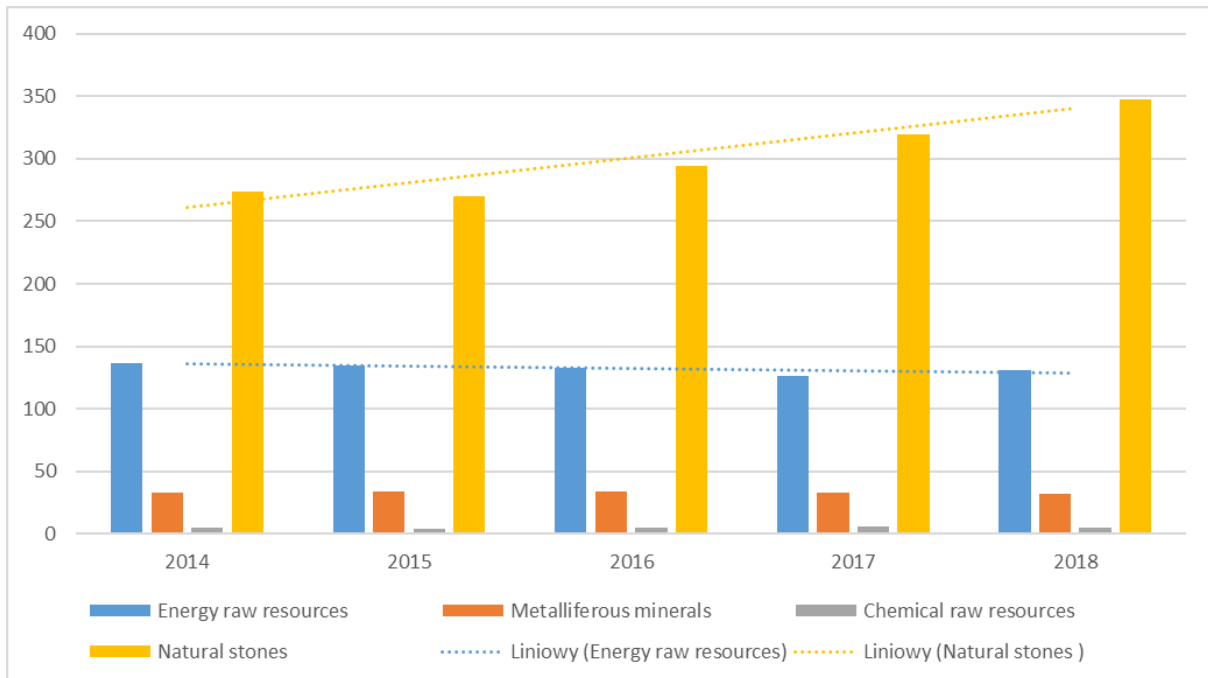


Figure 27. Pattern in output of particular groups of minerals in 2014-2018 period

Source: Own elaboration based on [4], [5], [6], [7], [8].

## 11.6. PESTEL Analysis of Raw Materials in Poland

In order to obtain an assessment of the internal barriers that limit the activity of the raw materials sector entities, the survey was conducted among 19 experts and practitioners, who know the conditions of such entities functioning on the Polish market. The survey enabled them to assess factors weights in the PESTEL analysis. The PESTEL analysis is a description of political, economic, social, technological, environmental, and legal areas and their impact on any organisation that operates within these areas. This analysis is helpful in the preparation of strategic development plans and many times it encourages a close inspection of one’s own institution in respect of the processes occurring in it.

The PESTEL analysis (Figure 28) was conducted with the use of point indicators, i.e. a scale. The respondents have assessed the impact of the selected groups on the activity of raw material sector entities in a 4-point scale, in which 4 means a very high impact in their assessment and 1 very low.

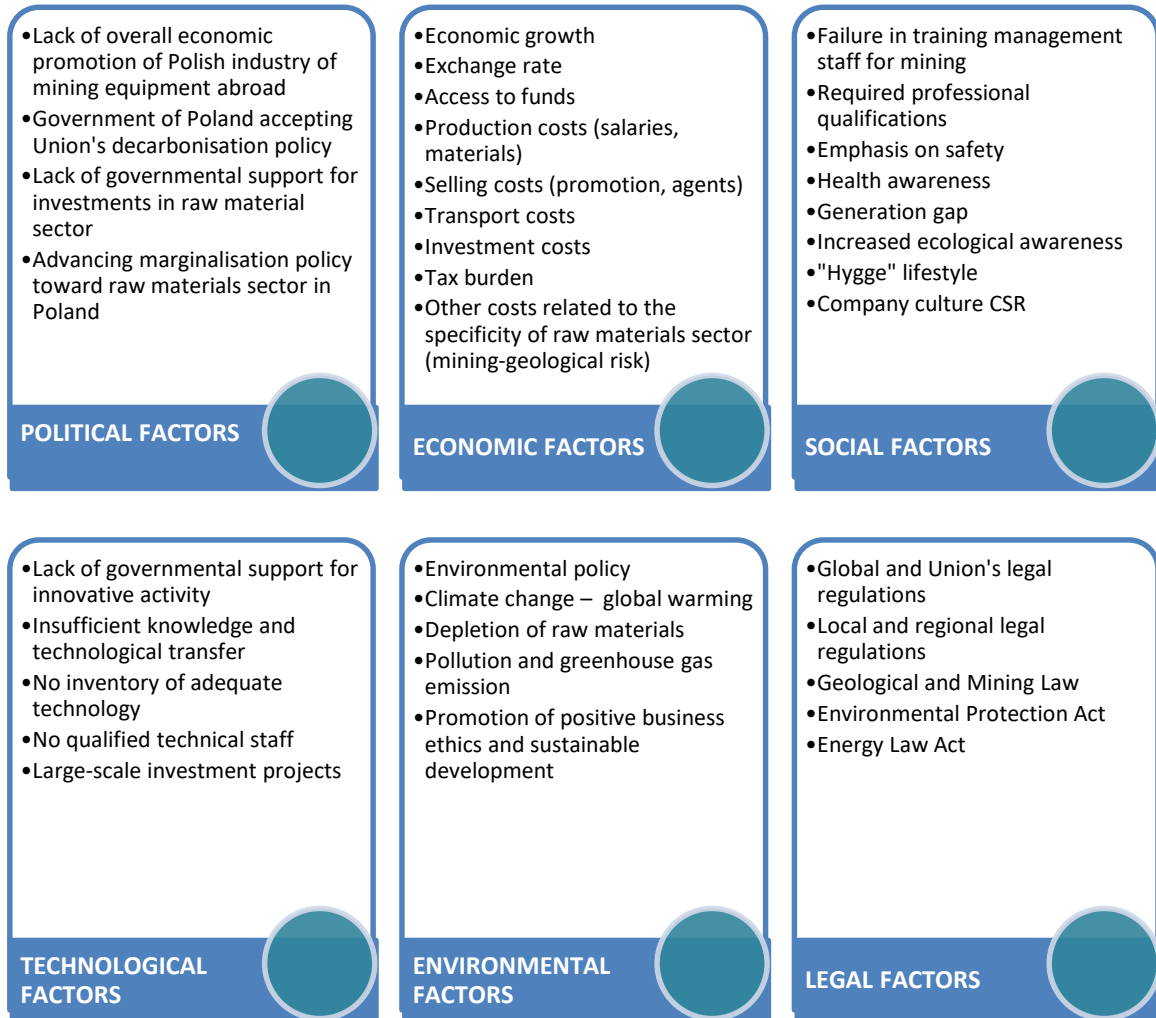


Figure 28. PESTEL analysis for Polish companies of RMs sector

Source: Own elaboration

The figures 29 to 34 show the results of average assessments for particular groups of factors with regard to the political, economic, social, technological, environmental, and legal areas.

The respondents considered Polish government's acceptance of the EU's decarbonisation policy and progressing marginalization of the raw materials sector in Poland as significant political barriers that hamper the functioning of Polish enterprises in the raw materials sector (Fig. 29). The lack of government support for investments in this sector, which could provide an additional stimulus for companies operating in this industry, is also acutely perceived. The lack of a general economic promotion of the mining machinery and equipment industries was considered to be a barrier of the lowest significance in this group. However, compared to the other barriers analysed in PESTEL, it is still quite of significance.

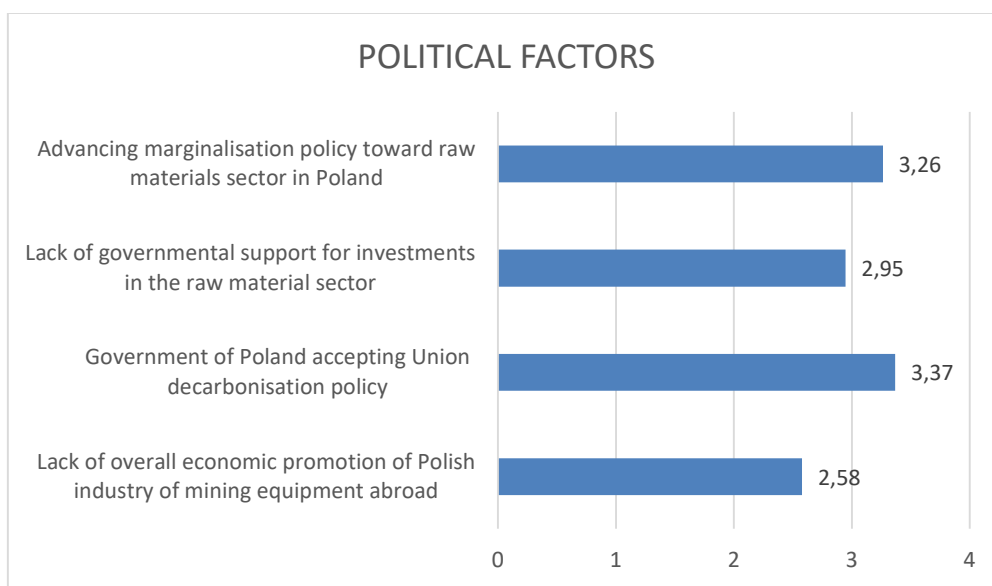


Figure 29. Average value of economic barriers on 1-4 scale

Source: Own elaboration

In the group of economic factors, the respondents considered the tax burden to be the most significant barrier in the Polish raw materials industry. In fact, in the Polish industry, the taxes, both national and local, are high and subsequent attempts of negotiations with a view of reducing the numerous tax burdens have not led to any outcome for several years now. High investment cost in the industry and high production costs are other barriers that significantly determine the operation of entities in the raw materials industry in Poland. In recent years, difficulties in accessing financial resources became quite critical - banks and other financial market operators are reluctant to grant loans and credits to the entities operating in the RMs area

in Poland. In the group of economic factors, the respondents indicated the selling costs (which are secondary costs), currency exchange rates and transport costs (Figure 30) as the least significant barriers.

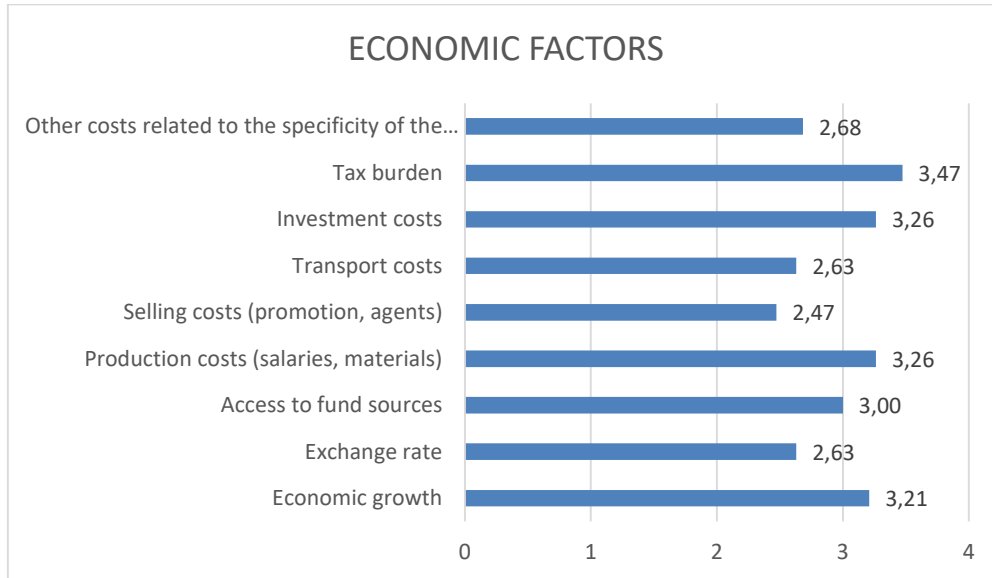


Figure 30. Average value of economic barriers on 1-4 scale

Source: own elaboration

Social factors are a group of barriers determined by society, so they are relatively volatile over time. The respondents indicated cessation of education for the mining industry, that will affect the raw materials production and make it difficult to find qualified specialists, as the most critical current issue. Among the significant factors hampering the development of the industry, the respondents also indicate an increase in the environmental awareness and generation gap, i.e. the structure of employees in the mining industry that is characterized by the lack of employees with an average job tenure. The respondents stated, that the "hygge" philosophy of life, which, although gaining importance in Poland, does not significantly translate into the development and existence of the raw materials industry (Figure 31), is least significant as a barrier.

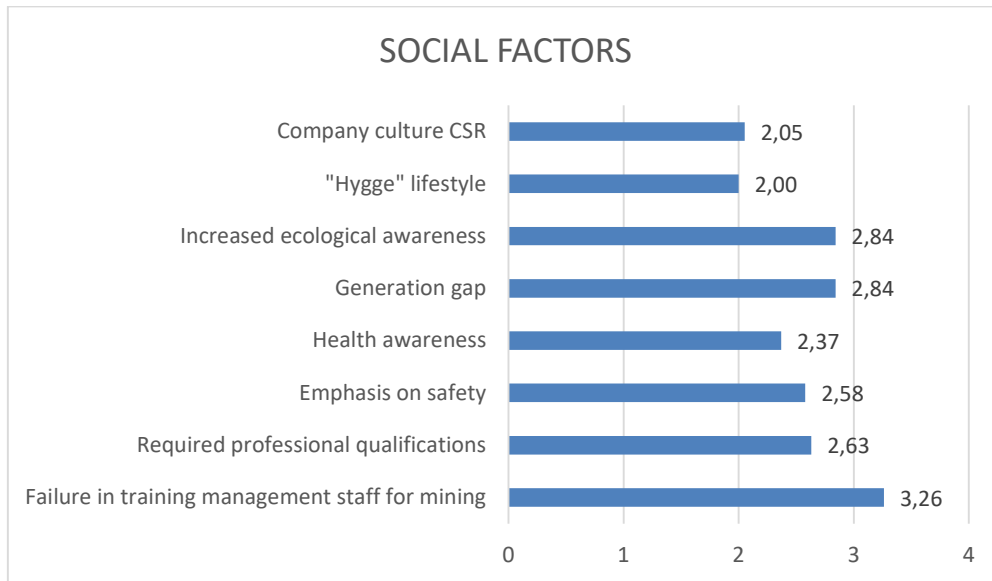


Figure 31. Average value of social barriers on 1-4 scale

Source: Own elaboration

Technological barriers can constitute a rather strong limitation in the functioning of enterprises, especially on the raw materials market. The respondents stated that delays in the transfer of knowledge and technology (Figure 32) are of major concern. This is a global trend and threat, closely related to the idea of Industry 4.0. These delays are mainly due to:

- Lack of developed strategies or implemented policies;
- Often erroneous allocation of EU funds that support broadly understood entrepreneurship but mainly in the SME sector, and not in strategically important sectors;
- Excessive formalization, bureaucratization of support mechanisms, which leads to the fact that funds are being spent in accordance with procedures but not necessarily development goals. This even leads to the avoidance of risky innovation pro-development undertakings (currently essential) in favour of safe and standard activities that do not bring major development changes;
- Low level of public administration representatives' competence;
- Fact that administrative issues take up to 90% of the time making it the detriment of substantive activities.

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A large scale of investment projects and the lack of appropriate technology are also significant barriers.

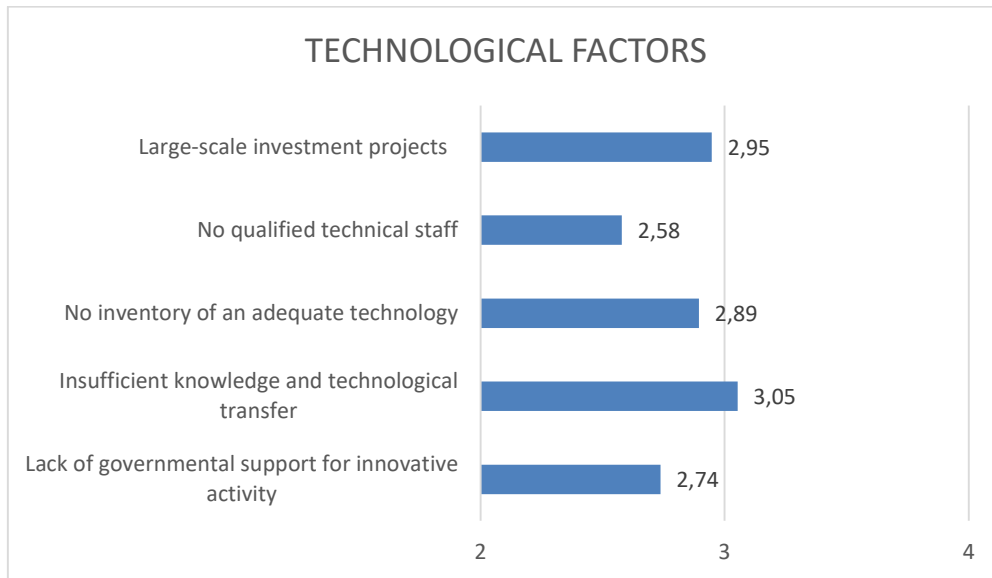


Figure 32. Average value of technological barriers on 1-4 scale

Source: Own elaboration

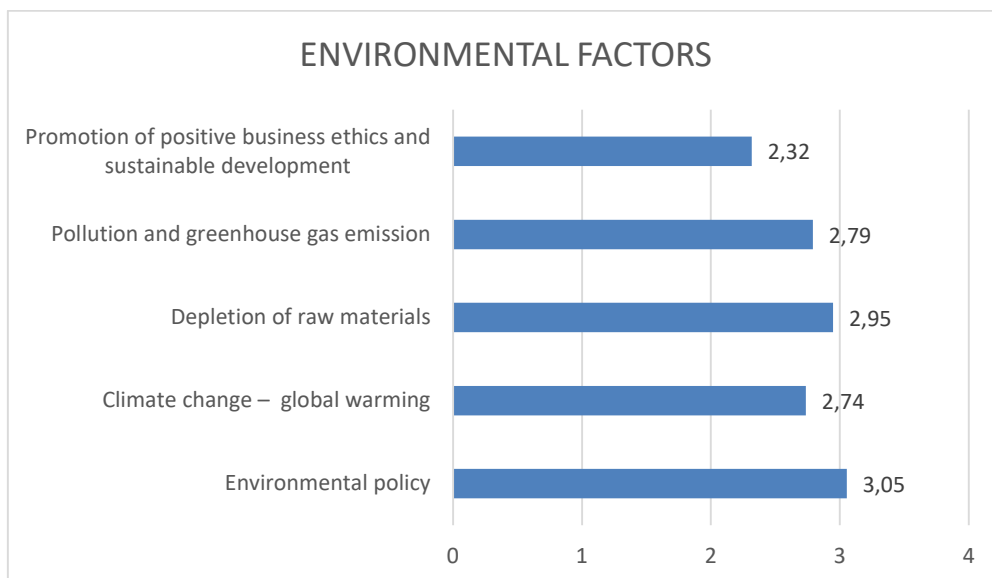


Figure 33.. Average value of environmental barriers on 1-4 scale

Source: Own elaboration

In the group of environmental factors, the respondents attributed the most significance to the environmental protection policy and the problem of resource depletion (Fig. 33). In the raw materials industry, these are important issues as the areas of *eco trends*, *green power*, *circular economy* etc. are systematically developing and gaining more and more supporters. This significantly translates into the functioning of enterprises in this industry. The respondents indicated the promotion of positive business ethics as a barrier with the least impact on the functioning of companies in the RMs industry.

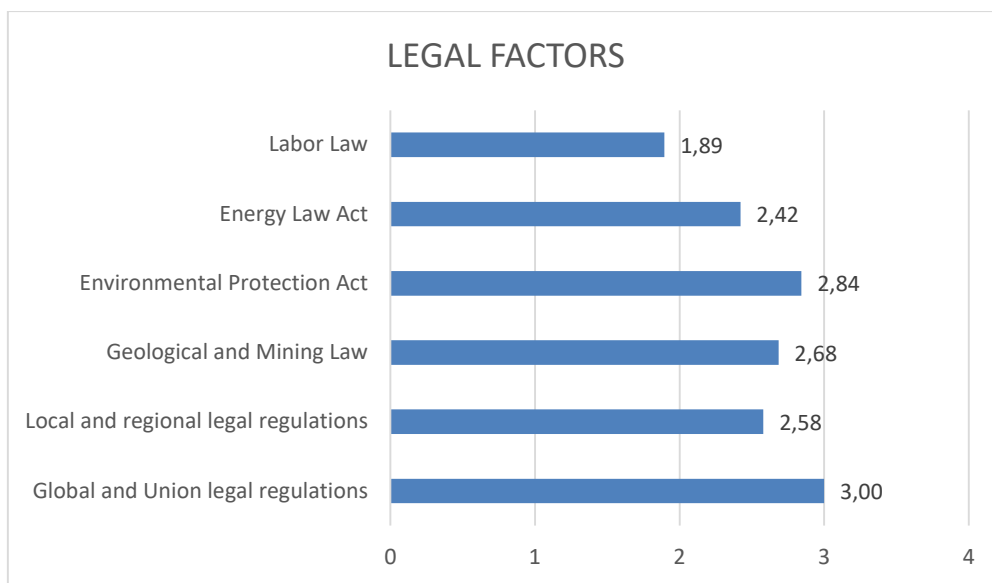


Figure 34. Average value of legislative barriers on 1-4 scale

Source: Own elaboration

As far as legislative factors are concerned, the global and EU legal regulations turn out to be crucial in the light of surveys. In fact, the EU regulations strongly interfere with the individual policies of member states, and the companies operating in the RMs area in Poland must therefore take into account the need to apply the provisions arising from the EU regulations and directives. This may strongly affect the freedom of Polish companies to act. Respondents considered the Labour Code provisions as the least restrictive (Figure 34).

## 11.7. Companies in Industry

The compilation presented below presents the financial data of entities of the most important industries: power, petroleum, chemical, mining, metallurgy, and steel distribution, as well as construction and transport, logistics, and services for industry.

*Table 28 Major stakeholders of Polish RMs sector*

No.	Company	SALE 2018 [PLN]	NET PROFIT 2018 [PLN]
1	POLSKI KONCERN NAFTOWY ORLEN SA (GK)	109,706,000,000	5,604,000,000
2	POLSKIE GÓRNICTWO NAFTOWE I GAZOWNICTWO SA (GK)	41,234,000,000	3,209,000,000
3	GRUPA LOTOS SA (GK)	30,121,700,000	1,587,400,000
4	PGE POLSKA GRUPA ENERGETYCZNA SA (GK)	25,946,000,000	1,511,000,000
5	LOTOS PALIWA SP. Z O.O.	23,988,240,000	180,536,000
6	KGHM POLSKA MIEDŹ SA (GK)	20,526,000,000	1,658,000,000
7	TAURON POLSKA ENERGIA SA (GK)	18,121,748,000	207,045,000
8	VOLKSWAGEN POZNAŃ SP. Z O.O.	17,913,514,000	393,194,000
9	ARCELORMITTAL POLAND SA	16,868,891,000	517,703,000
10	FCA POLAND SA	13,324,100,484	262,815,570
11	ENEA SA (GK)	12,672,770,000	719,250,000
12	PGE GÓRNICTWO I ENERGETYKA KONWENCJONALNA SA	12,403,966,648	39,892,862
13	ENERGA SA (GK)	10,337,000,000	744,000,000
14	POLSKIE SIECI ELEKTROENERGETYCZNE SA	10,097,051,000	489,908,000
15	GRUPA AZOTY SA (GK)	9,998,967,000	7,650,000
16	JASTRZĘBSKA SPÓŁKA WĘGLOWA SA (GK)	9,809,500,000	1,760,800,000
17	POLSKA GRUPA GÓRNICZA SA (GK)	9,548,495,000	494,887,000
18	PGE OBRÓT SA	8,913,146,354	-655,002,593
19	SHELL POLSKA SP. Z O.O.	7,663,284,000	b.d.
20	BUDIMEX SA (GK)	7,387,137,000	305,484,000

*Source: Author's own elaboration based on WSE data*

## 11.8. Stockholders in Poland

Companies from the RW sector listed on the Warsaw Stock Exchange, broken down into six sectors: mining, fuel and gas, energy, metallurgy, chemicals, and recycling.

Table 29. Stockholders in Poland

Sector	Stockholders in Poland
Mining	Jastrzębska Spółka Węglowa SA
	KGHM Polska Miedź SA
	Lubelski Węgiel Bogdanka SA
Fuel and gas	Grupa Lotos SA
	Polski Koncern Naftowy Orlen SA
	Polskie Górnictwo Naftowe i Gazownictwo SA
	SKOTAN SA
	TERMO-REX SA
	UNIMOT SA
Energy	Elektrociepłownia Będzin SA
	ENEA SA
	ENERGA SA
	ML SYSTEM SA
	PGE Polska Grupa Energetyczna SA
	POLENERGIA SA
	TAURON Polska Energia SA
	Zespół Elektrociepłowni Wrocławskich KOGENERACJA SA
	Zespół Elektrowni Pątnów-Adamów-Konin SA

<b>Metallurgy</b>	ALUMETAL SA
	Boryszew SA
	Cognor Holding SA
	Ferrum SA
	Grupa Kęty SA
	Mennica Polska SA
	Odlewnie Polskie SA
	PGO SA
	Stalprodukt SA
<b>Chemistry</b>	CIECH SA
	Grupa Azoty SA
	Grupa Azoty Zakłady Azotowe Puławy SA
	Grupa Azoty Zakłady Chemiczne Police SA
	PCC EXOL SA
	PCC ROKITA SA
	POLWAX SA
<b>Recycling</b>	DROP SA
	EKO EXPORT SA
	ELEMENTAL HOLDING SA
	Krynicki Recykling SA
	MO-BRUK SA
	Orzeł Biały SA

Source: Author's own elaboration based on WSE data

## 11.9. PESTEL analysis of IT in Polish Raw Materials Industry

A Pestel analysis conducted within the impact assessment of particular factors on the activity of IT entities in the Raw Materials sector in Poland was prepared on the basis of expert research. Ten specialists, well familiar with the RMs area, prepared an independent and anonymous evaluation of the particular factors divided into 6 groups. The factors were as follows:

*Table 30. Particular factors concerning activities of IT entities in Raw Materials sector in Poland*

Factor type	Factor
<b>Political factors</b>	State support in the form of tax allowances (special economic zones, etc.)
	No government support for IT investments in mineral resources sector
	Co-financing from the EU funds
	Progressing political marginalisation of mineral resources sector in Poland
<b>Economic factors</b>	Economic growth
	Financial performance of key target groups
	Pandemic situation
	Access to sources of funding (EU, KIC, Horizon 2020, etc.)
	Investment costs
	Tax burden
<b>Social factors</b>	Other costs related to specifics of Raw Materials sector
	Change in education trends (more emphasis put on IT sector)
	Required qualifications specialised education
	Growing importance of ICT technology in everyday life - new trends
	Growing importance of IT-related professions
<b>Technological factors</b>	Human capital investment
	Facilitating use of large amounts of data (cloud computing)
	Delays in knowledge and technology transfer
	Innovations
	Lack of appropriate technologies
	Lack of qualified staff
	IT cluster initiatives
	Growing pressure on Industry 4.0 idea
	Relatively large number of scientific centres (access to specialists, technologies, computing power)
Large scale of investment ventures	
<b>Environmental factors</b>	Increasing employee awareness concerning environmental protection
	Promoting business ethics
<b>Legislative factors</b>	Global and EU legal regulations
	Regional and local legislation
	Labour Code
	IT sector legislation (both in Poland and in EU)

*Source: Own elaboration*

In particular groups, the results of the analyses were as follows:

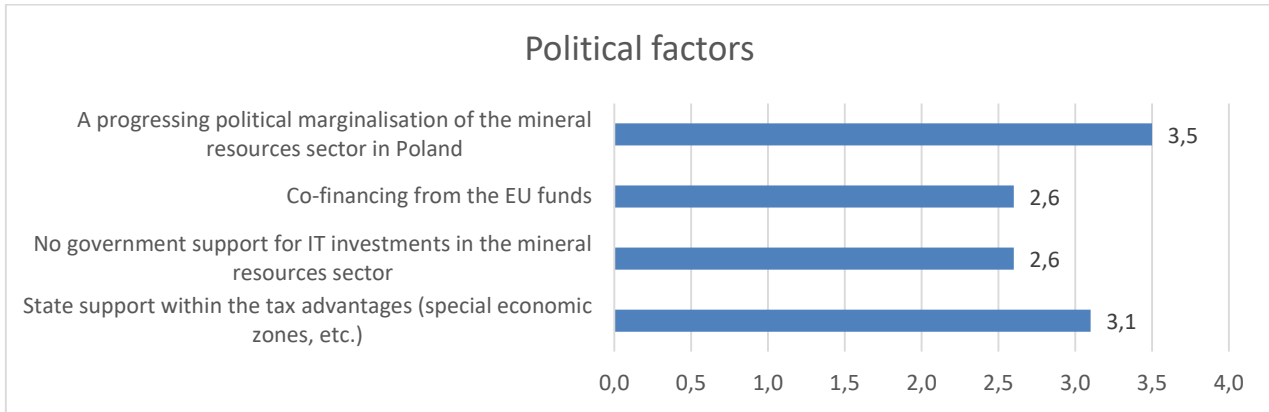


Figure 35. Average value of political factors in IT sector entities in Raw Materials sector in Poland (on 1-4 scale)

Source: Own elaboration

An important factor constituting a political barrier for the activities of IT sector entities in the Polish Raw Materials sector, which was particularly emphasised by the experts that have given it the most points, is undoubtedly the progressing political marginalisation of the mineral resources sector in our country (Fig. 35). It becomes visible through the lack of government support for IT investments, so necessary in the analysed sector. Despite the lack of government support for investments in the businesses operating in this sector, they can apply for EU funding. Government support includes only tax allowances for special economic zones (SEZs). Business activities performed in such zones may be conducted under favourable conditions, meaning that enterprises located in SEZs may receive public aid in the form of tax exemptions.

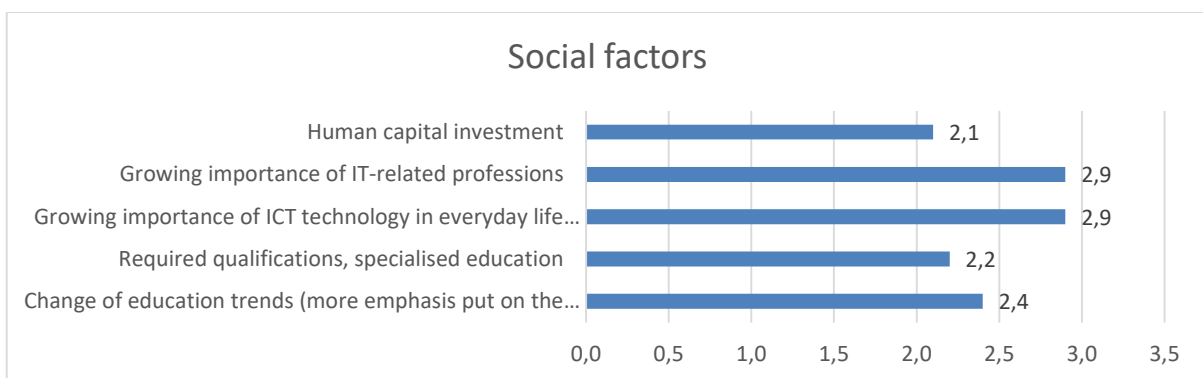


Figure 36. Average value of social factors in IT sector entities in Raw Materials sector in Poland (on 1-4 scale)

Source: Own elaboration

Social factors are a group of barriers determined by the society, so they are relatively volatile over time. At present, the most important social factors for the activities of the IT sector entities in the Raw Materials sector, as indicated by the respondents, were the recently growing importance of IT-related professions and new trends resulting from the growing importance of ICT technology in everyday life (Fig 36).

As indicated by respondents in the earlier survey, the lack of staff training for the needs of mining or mineral resources in general is mentioned in the responses of IT experts. The lack of staff has resulted in the growing importance of IT-related professions and in higher qualification requirements for the newly employed, ideally possessing specialised sector education. Such a situation has resulted in changes in education trends at universities related to IT sector requirements.

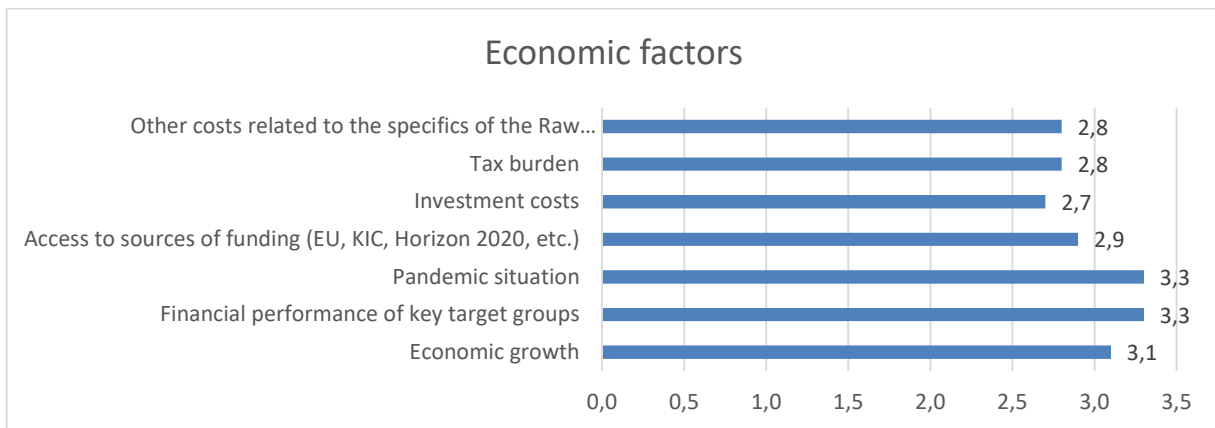


Figure 37.. Average value of economic factors in IT sector entities in Polish Raw Materials sector (on 1-4 scale)

Source: Own elaboration

In the group of economic factors, the experts indicated two factors as the most critical barriers in the current situation in Poland: pandemic situation, resulting in crisis situations for many enterprises on the market, and financial performance of key target groups (Fig. 37). The last factor seems to be a strong determinant for small enterprises which are just starting their business activities, and which find it difficult to acquire specific customers and to ensure the continuity of their orders. Economic growth was ranked third. Another barrier significantly determining the activity of IT sector entities in the raw materials industry in Poland is the access to the sources of funding (EU, KIC projects or Horizon 2020). The sources of funding are extremely important for the development of these enterprises, all the more so that they cannot count on the

government support as far as investment issues are concerned. In the economic factors group, the least significant barriers, as identified by the respondents, were tax burdens, other costs related to the specifics of the Raw Materials sector and investment costs.

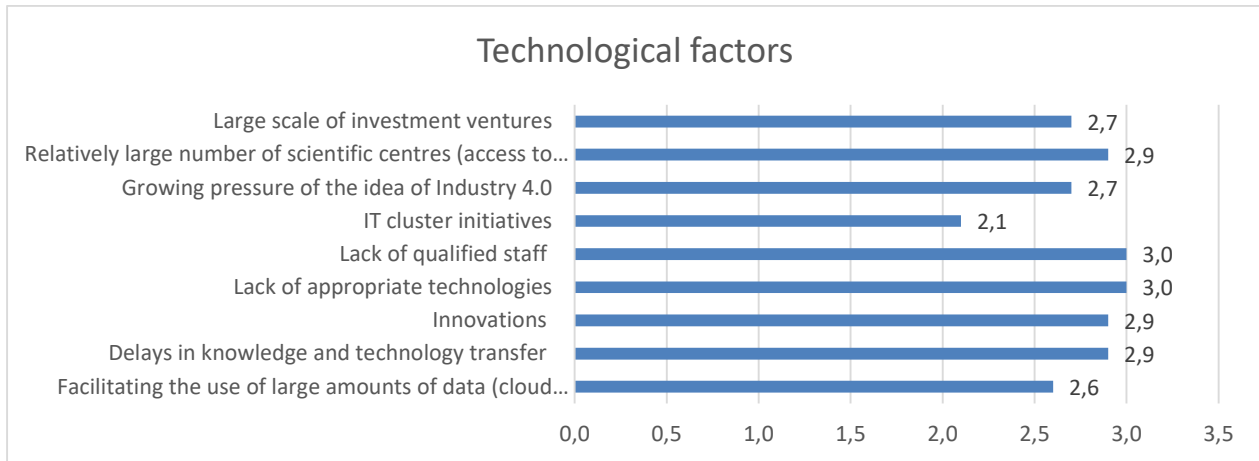


Figure 38. Average value of technological factors in IT sector entities in Polish Raw Materials sector (on 1-4 scale)

Source: Own elaboration

Technological barriers can constitute a rather strong limitation in the functioning of IT sector enterprises. According to the experts participating in the study, the greatest threat is posed by the lack of qualified staff and appropriate technologies. Moreover, this group includes a relatively large number of scientific centres, innovations and delays in knowledge and technology transfer (Fig. 38). It is a global trend and threat, closely linked to the idea of Industry 4.0, which constitutes an important barrier to the functioning of that sector. Delays in knowledge and technology transfer are the result of, among others:

- Lack of developed strategies or implemented policies;
- Often erroneous allocation of EU funds that support broadly understood entrepreneurship but mainly in the SME sector, and not in strategically important sectors;
- Excessive formalization, bureaucratization of support mechanisms, which leads to the fact that funds are spent in accordance with the set procedures but not necessarily with development goals. This even leads to avoiding risky innovation pro-development undertakings (currently essential), thus favouring safe and standard activities that do not bring major development changes;

- Low level of public administration representatives' competence;
- Fact that administrative issues take up to 90% of the time, which is to the detriment of substantive activities.

A large scale of investment ventures is also a significant barrier.

The lowest level of importance was given to the IT cluster initiatives.

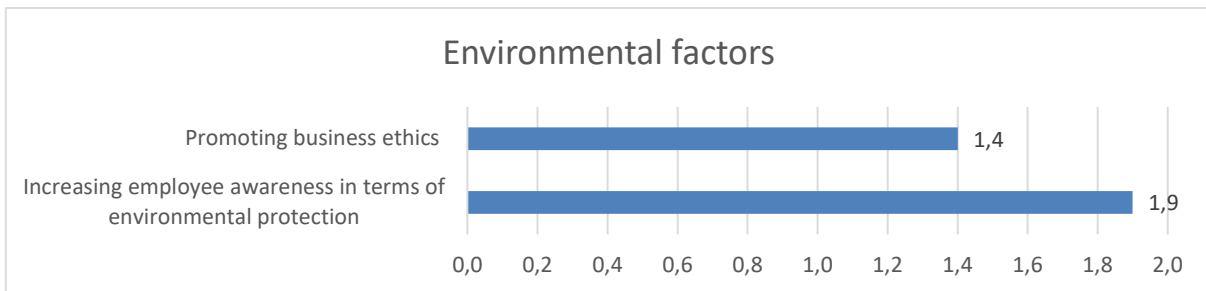


Figure 39. Average value of environmental factors in IT sector entities in Polish Raw Materials sector (on 1-4 scale)

Source: Own elaboration

In the group of environmental factors, the experts' team indicated an increasing employee awareness in terms of environmental protection as the most significant factor (Fig. 39). This is an extremely critical issue in current trends in environmental awareness. Promoting business ethics was indicated as the barrier with the least impact on the functioning of IT sector companies.

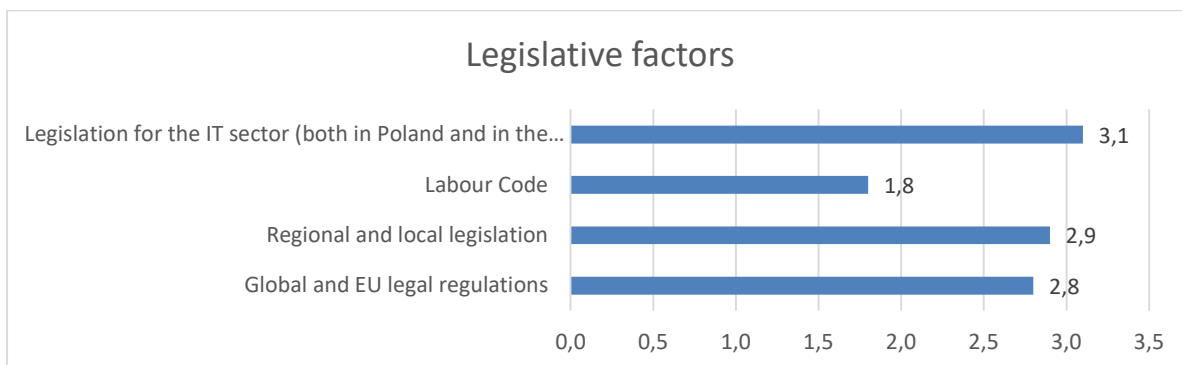


Figure 40. Average value of political factors in IT sector entities in Polish Raw Materials sector (on 1-4 scale)

Source: Own elaboration

In the group of legislative factors, the experts identified legislation for the IT sector as the most significant factor. Other positions include regional and local legislation as well as global and EU legal regulations (Fig. 40). The companies working in the IT sector must operate in accordance with the law and regulations applicable to the IT sector. The Labour Code regulations were indicated as the least restrictive factor.

### 11.10. Key Companies in Raw Materials IT Industry

Many entities operating on the RMs market in Poland have their own IT centres and departments, supporting both software and business analytics domains. This is particularly true for large entities such as JSW SA, PGG SA or LW Bogdanka or KGHM Polska Miedź. However, there are companies operating on the market that are getting ahead in the area. Table 31 shows the companies that are progressing most in the area and the scope of their basic activities.

*Table 31. Companies operating in IT sector in field of mineral resources in Poland*

Company name	Area of activity
ABB in Mining <a href="https://new.abb.com/mining">https://new.abb.com/mining</a>	<ul style="list-style-type: none"> <li>- Global leader in the energy industry and automation technologies;</li> <li>- Adding intelligent software to electrification, robotics, automation, and drive system products.</li> </ul>
CARBOAUTOMATYKA S.A. <a href="https://carbo.com.pl">https://carbo.com.pl</a>	<ul style="list-style-type: none"> <li>- Design, completion, and assembly of mining automation systems services;</li> <li>- Offering, among other things, safety, monitoring and communication systems products, gasometry products, as well as control and automation of technological process systems for underground mining.</li> </ul>
COIG S.A. <a href="https://www.coig.pl/">https://www.coig.pl/</a>	<ul style="list-style-type: none"> <li>- Company specializing in the delivery of comprehensive, dedicated IT solutions that support management processes;</li> <li>- Offering the only ERP system in the country that contains unique solutions for the mining industry;</li> <li>- Industry-related IT infrastructure security services that secure the entire IT infrastructure, including key data.</li> </ul>

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<p>Geotechnology Sp.z o.o. <a href="https://www.geotechnology.pl">https://www.geotechnology.pl</a></p>	<ul style="list-style-type: none"> <li>- Specializing in IT technologies and solutions;</li> <li>- Offering comprehensive IT support;</li> <li>- Designing and implementing IT solutions, or document circulation systems.</li> </ul>
<p>Haso S.C. <a href="http://haso.pl">http://haso.pl</a></p>	<ul style="list-style-type: none"> <li>- Offering comprehensive professional service solutions for the development and implementation of new mining and gas systems;</li> <li>- Offering automation systems that improve machine and equipment productivity, reduce operating costs, and improve machine safety;</li> <li>- Safety systems, automation.</li> </ul>
<p>PRGW Geologia i Informatyka w Górnictwie <a href="http://prgw.com.pl">http://prgw.com.pl</a></p>	<ul style="list-style-type: none"> <li>- Company's business portfolio covers the entire range of software, from Windows and Linux operating systems and basic utility programs, through Bentley CAD software to specialized mining facility management software.</li> </ul>
<p>RAW MATERIALS POLSKA SP. Z O.O. <a href="https://www.imsig.pl">https://www.imsig.pl</a></p>	<ul style="list-style-type: none"> <li>- Its activity covers software and IT consulting;</li> <li>- In particular, customised software development, creation, delivery, and documentation, customised programming, computer system design and planning.</li> </ul>
<p>Sevitel <a href="https://sevitel.pl">https://sevitel.pl</a></p>	<ul style="list-style-type: none"> <li>- Leading supplier and manufacturer of specialized top-quality innovative telecommunication, gasometric, uninterrupted power supply and information and communications technology solutions as well as work safety solutions for the mining industry and other industrial facilities.</li> </ul>
<p>TEL-STER Sp. z o.o. <a href="https://www.tel-ster.pl">https://www.tel-ster.pl</a></p>	<ul style="list-style-type: none"> <li>- Delivering modern industrial automation and gas industry technologies;</li> <li>- Offering comprehensive industrial automation equipment software implementation solutions (various types of software).</li> </ul>

<p>WASKO S.A. <a href="https://www.wasko.pl">https://www.wasko.pl</a></p>	<ul style="list-style-type: none"> <li>- One of the largest Polish companies implementing modern technologies;</li> <li>- Dealing with IT solutions, industrial automation, telecommunications and electronics design and integration.</li> </ul>
<p>ELGÓR+HANSEN S.A. <a href="https://elgorhansen.com/">https://elgorhansen.com/</a></p>	<ul style="list-style-type: none"> <li>- Installing industrial automation systems and software, in particular complex control (PLC, DCS) and visualisation (SCADA) of industrial object systems, such as production lines and moving machines;</li> <li>- Comprehensive production and supply of electrical power distribution equipment used on the floors of underground mining facilities, and of complete power supply and automation systems for facilities, machines and installations used in underground mining for haulage systems, high-efficiency mine face, longwall, and plough complexes at all supply voltage levels.</li> </ul>
<p>SOMAR S.A. <a href="https://somar.com.pl/">https://somar.com.pl/</a></p>	<ul style="list-style-type: none"> <li>- Company offering industrial technological process control and monitoring systems;</li> <li>- Completing and implementing monitoring systems for machines and equipment operating on mine floors;</li> <li>- Producing components and devices of its own design, designed for machines and system automation in coal mining.</li> </ul>
<p>PPHU ATUT Sp. z o.o. <a href="http://www.atutnet.com/pl">http://www.atutnet.com/pl</a></p>	<ul style="list-style-type: none"> <li>- Visualization and production process support systems;</li> <li>- Comprehensive solutions aimed at increasing crew safety, improving the efficiency of mining operations and ensuring continuous monitoring of technological process telemetric parameters;</li> <li>- Means of transport monitoring systems together with material logistics in technological processes on the surface and in underground mine workings.</li> </ul>
<p>INSTYTUT TECHNIK INNOWACYJNYCH EMAG <a href="http://www.ibemag.pl">http://www.ibemag.pl</a></p>	<ul style="list-style-type: none"> <li>- Institute offering IT, cyber security and 4.0 industry solutions;</li> </ul>

	<ul style="list-style-type: none"> <li>- Industrial automation, security, and telecommunications systems;</li> <li>- Technological process monitoring systems;</li> <li>- Environmental protection solutions.</li> </ul>
<p>SENTE  <a href="https://www.sente.pl">https://www.sente.pl</a></p>	<ul style="list-style-type: none"> <li>- Manufacturing industry solution covering all company areas that affect the manufacturing process;</li> <li>- Integrated manufacturing solutions, which include <a href="#">ERP</a>, MRP, MES and CRM system functionalities;</li> <li>- Production reporting models.</li> </ul>

## 12. Start-up Case study

Unfortunately, it was not possible to analyse the start-up market. The reason was a small number of such entities on the raw materials market, especially in the area of ICT. Another reason for the lack of market research in this industry is a significant reluctance to respond to questions - mostly because of competition and the need to protect sensitive data. The structure of the survey was very detailed and led to a general reluctance to respond.

Below presented is the analysis of research results concerning specific companies operating in the raw materials industry in Poland. There are two entities: entity X operating on the market for a long time and widely known in Poland that conducts activities in the field of ICT in the RMs industry and entity Y representing a one-man business with the activities performed in the same, i.e. RMs area.

The **X Company** focuses on delivering comprehensive, dedicated IT solutions to support management processes. The company was founded in 1951 to deliver computing services for the mining sector, so it is one of the oldest and most experienced Polish IT companies. The X Company is a member of the Polish Information Processing Society (PTI), an organization that has been bringing together professionals from the IT industry since 1981.

It skilfully uses its decades of experience and the latest IT achievements to support its customers in the areas of IT applications. The clients of Company X are the entities from the areas of:

- Local government administration - municipal and commune offices and its derivatives, marshal offices, etc.;
- Small and medium-sized industrial and service enterprises;
- Mining - most of them from the hard coal mining sector;
- Various entities, in particular those that use IT outsourcing services.

The bases for the wide range of IT services provided are proprietary management solutions, ERP systems of leading global software producers and a modern Data Processing Centre. These multi-module, professional management support systems are solutions primarily intended for medium and large applications. A

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significant supplement to the offer in the area of business software are the **systems supporting document and cash flow management** as well as **independent electronic platforms supporting selected** areas (purchases, task management, electronic auctions, property management, HR, clinic service). Each of the implemented projects involves groups of analysts, designers, programmers, consultants, implementation specialists and specialists in the field of services. As of the end of January 2020, there are 510 people employed, including 450 full-time employees.

X's own professional Data Processing Centre allows the company to outsource its IT solutions. The Data Processing Centre is also a standard and brings the possibility to provide services such as hosting, collocation, data processing (including those based on Business Intelligence tools) or a backup centre. Many years of experience in providing a wide range of these services result in Company X being also a recognized service provider in the area of system integration. The main goal of its activities is to provide high-quality solutions and services that will satisfy customers as much as possible. At each stage of creating, implementing, or improving an IT system, the customer can count on direct support of X Company's IT specialists in the form of conceptual and specialized consultancies. Then, by exploiting Company X solutions, users can be given various forms of support at the level of application service, technological supervision, and consulting.

#### Conclusions:

1. Company X is a large entity specializing in providing comprehensive IT solutions.
2. The company is one of the oldest and most experienced Polish IT companies - it was founded in 1951.
3. The mission of Company X is to systematically increase its value, which can be achieved through the continuous development of proprietary IT solutions.
4. Company X provides employees with an opportunity to continuously improve their qualifications.
5. Company X is a recognized service provider in the area of system integration.

Entity Y is a form of sole proprietorship the activity of which is based on the owner's work delivered to external entities. Additional manpower is only contracted only when there is a need to perform the work

commissioned to the company with the help of subcontractors. The company has two computers with high computing power (multi-threaded workstations) used to carry out orders, under which ventilation calculations are performed using CFD software. In such an enterprise, it is necessary to consider the lack of standing orders, which, from the point of view of economic efficiency, is of disadvantage. Moreover, the payment for the implementation of highly specialized and unusual orders is made only after order completion. The weaknesses of running a sole proprietorship (by the owner) outweigh the advantages. Insufficient competences and references of the owner prevent the company from participating in many tenders. Thus, the company may only become a subcontractor in such projects. The strength of this form of business, however, is its flexibility in the implementation of orders.

The company offers highly specialized engineering services whose recipients are: GDDKiA, management boards of mining companies, law offices. The scope of services provided (having the nature of unique expertise) is associated with the transfer of copyrights and property rights to the client, hence it is not possible to protect their intellectual property.

Inspiration for new ideas comes during the implementation of orders as part of cooperation with other entities, and new areas/obstacles appear that need to be solved.

The owner's participation as a member of the Polish Committee on Geotechnics and the Aerology Section of the Polish Academy of Sciences certainly has a positive impact on cooperation with the above-mentioned entities.

The most common problems encountered by the company are administrative and official matters (Tax Office, Social Insurance Authority, and others) and clients' slow decision-making process - it often takes a year from defining a problem to signing a contract.

The basic source of funding for the company is own resources.

The following tables 32, 33 and 34 summarize the most important elements of the survey from two entities, i.e. X and Y. The comparison of the entities was divided into three sections, namely: a short description of the companies, its location and cooperation, and policies and barriers.

Table 32 Part I – Brief company description

Area	Specification	Subject X	Subject Y
I. Brief company description	Legal form	Spółka akcyjna (joint stock company)	Sole proprietorship
	Range of operations	Unlimited	Voivodeship Mazowieckie, Śląskie, Podkarpackie, India
	Organizational structure	In general, the organizational structure is of a linear type with a supervisory and management level typical for a joint-stock company with a supervisory board and a multi-person management board. At lower management levels, the Company has a linear, departmental structure, with departments assigned to particular product/activity groups.	none
	Advantages of technical equipment	Extensive Data Centre is equipped with the latest generation software and hardware	- Two high-performance computers (multi-core workstations); - CFD software.
	Advantages / disadvantages of technological equipment	Latest generation of technological equipment	Not applicable
	Disadvantages of technical equipment	None	None
	Barriers to investment activities	No significant barriers to investments have been identified both in maintenance and development and in financing.	- Lack of standing orders; - Payment for the order only after its completion.
	Strengths	- Experience; - Competences; - Own professional environment; - Data Processing Centre; - Geographical location.	High flexibility in the implementation of orders (simplification of decision-making and administration)
	Weaknesses	- No developed sales methods in the sector of small and individual customers	- Lack of competence to handle larger orders; - Lack of appropriate references;

			<ul style="list-style-type: none"> <li>- Exclusion from many tenders;</li> <li>- Assuming a role of a subcontractor.</li> </ul>
Brief history	<ul style="list-style-type: none"> <li>- 1951 - Company establishment;</li> <li>- 1976 - State-owned enterprise established; at that time, the company was implementing new services and equipment solutions in the mining industry;</li> <li>-1994 - Transformation into a sole shareholder company of Treasury;</li> <li>-2004 - Modern Data Processing Centre.</li> <li>- 2012 - Start of the privatization process, completed in 2015.</li> </ul>		<ul style="list-style-type: none"> <li>- 2008-2012 - Company originally operating as a civil law partnership, then dissolved;</li> <li>- Since 2018, its activities resumed under a different legal form.</li> </ul>
Products, services	Very extensive range of both finished products and services.		Engineering services
Recipients	<ul style="list-style-type: none"> <li>- Local government administration - municipal and commune offices and derivatives, marshal offices, etc.;</li> <li>- Small and medium-sized industrial and service enterprises;</li> <li>- Mining - most entities from the hard coal mining sector;</li> <li>- Various entities, particularly those using IT outsourcing services in particular.</li> </ul>		<p>GDDKiA</p> <ul style="list-style-type: none"> <li>- Management boards of mining companies;</li> <li>- Law firms.</li> </ul>
Protection of intellectual property	- Trademark		<ul style="list-style-type: none"> <li>- None;</li> <li>- Transfer of copyrights and property rights to the client takes place.</li> </ul>
Differences in the offered product and services from the competitors	X's IT systems are mainly delivered in the form of large, integrated, and complete packages tailored to customers' specific needs		- Uniqueness of expertise.

	Customers - areas	<ul style="list-style-type: none"> <li>- Area 1: State and local government administration;</li> <li>- Area 2: Mining industry;</li> <li>- Area 3: Small and medium-sized enterprises;</li> <li>- Area 4: Entities using services in the field of ICT.</li> </ul>	<ul style="list-style-type: none"> <li>- Area 1: Road construction, tunnel construction, tunnel ventilation, safety;</li> <li>- Area 2: Technical and economic analyses related to the mining industry, consulting, expertise.</li> </ul>
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Source: Own elaboration

Table 33. Part II - Location and cooperation

Area	Specification	Subject X	Subject Y
II. Location and cooperation	Choice of location	Proximity of the mining sector - Katowice - capital of the Upper Silesian Coal District	Ownership rights to the premises
	Key customers	<ul style="list-style-type: none"> <li>- Other WASKO CG companies;</li> <li>- Various subcontractors.</li> </ul>	<ul style="list-style-type: none"> <li>- Court valuers;</li> <li>- Law firms;</li> <li>- Individuals.</li> </ul>
	Other clients' sectors	<ul style="list-style-type: none"> <li>- IT sector entities;</li> <li>- Construction services;</li> <li>- Telecommunication services.</li> </ul>	<ul style="list-style-type: none"> <li>- Mining industry;</li> <li>- Road construction.</li> </ul>
	Factors influencing company's operations	<ul style="list-style-type: none"> <li>- Business areas;</li> <li>- Qualified workforce;</li> <li>- Competition;</li> <li>- Companies from related industries;</li> <li>- Availability of suppliers;</li> <li>- Market development dynamics;</li> <li>- Organisation of major events (fairs, festivals ...);</li> <li>- Educational opportunities;</li> <li>- Availability of financial resources;</li> <li>- State aid.</li> </ul>	<ul style="list-style-type: none"> <li>- Business areas;</li> <li>- Qualified workforce;</li> <li>- Availability of suppliers.</li> </ul>

	Factors with neutral impact on company's operations	<ul style="list-style-type: none"> <li>- Local market size;</li> <li>- Business infrastructure.</li> </ul>	<ul style="list-style-type: none"> <li>- Local market size;</li> <li>- Presentation of results: conferences, seminars, advertising;</li> <li>- Organisation of major events (fairs, festivals ...);</li> <li>- Availability of financial resources;</li> <li>- State aid.</li> </ul>
	Factors with no impact on company's operations	<ul style="list-style-type: none"> <li>- Presentation of results: conferences, seminars, advertising</li> </ul>	<ul style="list-style-type: none"> <li>- Competition;</li> <li>- Companies from industries related to theirs;</li> <li>- Market development dynamics;</li> <li>- Educational opportunities;</li> <li>- Business infrastructure.</li> </ul>
	Evaluation of company's position in industry (1-10 scale)	"Lack of information"	4
	Conception of new products	<ul style="list-style-type: none"> <li>- New products are the result of customer expectations;</li> <li>- They also appear at fairs and conferences;</li> <li>- Arising from contacts with the scientific community (business/product trends).</li> </ul>	New problems to be solved appearing during the implementation of orders
	Membership in associations	Polish Information Processing Society	<ul style="list-style-type: none"> <li>- Polish Committee on Geotechnics;</li> <li>- Aerology Section of the Polish Academy of Sciences.</li> </ul>

Source: own elaboration

Table 34. Part III - Policy and barriers

Area	Specification	Subject X	Subject Y
III. Policy and	Most common problems of the company	<ul style="list-style-type: none"> <li>- Acquiring high-class IT specialists;</li> <li>- Significant competition;</li> </ul>	<ul style="list-style-type: none"> <li>- Administrative, official matters (Tax Office, Social Insurance Institution and others);</li> </ul>

		- Strong demand on the market.	- Indecision among clients.
Sources of funding		Own resources	Own resources
Significant sources of funding for such activities		- Own resources; - Credits (alternatively).	- Own resources; - Public sources of finance; - Foreign sources (e.g. the EU).
Insignificant sources of funding for such activities		- Sponsors; - Local sources (municipality, commune); - Public financial sources; - Foreign sources (e.g. the EU).	- Loans; - Sponsors; - Local sources (municipality, commune).
What form of support should state, region, city provide?		State: legal and financial support for R&D projects	-
Have you ever used such support?		Yes	No
Type of support		R&D project - support through the National Centre for Research and Development (NCBiR) as part of a consortium	-

Source: Own elaboration

Despite the difference in the size of the analysed entities, as well as the scope and scale of their activities, some similarities are noted (Table 31). Customer to whom they address their offer is a key element. The main customer in both cases is the mining sector. A link between them is also the product, namely various types of calculations services, expert opinions, etc., for which both entities are adequately equipped with specialized software. Due to the common area of activity, there are also overlapping factors that influence their activities, which include: business areas, qualified/workforce and availability of suppliers. The ideas of both entities for new products arise during the implementation of orders, i.e. they are a response to customers' expectations. Similar are also the sources of funding for both activities - both use their own financial resources (Table 32).

On the other hand, there are elements proving differences between the analysed entities. The protection of intellectual property is essential. Entity X has its own trademark, while the scope of services of entity Y involves the transfer of copyrights and property rights to the customer, hence it is not possible to protect them (Table 30). Despite having tried to apply for patent protection of its own solutions with a view of their subsequent sale, the owner withdrew from this form of protection due to the process being very time consuming (Patent Office's refusal of registration and protracted procedure). The second major difference is the aid and support from the state and regional bodies. It can be noted that entity X that conducts more extensive activities and is known on the market, can count on legal and financial support for implemented R&D projects having the form of a state aid. It is difficult to obtain such a support by a small business that has been fairly new to the market.

Nevertheless, both entities that responded to the surveys, render their services in the IT field, using various types of software necessary for the implementation of orders in the mining sector. As one can see, regardless of the size of such an entity and the scale of its operations, any company (even the smallest) can find recipients of its products and services. Especially given the fact that the market demands a high number of services offered by the respondents X and Y.

## 13. Potential Entrepreneurs

As part of the analysis of potential entrepreneurs' attitudes, surveys were conducted among the current students of the Faculty of Mining and Geoengineering at the AGH University of Science and Technology in Krakow (there were initially supposed to be direct interviews with students; due to the Covid-19 pandemic, however, it was necessary to change the way of obtaining information). The research covered master's degree students in the fields related to Raw Materials. These were especially students of the Faculty of Mining and Geoengineering: Mining and Geology, Engineering and Management of Industrial Processes (and Management and Production Engineering) and Civil Engineering.

Students responded to the following questions:

1. Did you gain any entrepreneurship knowledge during your studies?
2. If so, what were the strengths and weaknesses of it?
3. What experience do you have with setting up your own company or opening a start-up in the raw materials industry or in any other industry that operates within the raw materials industry?
4. Are you planning to set up your own business or start-up in the raw materials industry or some other industry operating within the raw materials industry?
5. Do you know how to open a company, start-up, or own business in Poland?
6. Do you know that there are entities that offer support for start-up companies? If so, please list them.
7. What information about the market can, in your opinion, be helpful for new entrepreneurs in Poland (e.g. market trends, customer needs, segmentation, tax aspects, infrastructure...)?
8. What do you think are new Polish entrepreneurs' weaknesses?
9. What do you think are new Polish entrepreneur's strengths?
10. What factors, activities or circumstances could have led you to opening your own business or start-up in the raw materials or other industry operating within the raw materials industry?
11. Do you think that the knowledge you acquired during your studies was sufficient for opening your own business after graduation? What did you miss?

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12. Do you think that the skills and social competences you acquired during your studies were sufficient for opening your own business after graduation? What did you miss?

As a result of the conducted research, the following conclusions can be drawn on particular issues related to the students' knowledge acquisition and perception of running their own business after graduation (in the order the questions were asked).

Ad1) The vast majority of the respondents (15 out of 16) confirmed that they had gained entrepreneurship knowledge during the didactic process.

Ad 2) Students from the Faculty of Mining and Geology strongly emphasized that they had knowledge of the mining industry, but they pointed out weak parts such as the lack or an insufficient number of learning programmes on how to run one's own company. The strength is, in their opinion, the opportunity to take a fresh look at sciences useful in life. However, a low number of contact hours in a programme of studies did not allow for a sufficient exploitation of their potential and failed to communicate enough practical knowledge of entrepreneurship. On the other hand, students of Management and Production Engineering or Engineering and Management of Industrial Processes put a great emphasis on the economy of enterprises, good substantive preparation of lecturers and the number of interesting aspects related to entrepreneurship. They pointed out the following weaknesses: not enough didactic hours, lack of information about the business plan in lectures, not enough practical training sessions.

Ad 3) When asked about their experience related to the opening of their own company or start-up in the raw materials industry or other industries operating within the raw material industry, they all stated that they did not have such experience. There was a remark that during their studies they had conducted numerous projects in which they established theoretical companies from various industries and then worked on their development from different perspectives (depending on the subject).

Ad 4) The replies to the question about plans to open their own company or start-up in the raw materials industry or other industries operating within the raw materials industry, were as follows:

No - 10 answers

Yes, but later -3

Yes - 3 answers

Ad 5) The question about knowledge on how to open a company, start-up, or one's own business in Poland revealed the lack of this type of knowledge, which is by far the biggest shortcoming of the programme. Students pay particular attention to complicated provisions related to social security, taxes, and administrative procedures. It can be seen, however, that students of management-related faculties acquired such knowledge, at least at a general level. However, it is worrying that half of the respondents do not have such knowledge at all.

Ad 6) As for the support of the activities by assisting entities, half of the replies were negative - students do not know institutions and units that could provide them with support. And most of the supporting entities that were indicated by them, were mainly entities operating at the university. It is worrying that they do not indicate EU solutions as support for businesses or start-ups.

Ad 7) The respondents show much more interest in indicating market information which, in their opinion, may be helpful for potential entrepreneurs in Poland. The information mainly points to the market trends, according to which they could orientate themselves in the area of activities. They will also be helped by the information on niche markets in which they can operate, by the information about competition, demand for and supply of the offered products and by the information about costs of doing business (taxes, other costs, e.g. website maintenance), customers' needs in different regions, and market rates.

Ad 8) The following weaknesses that may affect new entrepreneurs in Poland were indicated:

- Bureaucracy;
- Complicated tax law;
- The state not helping enough with the establishment of new businesses;
- Ever-increasing competition;
- Incomprehensible administrative procedures;
- Insufficient knowledge about start-up regulations and standards as well as fear of failure;
- Difficulties in obtaining adequate funds to set up a company (high requirements to receive subsidies).

Ad 9) On the other hand, the following statements indicted strong points:

- Since Poland is in the group of developing countries there are many areas in which the corresponding enterprises are missing;
- There is a chance to introduce new, innovative products;
- Assistance in the initial stage of business development through start-up support funds, co-financing;
- Geographical location of the country, extensive ICT infrastructure;
- Tax exemption up to 26 years, "0" tax for young entrepreneurs;
- Lower social security contributions for the first 3 years, subsidies from the employment office;
- Increasing consumer awareness (e.g. ecology), customers are paying more and more attention to the quality of services and market openness to novelties;

Ad 10) As stated herein, the following elements could help with the establishment of one's own company or start-up in the raw materials industry or other industries operating in the field of raw materials:

- Opportunities for development prospects of own business;
- Substantial simplification of the tax and fiscal system;
- Change in the state's fiscal and resource policy;
- Exemption from paying taxes for the first min. 5 years of operation, support in the field of applicable law;
- Courses and training free of charge;
- Knowledge acquired during my studies influenced my perception of running my own business;
- Independence, flexibility (working hours, location), willingness to introduce innovations into the industry;
- Ease of setting up a company and preparing a business plan, increase in the demand and interest in the raw materials industry, high revenues for a company in the raw materials industry.

Ad 11) In terms of the knowledge acquired during studies, this was not sufficient for opening one's own business after graduation; the following two were most frequently mentioned: tax law and administrative procedures for establishing a company, start-up or business activities.

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Ad 12) In terms of skills and social competences acquired during studies that were not sufficient to open the own business after graduation, the following were mentioned: English skills and practical skills in opening and running a business.

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## 14. Summary

The mineral resources market in Poland is large. Not only manufacturing companies but also the whole range of entities operating in the raw materials industry, are situated on the market. A number of conclusions can be drawn from the prepared analyses concerning both the market itself and the entities operating on it, as well as from the examining of expectations of those who may soon become active players on the market.

### **Mineral Raw Materials in Poland**

Poland is a country rich in all four groups of mineral raw materials (energy resources, metallic resources, chemical resources, and rock resources). Due to the fact that the mineral raw materials are included in the group of depletable resources, their rational use, and the efforts to replace them with renewable sources have become of crucial importance. This issue concerns energy raw materials the most. Therefore, we have a growing number of wind farms, and solar and hydro power stations. The manufacture of biofuels is also increasing, which contributes to the improvement of the environmental cleanliness.

In Poland, the biggest deposits of mineral raw materials are those of hard coal, brown coal, rock salt, copper, zinc, and lead ore. Raw and metalliferous materials play the most important role in our country. The possession of own natural resources gives Poland significant independence. Such independence of the country is possible especially in connection with the use of hard coal and brown coal deposits in power and metallurgy industries.

Poland is one of the leading countries in hard coal production (5<sup>th</sup> place), silver extraction, coking coal extraction (8<sup>th</sup> place) and steam coal extraction (10<sup>th</sup> place). According to the balance of mineral resources deposits in Poland for the 2014-2018 period, only a part of the balance resources of individual raw materials was managed. It is therefore very important to support companies operating in the raw materials industry with various programs identifying deposits and with specialized software in the field of IT services for the mining sector. There is also a clear field of activities of the Junior Miners type of companies.

### **Determining Key Area for Potential Entrepreneurs in Poland**

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In the process of determining the key area for potential entrepreneurs in Poland, a broad analysis of the RMs market was performed. Based on the research given, the IT sector was selected. The key area of interest for potential entrepreneurs should also include the Internet and business in its broadest sense.

Combining the results of the analysis with the classification of activities in Poland (NACE classification), it was diagnosed that potential entrepreneurs should invest in the activities related to software and IT consulting and related activities. It is closely related to Industry 4.0 that is entering the Polish market and widely understood ICT technologies.

To sum up, the following are the most innovative areas in the ICT sector, which have or may have a potential in the Polish RMs sector:

- Intelligent sensor network technologies;
- Space navigation systems;
- Observation and identification systems using different ranges of electromagnetic waves than visible light and infrared;
- Cyberspace protection systems eradicating risks by developing IT infrastructure;
- Infrastructure and technologies of the distributed systems for e-business;
- Systems of logistic support and supply chain management;
- Intelligent control traffic system;
- RFID (radio-frequency identification) technologies;
- Semantic network technologies;
- Technologies of artificial intelligence for manufacture systems.

## Stockholders

Many companies from the RW sector are listed on the Warsaw Stock Exchange in Poland. To be more precise, there are 3 companies from the mining industry, 6 companies from the fuel and gas sector, 9 companies from the power industry, 9 companies from the metallurgy industry, 7 companies representing the chemical industry and 6 companies from the recycling industry present there. It should be mentioned

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that some other RW sector entities on the Polish market are already in the process of preparation for entering the Warsaw Stock Exchange.

### **Macro Environmental Analysis of RMs Area in Poland**

The PESTEL analysis was conducted in the following areas: political, economic, social, technological, environmental, and legislative. According to the research, Polish government's acceptance of the EU decarbonisation policy and progressing marginalization of the raw materials sector in Poland are political barriers that hamper the functioning of Polish enterprises in the raw materials sector. In addition, the lack of government support for investment in this sector is also acute.

In the group of economic factors, the respondents considered the tax burden to be the most significant barrier in the Polish raw materials industry. The high investment cost in the industry and high production costs are other barriers that largely determine the operation of entities in the raw materials industry in Poland. Due to the specific nature of the raw materials industry, there is a problem to access sources for financing business operations.

In the social area, the impact of the failure to apply staff training for mining purposes was identified as a barrier that makes it difficult to find qualified specialists. Among the relevant factors hampering the development of the industry, respondents also indicate an increase in environmental awareness and the generation gap.

Technological barriers can also constitute quite a strong limitation for the functioning of enterprises, especially on the raw materials market. According to the respondents, delays in the transfer of knowledge and technology are the greatest threats. This is a global trend and threat closely related to the idea of Industry 4.0.

However, in the group of environmental factors, the greatest emphasis was put on the environmental policy and natural resource depletion. In the raw materials industry, these are critical issues as the areas of eco trends, green power, circular economy etc. are systematically developing and gaining more and more supporters.

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As far as legislative factors are concerned, the global and EU legal regulations are perceived to be crucial in the light of surveys. EU regulations strongly interfere with the individual policies of member states, and therefore companies operating in the RMs area in Poland must take into account the need for applying the provisions arising from EU regulations and directives.

### **Analysis of Entities Operating on RM Market**

The analysis presented in the report shows that:

- Both entities that responded to the surveys conduct their services in the field of IT using various types of software necessary for the implementation of orders in the mining sector;
- Entity X, which is a large company, is recognizable on the market and does not have to look for customers; on the contrary, it is the customers who contact the company;
- It can be seen that entity Y, which is a smaller company, is struggling with more inconvenience of conducting this type of service activities (lack of standing orders, constant search for customers, difficulties in obtaining state support);
- Nevertheless, according to the submitted questionnaires, regardless of size of the entity and the scale of its operations, any company (even the smallest) can find recipients of its products and services.

The market has a high demand for the IT services offered by the respondents X and Y, as confirmed by previous surveys aiming at the identification of the key area of business in the RMs sector.

### **Potential Entrepreneurs**

- In recent years, the students from the Raw Materials sector have average to good theoretical preparation for running own businesses or setting up start-ups in the RMs industry;
- They, however, emphasize that they lack detailed knowledge related to tax law and administrative procedures and the knowledge on how to set up such a start-up or company;
- They are aware of niches in the industry and realize that such a niche can be an opportunity for them to succeed;

- Regarding the support for activities offered by assisting units it is unfortunate that they stated to have no overview of which units and institutions can provide such an assistance; they know that there is a possible support from EU funds but they lack detailed information on the matter;
- They are aware of the weaknesses and strengths of running a business in the RMs sector and are able to successfully identify those strengths and weaknesses.

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# CHAPTER 4

SLOVAKIA

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## 15. Overview of Slovak Raw Materials Market

Within the frame of certain regions, the base of mineral raw materials provides the value that can be comprehensively evaluated under the condition of their optimal use. This way, there are benefits to enjoy by the owner, state, mining company and a particular region (Ciruelos & Duchene, 1983). The benefit for the state lies in a reasonable and rational use of deposits as defined in the legislation concerning the use of raw materials. The benefit for mining organizations is represented by the profit they make and by its sustainability. The benefit for the region lies in the administrative creation of wealth for the region's inhabitants visible through the support of new working positions, support of new regional taxes orientated directly on the region and the availability of raw materials sources that are necessary for the region's development. The owner of raw materials reserved deposits in conditions of Slovakia is the state, which does not have an obligation to evaluate the costs of all the recorded deposits of reserved raw materials (Zuberec, et al., 2005). The Slovak sector of raw materials mining and processing is fully privatized and the state as the owner of the reserved deposits of raw materials creates space and conditions for the effective use of raw materials by business entities in compliance with the available legislation. The principle of freedom to conduct a business while observing the determined rules also applies to the use of raw materials.

It means that the issues concerning the evaluation of raw material deposits are very topical and necessary for both the business sector and the private sector (Cehlár & Maras, 2001). In developed market economies, the evaluation of reserved deposits is considered one of the most complex and, at the same time, most important activities for the discovery and research of raw material deposits. It is only possible to estimate the prices of deposits and raw material sources in the Slovak market under Act No. 526/1990 Coll. on prices. However, it would not be advisable to stipulate detailed pricing procedures evaluating a wide range of real estate. The present mining practice shows that to evaluate non-monetary deposits to equity of a company, market estimates use mainly capital debts and warranty coverage.

Table 35 clearly shows that the GDP development in the Industry Total and Production sector remained rather stable for the whole period. In the last period, there is a gradual decline in mining activities due to the growth of prices of the inputs for the mining process and the activities conducted in the field of mining and,

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last but not least, due to the consequences of the Slovak and global economic depression worldwide.

Table 35 Development of GDP structure and unemployment (%)

Sector (SK NACE Rev. 2)	2004	2006	2008	2010	2012	2014	2016	Average
Sector share in GDP - current prices (%)								
Agriculture, forestry, fishery	3.6	3.2	3.7	2.6	3.2	4.0	3.4	3.3
<i>Industry total</i>	<i>26.9</i>	<i>28.0</i>	<i>25.8</i>	<i>23.9</i>	<i>24.1</i>	<i>24.3</i>	<i>24.6</i>	<i>24.9</i>
Production	21.1	21.2	20.2	18.9	19.0	19.8	20.5	19.7
Construction	5.5	6.9	8.6	8.1	8.2	7.0	6.8	7.3
Services	53.5	52.1	52.6	56.3	55.8	55.4	55.3	54.7
Sector share in total employment (%)								
Agriculture, forestry, fishery	4.7	4.0	3.6	3.4	3.2	3.3	3.1	3.6
<i>Industry total</i>	<i>27.0</i>	<i>26.5</i>	<i>26.3</i>	<i>23.6</i>	<i>23.8</i>	<i>23.7</i>	<i>24.0</i>	<i>24.9</i>
Production	24.1	23.7	23.9	21.3	21.6	21.6	22.0	22.5
Construction	6.8	7.5	8.1	8.5	7.8	7.4	7.3	7.6
Services	61.5	62.0	62.0	64.6	65.3	65.6	65.6	63.9

Source: Own processing of the data provided by Statistical Office of SR

All the stock of raw materials in Slovakia is divided into four groups:

- Energetic – petroleum, coal, natural gas, uranium, lignite, anthracite, bituminous rocks;
- Ores – iron, copper, lead, zinc, antimony, mercury, silver, gold, etc.;
- Non-metals – barite, bentonite, quartz, magnesite, talc, etc.;
- Construction – building stone, gravel, bricks, etc.;
- Other – mineralized waters, pyrites (Baláž & Kúšik, 2013).

The deployment of raw materials deposits in Slovakia is uneven. It depends mainly on the geological structure of a particular locality. The raw materials mined in Slovakia are mostly intended for domestic

consumption. Slovakia mainly imports petroleum, natural gas, black coal, iron ores, and the raw materials for metallurgy (Baláž & Kúšik, 2013). The mining of raw materials is characterized by a high rate of human work activities. It is, therefore, a very good source of employment. On the other hand, it is not that profitable. The total value of profit achieved in the analysed period was EUR 330 million which represents 0.46% of the total GDP. Of the total mining activities in Slovakia, the mining of fuels and energy materials represent 12.5%, ores 2.1%, and non-metallic materials 85.4%. The production of the majority of non-metallic and construction raw materials (magnesite, limestone, dolomite, gypsum, building stone, etc.) covers considerably their domestic consumption. Mineral-based raw materials and products represent crucial elements of the Slovak foreign trade. One of the most imported materials are fuels (petroleum, natural gas, black coal) and ores (iron ores, raw materials for aluminium metallurgy, steel, and ferroalloys). As regards the mineral-based materials, Slovakia mostly exports iron, steel, aluminium, ferroalloys, magnesite, concrete, bentonite, dolomite, and other products, of which the most common are non-metallic raw materials. Of the seven types of registered energetic raw materials (petroleum, natural gas, brown coal, lignite, uranium ores, anthracite, and bituminous rocks) only four are used by industries, namely petroleum, gas, brown coal, and lignite ([www.hbu.sk](http://www.hbu.sk)). The economic importance of uranium ores, anthracite and bituminous rocks is negligible due to their volume and quality. Slovakia has limited reserves of energy sources, mainly petroleum and natural gas. The investigation of the Slovak raw materials potential is a geological task that is performed in accordance with the analysis and evaluation of chosen ores and other raw materials considering their importance for the Slovak economy, i.e. considering the possibility of their use in terms of their volume, quality, potential replacement, the demand-supply structure as well as the identification of weaknesses and strengths (SWOT analysis) of individual types of raw materials. According to the chosen parameter-based evaluation of raw materials potential, the raw materials (or individual deposit objects) strategic for the Slovak economy will be identified and their further use will be evaluated from their economical perspective. The results of the task should serve as a basis for making decisions about the use of such raw materials sources in the future.

## 15.1. Export and Import and Their Economic and Social Impacts

Mining and quarrying in Slovakia provide important inputs mainly for the raw material processing industry and energetics. However, the stocks of raw and energetic materials in Slovakia are greatly insufficient. Even

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though Slovakia is dependent on import when it comes to fuel and energetic and ore raw materials, there are several types of raw materials mined for industry and construction that have positive economic effect on our economy. The mining of brown coal and lignite covers approximately 80% of our domestic consumption. Within the frame of the Slovak energetic policy, the domestic sources of brown coal and lignite are considered a strategic raw materials basis, decreasing Slovakia's dependence on the import of primary fuel and energetic materials, a reserve for unexpected situations and a source of job opportunities. Due to the verified geological stocks of petroleum and natural gas, it is not possible to expect any considerable increase in domestic mining volume in the future and therefore it will be necessary to continue supplying such commodities by import. Slovakia is, after Ukraine, the second biggest transition country of natural gas in Europe. In connection with gas market liberalization, the main attention will be paid to the increasing of quality of services, connected with natural gas stocks in the future. A decrease in energetic demand to the level of the EU countries shall still be of priority. Mining is no longer profitable when considering high production costs in the field of domestic raw materials mining and processing, The critical ore commodities are therefore supplied by import. As regards the reserved deposits of non-metallic raw materials, however, they form the key group of raw materials in Slovakia. In 2015, the geological stocks of reserved deposits reached as many as 16,605 mil. tons. The given group is dominated by non-metallic raw materials (12,586 mil. tons). The year 2018 proved to be a year with a continuous increase in the mining of construction and non-metallic materials. From the long-term (2000 – 2018) trend perspective, there was a significant decrease in the mining of ore materials (by 95.3 %) and energetic materials (by 50.5 %). This decrease was accompanied with a growth in the mining of non-metallic materials (by 9 %) and construction materials (by 49 %). In 2018, the rate of mining energetic materials to stock presented 0.16 %, ores materials presented 0.01 %, non-metallic materials 0.09 %, and construction materials 0.62 % (Ministry of Environment, SR, 2018). The selected Mining and Quarrying financial indices are given in Table 36.

*Table 36 Chosen industrial indices in 05-09 Mining and quarrying in EUR mil.*

	2011	2012	2014	2016	2018
Costs					
05-09 Mining and quarrying	456.79	419.28	807.03	464.67	465.84

Revenues					
05-09 Mining and quarrying	600.99	562.98	617.09	601.14	608.76
Earnings before tax (EBT)					
05-09 Mining and quarrying	144.20	143.70	-189.94	136.47	142.92
Debts to 31 <sup>st</sup> December					
05-09 Mining and quarrying	267.50	274.12	148.70	141.85	128.28
Stock to 31 <sup>st</sup> December					
05-09 Mining and quarrying	31.59	37.34	52.20	47.55	43.39

The non-metallic materials that are most important for export are magnesite, dolomite, stone salt, bentonite, limestone and baryte. The magnesite industry with the verified geological stock of magnesite and built mining and magnesite processing capacities is one of the key producers of alkaline refractory materials in the world (Ministry of Economy of the SR, 2014). Petroleum is mined in Slovakia mostly in the Gajary and Dúbrava deposits, gasoline in the eastern Slovakia (Senné, Stretava, and Ptrukša). Despite having these deposits, the consumption of the materials is mostly covered by import since the domestic production to consumption ratio represents as little as 1% (see Table 37).

*Table 37 Balance of petroleum and production in TJ*

	2011	2012	2014	2016	2018
Primary production	9,396	9,270	9,522	9,603	9,944
Import	306,719	278,424	303,570	276,500	317,082
Export	164,406	147,497	175,244	155,288	186,484
Change in stock	-2,010	159	-1,814	-3,505	-1,292
Gross domestic consumption	149,699	140,356	136,034	127,310	139,250

Transformation – input	301,238	267,580	292,794	255,444	289,036
Transformation input – production of electricity – heat equipment total	11,265	10,415	9,235	6,895	8,536

Natural gas is mainly obtained from the deposits in the eastern Slovakia (approximately 70% of mining), and the remaining production comes from the deposits in Viedenská panva (*Vienna Basin*) and Podunajská nížina (*Danubian Lowland*). The gas extracted from the Slovak deposits covers as little as about 3% of its total consumption and it is therefore necessary to import it. The only producer of oil and natural gas is currently the Nafta joint-stock company. Due to the volume of verified stocks of oil and natural gas, this situation will probably not change in the future. This means that Slovakia will remain dependent on the import of the materials given. See the data in Table 38.

Table 38 Balance of gas fuel in TJ

	2011	2012	2014	2016	2018
Primary production	4,303	5,325	4,370	3,510	3,258
Import	203,567	165,774	182,455	165,643	154,390
Export	103	1,623	519	104	-
Change in stock	-13,621	13,294	4,529	-11,109	4,779
Gross domestic consumption	194,146	182,770	190,835	157,940	162,427
Transformation – input	44,612	41,886	37,954	29,514	31,037
Transformation input – production of electricity – heat equipment total	30,178	28,130	26,349	19,804	20,203

Brown coal is extracted from the deposits in Handlová, Cigeľ, Nováky (Hornonitrianske bane, a.s.) and Modrý Kameň (Baňa Dolina, a. s.). Lignite is extracted from the deposit Gbely (Baňa Záhorie, a. s.). The biggest

domestic consumer of energetic coal and lignite is the Elektrárne Nováky (*Nováky Power Plant*) and a part of their production is consumed by a heating plant and chemical industrial plants (Chemko Strážske). The domestic mining covers approximately 80% of brown coal consumption (Table 39). The dependence on hard coal import is permanent.

Table 39 Balance of solid fuels in TJ

	2011	2012	2014	2016	2018
Primary production	26,355	25,580	25,674	25,400	21,810
Import	131,587	132,238	118,615	120,631	116,730
Export	6,986	3,312	3,527	2,850	2,104
Change in stock	3,162	-8,703	3,564	-357	490
Gross domestic consumption	154,118	145,803	144,326	142,824	136,926
Transformation – input	169,202	168,980	165,795	167,420	164,833
Transformation input – production of electricity – heat equipment total	50,800	48,513	44,709	41,850	40,751

Of the 12 registered types of ore materials, only gold ore deposits are currently of economic importance, even though small. The stock of other ores is insignificant considering their volume and, most importantly, their quality. It is therefore necessary to import substantial volumes of such materials in order to satisfy the needs of the metallurgical industry. The mining of gold ores is currently declining due to the termination of stock in the only exploited deposit in Banská Hodruša (Slovenská banská, spol. s r. o.). -The deposit is practically depleted. At the same time, however, deposit geological survey has been initiated on the east side of the mined-out area. The production, which has the form of concentrates, is mostly exported; only a part of the concentrates is processed in Kremnica.

Non-metallic raw materials represent the key group of raw materials considering their stock, the values of production and export. The most important Slovak export commodity is concrete, followed by magnesite

and dolomite products. The materials with potential are raw materials used in ecology (bentonite and zeolite); their importance is still increasing.

*Table 40 Balance of RES fuels and waste in TJ*

	2011	2012	2014	2016	2018
Primary production	44,278	45,035	46,924	48,771	58,297
Import	1,303	1,263	2,149	2,942	4,236
Export	1,816	2,042	3,157	3,474	4,418
Change in stock	-559	98	84	217	-8
Gross domestic consumption	43,206	44,354	46,000	48,456	58,107
Transformation – input	16,515	22,598	22,744	20,857	24,010
Transformation input – production of electricity – heat equipment total	13,494	19,390	19,536	18,617	21,551

The mining of building stone was around 9 mil. tons per year in the last years and it still shows an increasing trend. The key producers of building stone are Slovenský vodohospodársky podnik, š.p., Stredoslovenské kameňolomy, a. s., Doprastav, a. s. and Malokarpatské štrkopieskovne, a. s. The main producers of gravel are Alas Slovakia, spol. s r. o., VSH, a. s. (Betox, spol. s r. o.) and V.D.S., a. s. covering together almost 70% of the total gravel production of Slovakia (Table 41).

*Table 41 History of building stone mining*

Mineral		2011	2012	2014	2016	2018
Building stone	kt	15,373.39	12,076.80	11,826.56	14,339.20	18,290.40

## 15.2. Overview of Number of Mining Companies

As part of the mining sector analysis, it is important to monitor the number of founded and dissolved mining

companies in Slovakia. Table 42 illustrates the total number of mining companies in individual counties/regions. The data only covers the 2010-2018 period.

*Table 42 Number of companies in mining and quarrying industries in Slovakia*

Number of mining and quarrying companies						
Region	Year					
	2010	2011	2012	2014	2016	2018
Bratislava	25	27	30	35	38	42
Trnava	16	16	16	16	13	17
Trenčín	14	13	11	10	11	11
Nitra	11	12	14	13	14	14
Žilina	19	17	19	18	21	25
Banská Bystrica	39	39	40	37	39	33
Prešov	15	15	14	14	15	20
Košice	27	26	27	23	24	25
<b>Total</b>	<b>166</b>	<b>165</b>	<b>171</b>	<b>166</b>	<b>175</b>	<b>187</b>

*Source:* Own processing of the data provided by Statistical Office of SR

In 2016, most companies active in mining and quarrying were in the Banská Bystrica region. In 2018, the highest number of such companies (42 to be precise) was recorded in the Bratislava region. The lowest number of the companies was found in the Trenčín region. There were all together 187 companies active in the mining industry in Slovakia in 2018. As of 2014, the number of these companies has been gradually increasing, which is ideal from the perspective of mining, sales, and new job positions in the mining sector. Figures 41 and 42 illustrate the number of newly established and terminated companies in the mining and quarrying industry in Slovakia in the period subject to analysis.

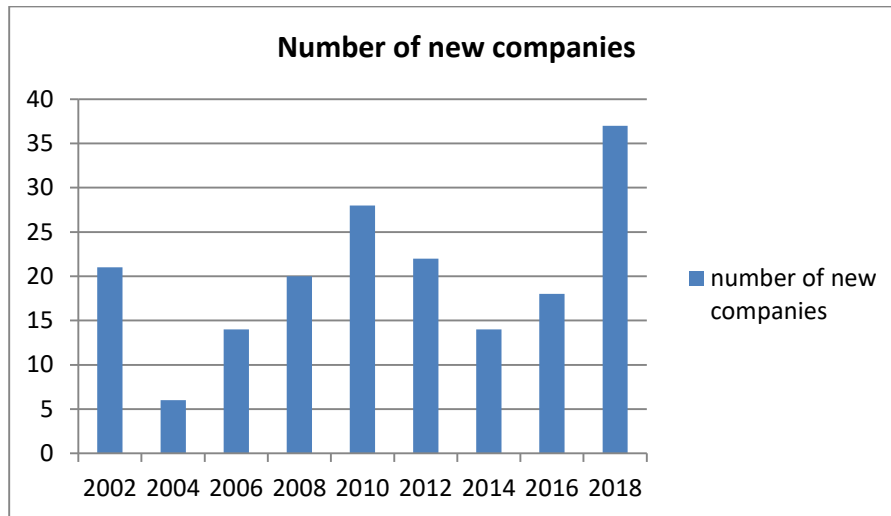


Figure 41 Number of newly established companies in mining and quarrying industries in Slovakia

Source: Own processing of the data provided by Statistical Office of SR

Figure 41 shows we that there is an increasing number of newly established companies in the mining industry. It also shows, however, that the number of terminated companies is decreasing without any rapid drops as can be seen in Figure 42. It means that there is a positive situation for the mining sector. It can therefore be stated that the mining in Slovakia is still showing a developing trend.

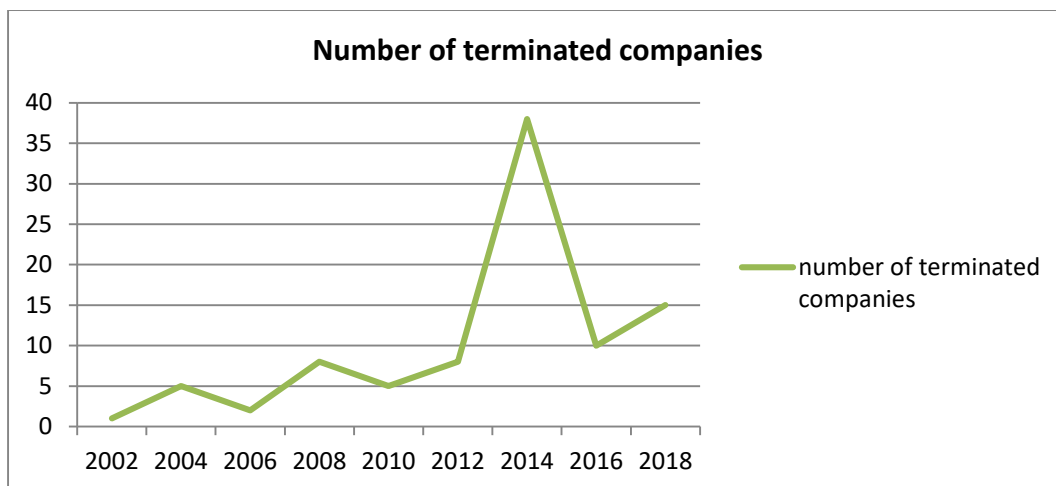


Figure 42 Number of terminated companies in mining and quarrying industry in Slovakia

Source: Own processing of the data provided by Statistical Office of SR

### 15.3. Overview of Employment in Mining Industry

An important index forming part of the analysis of the sectors is the employment in mining. The average registered number of employees in the mining industry for all Slovak regions is illustrated in Table 43. The index data is shown for the 2010-2018 period.

*Table 43 Development of employees in mining and quarrying industries in Slovakia*

<b>Average registered number of employees in mining and quarrying industry in persons</b>						
<b>Region</b>	<b>Years</b>					
	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2014</b>	<b>2016</b>	<b>2018</b>
Bratislava	614	735	687	784	690	557
Trnava	835	686	421	363	589	553
Trenčín	3,662	3,55	3,541	3,746	3,667	3,852
Nitra	132	107	-	-	90	67
Žilina	310	362	463	444	455	507
Banská Bystrica	886	634	568	584	521	459
Prešov	483	111	184	-	254	189
Košice	983	766	608	756	742	604

*Source: Own processing of the data provided by Statistical Office of SR*

As stated in Table 43, a majority of workers in the mining and quarrying industries is in the Trenčín region, which amounted to 3,852 employees in the field in 2018. It is partially due to the fact that the major employer in this region is a company mining brown coal and lignite. Since 2010, the lowest number of the employees in the mining industry has been in the Nitra region. The comparison of the average number of employees in individual sectors is given in Table 44.

Table 44 Average number of employees in individual industries of Slovakia

Average number of employees								
	2008	2009	2010	2011	2012	2014	2016	2018
Mining and quarrying	8,891	8,034	7,351	7,620	7,354	7105	6,935	6,742
Industrial production	532,853	447,685	430,658	452,006	449,126	445,301	453,535	463,606
Electricity, gas, and steam supply	21,751	20,505	19,948	18,974	18,255	17,542	18,136	17,765
Water supply and wastewater treatment	22,499	21,609	21,095	21,161	20,450	21,513	20,833	20,601
Sum	<b>585,993</b>	<b>497,883</b>	<b>479,052</b>	<b>499,760</b>	<b>495,185</b>	<b>491,461</b>	<b>499,439</b>	<b>508,714</b>

Source: Own processing of the data provided by Statistical Office of SR

It can be stated that in all the sectors stated in Table 44, the average number of employees showed a decreasing trend. Of all the sectors, the lowest number of employees is employed in the mining and quarrying industries, with only 6,742 workers in 2018. The biggest number of manpower was in industrial production ([www.statistics.sk](http://www.statistics.sk)).

## 15.4. Sales in Mining Industry

In the mining industry, it is equally important to monitor the development of sales as illustrated in Figure 43 covering the 1990-2015 period subject to analysis. The values of the index are calculated based on the actual exchange rate.

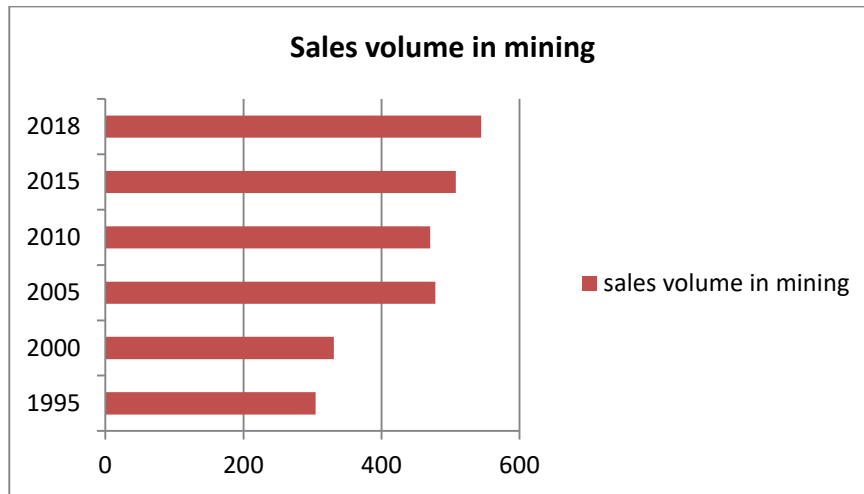


Figure 43 Sales in mining industry in Slovakia in mil. of EUR

Source: Own processing of the data provided by Statistical Office of SR

Based on Figure 43 it can be stated that sales have been gradually increasing since 1990. A minor decrease in sales was only recorded in 2005. However, this was followed by a continuous increase in the later years. In 2015, the sales in the mining industry were approximately EUR 544 mil. From the sales point of view, it is important to follow up sales from raw material mining. Figure 44 shows the development of raw materials mining in Slovakia in the last 25 years.

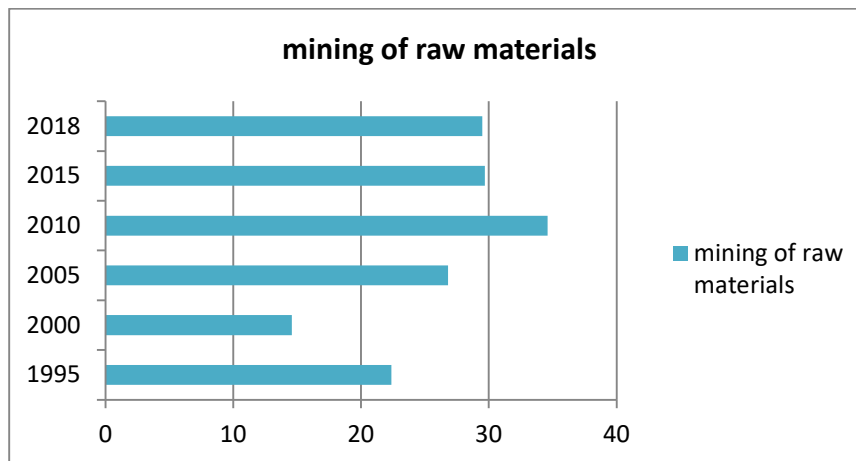


Figure 44 Mining of raw materials in Slovakia in mil. tons

Source: Own processing of the data provided by Statistical Office of SR

During the analysed period, the highest volume of mining was recorded in 2005, i.e. 34.6 mil. tons. The mining of raw materials in Slovakia has been gradually reducing since then. In 2015, Slovakia mined 29.6 mil. tons of raw materials.

## 15.5. Use of Raw Materials in Individual Industrial Sectors

**New RM Policy** should have a broad impact on other industrial sectors, with the priority of RM security being sustainable development. One of the present development trends is **circular economy**. Its application for the change of the RM economy represents a close and isolated view of RMs as an object of Raw Materials Industry that monitors the whole RM life cycle.

At the national level, however, a growing importance of RMs has been yet reflected in various areas and strategic materials. An extraordinary position of RM industry arises from the frame of the **RIS3 SK** document. Based on this position RMs are part of the horizontal priority „**Energetics, RM and Food Security**“. RMs are one of the four defined areas of economic specialization. In the defined perspective areas of specialization, RMs have a dominant position orientated to innovate RMs in three areas (SC5-14-2016-2017) - Raw materials Innovation actions:

- a) Intelligent mining on land;
- b) Processing of lower grade and/or complex primary and/or secondary raw materials in the most sustainable ways;
- c) Sustainable metallurgical processes.

The dominant part of the Slovak RM industry is „Production and processing of iron and steel“, as one of the four defined areas of economic specialization in Slovakia. In other two areas of economic specialization, RMs industry represents a supplier of raw materials, while RMs disposal is one of the strategic reasons for the development of economic specialization: „Automotive industry and engineering“ and „Consumer electronics and electric tools“.

In the defined perspective areas of specialization, RMs have dominant position since they belong to three of six areas:

- Processing and evaluation of light metals and their alloys;
- Evaluation of domestic RMs base;
- Support of intelligent technologies in the area of RMs and waste processing in the region.

Technological changes have the biggest impact on development of the RMs industry. To be more precise, it is the 4<sup>th</sup> technological revolution in the field of informatization, automatization and robotics. Such trends are also visible in the RMs industry. Technological development brings the need for RMs in an ever more extending spectrum, in the need of higher quality and composite materials, etc. New technologies bring not only new markets, but also a change in the production characteristics and in the transition from quantity to quality. Future SMART Technologies would be more intelligent, more flexible, etc.



*Figure 45 Using RMs in technologies*

Due to the new technologies, the structure of the RMs industry should be reconsidered. Just like other industries, the RMs industry should also change from the **PUSH (stocking) to the PULL (ordering)** strategy so as to reflect the actual form its industrial processes.

Long-term skills in the transfer of new solutions and technologies to the business area are to be used for the need of verifying the semi-operation and pilot operation functioning. The current preference of basic research allowed for the generation of new original ideas, but their actual application must be forerun by their transforming into technical solutions applicable in concrete business conditions. Without verifying technical solutions, at least in the semi operation conditions, under the supervision of idea authors, it is impossible to transfer even the best and most original ideas to practice. The biggest obstacle for the application of the Slovak and European research results is the absence of possibilities for semi operation and pilot operation verification of new solutions.

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<p>Long-term RaD program</p> <p><i>Supporting long term strategic research (7-10 years) in RIS3 SK priority areas</i></p>	<p>RaD capacities</p> <p><i>Building new and supporting existing R&amp;D capacities in companies and/or groups of companies (mainly clusters) in order to implement projects with innovation potential</i></p>	<p>RaD infrastructure</p> <p><i>Modernization and further development of infrastructure in technological localities of research institutions from public and state sector in RIS3 SK priority area</i></p>	<p>RaD policy</p> <p><i>Supporting the net of companies, including clusters, and technological platforms connected to R&amp;D innovative activities</i></p>	<p>Pilot innovation and eco projects</p> <p><i>Supporting research, development, and innovation activities (technological etc.) in companies and / or in clusters</i></p>	<p>Connecting Research, Education, and Innovation</p> <p><i>Increasing quality and effectiveness of production and of technological processes through increasing technological and innovation level in companies</i></p>	<p>Implementing R&amp;D results</p> <p><i>Supporting establishment of innovative products and services in market</i></p>

Figure 46 Potential Long-term Research and Development (R&D) programs for RMs industry

## 15.6. Growth Rate of Sales in Industries and their Correlation

The development of mining sales, compared with other industries, is illustrated by Table 45 and Figure 47.

*Table 45 Trend of sales development in industrial sector (2010-2018) in %*

	2018	2017	2016	2015	2014	2013	2012	2011	2010
<b>Industry together</b>	<b>114.73</b>	<b>106.83</b>	<b>101.43</b>	<b>99,9</b>	<b>71.1</b>	<b>86.88</b>	<b>95/27</b>	<b>106.18</b>	<b>74.81</b>
<b>Mining and extraction</b>	<b>103.88</b>	<b>94.87</b>	<b>9315</b>	<b>108.78</b>	<b>85.44</b>	<b>84.59</b>	<b>87.33</b>	<b>107.96</b>	<b>94.62</b>
Industrial production	106.49	106.44	100.93	99.35	84.59	91.78	90.13	84.27	72.56
Production of coke and refined petroleum products	94.61	86.71	75.05	99.96	101.53	127.42	126.87	129.32	66.59
Production of chemicals and chemical products	95.05	97.93	90.28	100.84	96.71	103.42	109.96	129.09	88.83
Production of products from plastics and rubber	115.53	110.33	106.18	99.86	87.58	89.39	97.51	86.41	73.13
Production of metals and metal construction	126.84	114.11	99.87	99.43	105.71	86.61	88.02	85.68	77.97
Production of computer, electronic and optical products	78.63	93.39	100.31	91.08	97.75	99.78	106.63	102.18	137.74
Production of electric equipment	110.14	108.66	104.44	100.01	93.01	85.61	74.01	72.94	61.28
Production of machinery	125.8	118.64	105.37	100.11	91.99	87.34	74.46	70.66	58.02
Production of transport machinery	123.69	98.94	106.49	100.49	87.59	87.13	81.91	68.32	52.74
Other production, repairing and installation of machinery	106.37	104.81	97.18	100.03	93.26	84.06	97.06	85.48	80
Supply of electricity, gas, steam, and cold air	114.26	109.8	100.45	99.96	97.33	112.03	133.04	107.38	87.45
supply of water, cleaning of wastewater and waste disposal	118.13	107.04	105.6	99.16	91.82	95.83	96.37	89.91	92.34

Source: Own processing, according to data from <http://datacube.statistics.sk/>

The trend of development in mining sectors is very similar to industrial production; the most favourable conditions were in 2015 when the highest growth rate was recorded; the lowest rate was reached in 2013. All the other sectors using raw materials showed a different trend of sales development. In 2018, the most positive trend was seen in the production of metals and metal construction; the mining sector showed a gradual increase, although not the highest in its history.

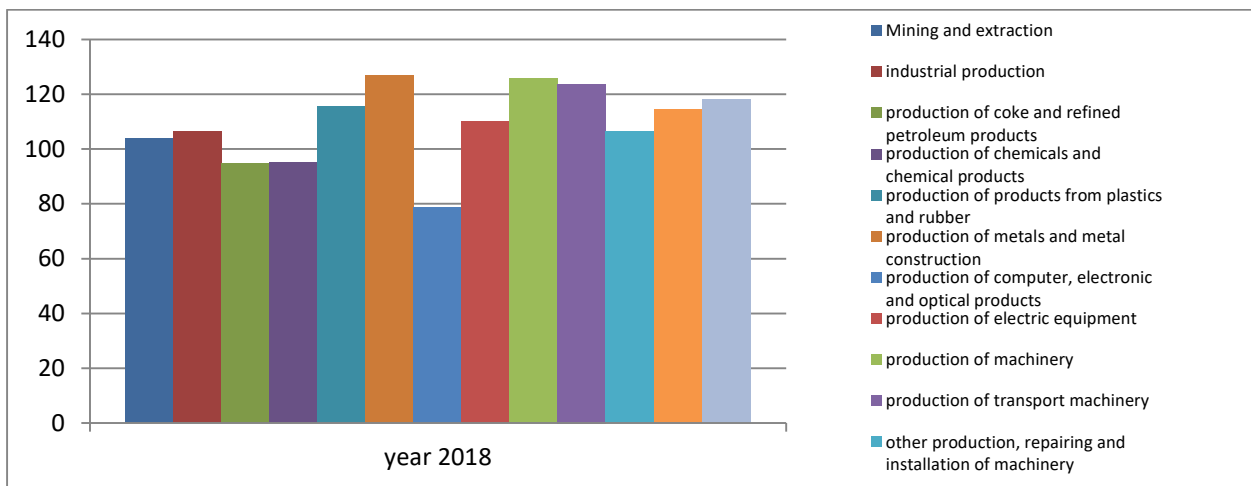


Figure 47 Growth rate of industries in 2018

Source: Own processing, according to <http://datacube.statistics.sk/> data

## 16. Sector Selection- Methodology

Our selection of a sector was based on the statistical classification of economic activities SK NACE Rev.2. For the purpose of our internal analysis, the sectors directly connected with the field of expertise of the FBERG Faculty were selected. The following table shows the overview of the sectors.

*Table 46 Sectors connected to RMs and to education of students at FBERG*

Division	Title
19	Manufacture of coke and refined petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
22	Manufacture of rubber and plastic products
23	Manufacture of other non-metallic mineral products
24	Manufacture of basic metals
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment n.e.c.
29	Manufacture of motor vehicles, trailers, and semitrailers
30	Manufacture of other transport equipment
35	Electricity, gas, steam, and air conditioning supply
36	Water collection, treatment, and supply
37	Sewerage
38	Waste collection, treatment, and disposal activities; materials recovery
39	Remediation activities and other waste management services

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41	Construction of buildings
42	Civil engineering
43	Specified construction activities

According to the analysis of key words: <https://app.kwfinder.com> , we compared intensity of individual sectors finding (see Table 47).

Table 47 Key word analysis

klúčové slovo	KS-analytika	Intenzita	odvetvie
Electric equipment	Electric equipment	1080	Production of electric devices
Electric equipment	Electric tools	27091	Production of electric devices
Electric equipment	Electric transformer	8061	Production of electric devices
Electric equipment	Electrical goods	4400	Production of electric devices
Electric equipment	Electrical equipment company	1000	Production of electric devices
Metal construction	Metal construction	2400	Production of constructions, except machines and equipment
Metal construction	Steel construction	4418	Production of constructions, except machines and equipment
Metal construction	Steel frame building	2900	Production of constructions, except machines and equipment
Metal construction	Metal carports	27050	Production of constructions, except machines and equipment
Metal construction	Metal building for sale	6600	Production of constructions, except machines and equipment
Computer production	Computer production	90	Production of computer, electronic and optical products
Computer production	Best laptops	7838	Production of computer, electronic and optical products
Computer products	Computer products	35	Production of computer, electronic and optical products
Computer products	Computer aided design	9894	Production of computer, electronic and optical products
Computer products	Cad design	3600	Production of computer, electronic and optical products
Computer products	Computer aided manufacturing	4400	Production of computer, electronic and optical products
Computer products	Computer camera	8067	Production of computer, electronic and optical products
Computer products	Industrial computer	1300	Production of computer, electronic and optical products
Electronic products	Electronic products	1900	Production of computer, electronic and optical products
Electronic products	Electronics	246951	Production of computer, electronic and optical products
Electronic products	Electronics components	63061	Production of computer, electronic and optical products
Electronic products	Electronic items	6238	Production of computer, electronic and optical products
Electronic products	Electrical goods	4400	Production of computer, electronic and optical products
Machinery	Machinery	49533	Production of machines and equipment
Machinery	Machine	247164	Production of machines and equipment
Machinery	Used machinery	2933	Production of machines and equipment
Machinery	Used machinery for sale	1672	Production of machines and equipment
Machinery	Machinery tools	1144	Production of machines and equipment
Machinery	Machinery sales	8100	Production of machines and equipment
Machinery	Heavy machinery	9879	Production of machines and equipment
Machinery	Construction machinery	8193	Production of machines and equipment
Metal processing	Metal processing	1964	Production and processing of metals

The results of the key words analysis had been translated into the graph presenting the found terms grouped according to the key words, where:

- Axis x represents the search the classification of terms in an analytical way;

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➤ Axis y represents individual sectors;

The Groups are formed according to the key words to which searched terms belong. The size of each bubble shows how many times a certain searched word (key word) was found.

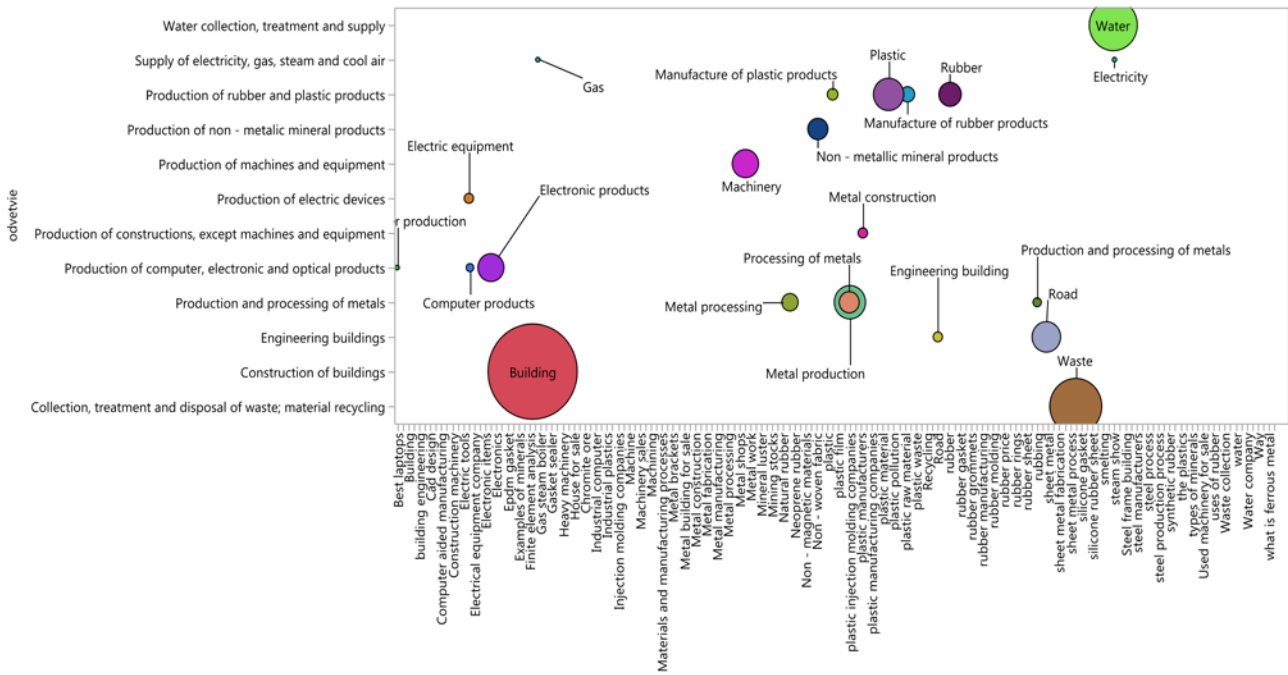


Figure 48 Bubble groups of sectors

According to the bubble analysis, we discovered that the most frequently searched term was connected with the key term „building”, which belongs to the **Construction of buildings** sector. Therefore, the given sector has been chosen for our further analysis.

## 17. PESTEL Analysis

### 17.1. Present State of Construction Sector

In spite of various economic impacts on the area of private and public investments, construction has remained one of the determinant sectors of Slovak economy. In 2018, the percentage of construction on GDP represented around 7.8% and the construction sector employed approximately 7.0% of the total number of the employed in the Slovak market. At the same time, it is the main sector constructing the buildings and sites that represent an important part of investments or contribute significantly to the gross fixed capital of the whole economy. In 2018, the buildings and sites covered as much as 44.7% of the gross fix capital achieved.

The construction sector creates works with a long-term life cycle, thus providing not only a particular production process but also contributing architecturally and culturally. The architectural and cultural contributions form a significant part of intellectual performance and, last but not least, have substantial aesthetic, ecological and social impacts. Moreover, the sector is a heavy consumer of various types of energy, raw and other materials, and products. At the same time, the sector produces vast volumes of construction and demolition waste and emissions. From this point of view, the relation between construction activities and the environment on one hand and sustainable development on the other is therefore crucial and considerable. It is therefore especially important for the construction sector to observe the principles of sustainable development. The construction sector is, at the same time, an important indicator of the cyclical development of the whole economy, closely connected to economic deviations and changes.

In this sense, the sector reacts directly and immediately on any changes in the economic cycle and it influences multiplicatively the development of other sectors. It means that in the country's economy, investing in construction results in a whole chain of demands for goods and services in the related sectors, which brings positive results mainly in area of economic activities, employment rate and, retrospectively speaking, public budget balances. In period after 1989, the Slovak construction sector underwent extensive restructuring. Apart from a considerable increase in the level of architecture and in the quality of buildings, there has also been a change in the number and size of construction companies, in legal forms of business entities and crucial changes in the ownership structure of construction companies.

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After the above transformation, the Slovak construction sector has adopted an organization structure applied commonly abroad. Thus, a natural hierarchy of small (up to 49 employees), medium-size (up to 249 employees) and big (250 and more employees) enterprises has clearly shown. The structure of such companies corresponds with the order and demand structures. In this connection, a special group is formed by self-employed individuals or, in other words, sole traders in the construction sector. All the groups mentioned have found their natural place in the construction market.

On the 31<sup>st</sup> December 2018, there were 21,500 enterprises in the Slovak construction sector according to the organization statistics, of which 18,474 represented private companies and 22 the companies falling under the public sector. Of the total number of companies, 3,004 are controlled from abroad. There were 73,831 natural persons and 13 entities under public administration in the construction sector, which represented 95,344 legal entities. The given data was published in March 2019 in the Statistical Report of Basic Development Trends in Slovak Economy in 4<sup>th</sup> Quarter of 2018 by ŠÚ SR (Štatistický úrad Slovenskej Republiky/ *Statistical Office of the Slovak Republic*). According to the organization statistics published at [www.statistics.sk](http://www.statistics.sk) on 31<sup>st</sup> December 2018, there were active companies in the sector of the following structure: 95,344 economic entities in the sector, of which 73,828 were sole traders, 3 other physical persons, 290 joint-stock companies, 19,501 limited companies, 40 other business entities, 48 cooperatives, 9 subsidised organizations, 2 budgetary organizations and 1,623 companies of other legal forms.

The biggest percentage of construction was 35.1%, which was reached by small construction companies with 0-49 employees (year-on-year growth 18.3%) in 2018. Considering the structure of the sizes of enterprises based on their contribution to the volume of performed construction in 2018, medium-size enterprises with 50-249 employees contributed least (17.4%). In the year given, their production was by 20.3% higher than in 2017. Sole traders participated in the whole construction production with 26.2%, which is by 2.3% more than in the preceding year. The same year (2018), big construction companies with 250 and more employees contributed to the above production with 21.3%, which represents a year-on-year increase of 9.5%.

Of 166,631 employees, which is the average number of the employed in 2018, there was the highest percentage of sole traders (58.4 %; 97,368 people), which means that the number of sole traders increased

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compared to the year 2017 by 1.3 %. In terms of the number of employees, large enterprises employing 250 and more people represented the lowest percentage (5.0%). In 2018, the average percentage of the employed in big companies increased compared to 2017 by 8.2 %, i.e. to 8,262 employees. The same year, the participation of small companies (0-49 employees) in the total employment in the construction sector was 28.1%; medium-size enterprises (50-249 employees) contributed with as little as 8.5 %.

Compared to 2017, the number of employees in 2018 increased in category of enterprises with 0-49 employees by 7.8 % (by 3,406 persons), and in the category of companies with 50-249 employees by 0.5 % (by 108 persons). Considering the 2018 employment in construction sector as a whole, it increased by 3.3%. The 2018 total annual growth of construction production increased by 12.1 %, it means from EUR 5,136.8 mil. to EUR 5, 758.1 mil. (non-construction enterprises excluded), which was mainly due to the 20.3% growth of its volume in medium-size enterprises (50-249 employees) and 123.3% growth in large enterprises (250-499 employees).

Construction production in 2018 increased its dynamics, resulting in a year-on-year increase by 8.5% (in 2017 by 3.0 %). The own performance and goods sales increased in fixed prices in the construction sector by 11% compared to 2017. The 2018 growth of the sector was positively influenced by the finishing construction of the production plant Jaguar Land Rover and, most importantly, by the started construction of the Bratislava ring road. In the last years, the performance of the construction sector has also been influenced by a considerable development of housing construction, which was supported by more convenient mortgages and the growing income of inhabitants.

*Table 48 Development of construction production volume by ownership sectors in 2012 – 2018*

Index	2012	2013	2014	2015	2016	2017	2018
Construction production (mil. EUR) (fixed prices 2015)	5,031.0	4,764.3	4,565.6	5,387.5	4,810.1	4,954.8	5,372.2
- Index (previous year = 100)	87.5	94.7	95.8	118.0	89.3	103.0	108.4
- Percentage of private sector's contribution to	99.8	99.8	99.9	99.9	99.9	99.7	99.8

construction production (%)							
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Table 49 Selected financial indices by districts in Slovakia in 2018 (in mil. EUR, at current prices)

District /region	Revenues	Turnover total	Costs total	Value added	Profit/loss
Bratislava	2,022.97	1,953.53	1,916.72	411.72	106.26
Trnava	132.03	128.22	114.81	32.41	17.23
Trenčín	121.91	114.29	109.15	33.87	12.76
Nitra	280.01	275.35	264.67	59.77	15.34
Žilina	223.69	206.76	210.10	66.46	13.59
Banská Bystrica	104.78	101.24	95.20	28.43	9.59
Prešov	99.13	87.32	99.65	22.75	-0.52
Košice	468.43	376.93	448.23	74.67	20.20
<b>Total</b>	<b>3,452.96</b>	<b>3,243.64</b>	<b>3 258.52</b>	<b>730.08</b>	<b>194.44</b>

Table 50 Selected financial indices by the volume of companies in 2018

Size group by number of employees	Revenues	Turnover total	Costs total	Value added	Profit/loss
20-49	477.32	462.50	422.70	171.86	54,61
50-99	452.44	435.16	419.36	108.25	33,08
100-249	759.54	744.34	706.70	177.88	52,84
250-499	587.30	514.53	592.96	95.01	-5,65
500-999	927.62	840.89	906.41	118.17	21.21
1,000 and more	248.74	246.21	210.39	58.91	38.35
<b>Total</b>	<b>3,452.96</b>	<b>3,243.64</b>	<b>3,258.52</b>	<b>730.08</b>	<b>194.44</b>

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The percentage of construction sector contribution to the 2018 GDP was 7%, which represented a decrease compared to 2017. In 2017, the percentage of the sector contribution to the GDP was 7.4%.

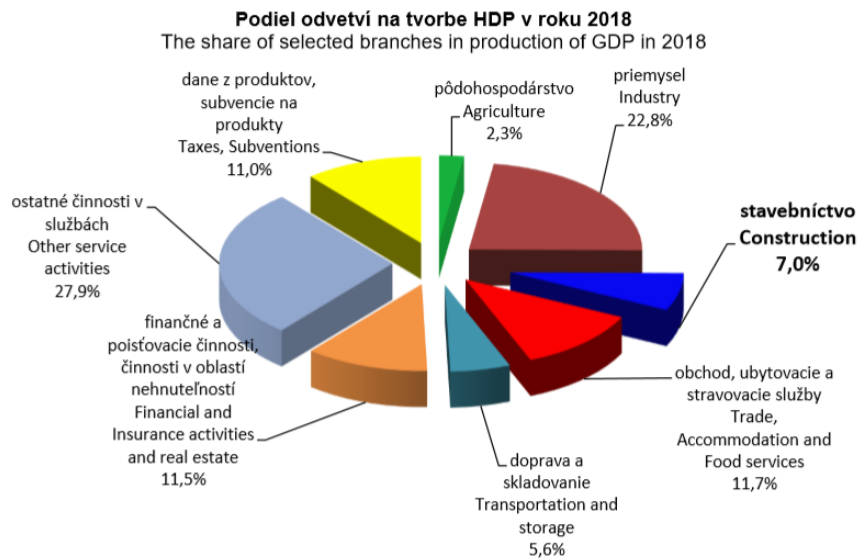


Figure 49 Percentage by which sectors contributed to GDP in 2018 (kto prerobí graf?)

Small enterprises were the greatest contributors to the total volume of construction production (EUR 5,758.1 mil., construction plants of non-construction enterprises excluded), with the percentage amount to over one third (35.1 %). The sole traders contributed to construction production with 26.2%. The medium-size enterprises represented 17.4 %. The small and medium enterprises (including sole traders) represented together almost four fifths (78.7 %) of the total construction production in 2018. Large enterprises generated as much as 21.3% of the volume given. The development of construction production of individual categories of business entities is illustrated by the following table (Table 38).

Table 51 Development of construction production by volume category and legal form of companies (in mil. EUR)

Category of business entity	2016	2017	2018	Percentage in 2018	Index 2018/2017 - current prices
Traders	1,485.3	1,476.3	1 510.4	26.2%	↑ 102.3
Small enterprises (0-49)	1,508.7	1,706.8	2,018.6	35.1%	↑ 118.3
Medium-size enterprises (50-249)	804.6	832.5	1,001.1	17.4%	↑ 120.3
Large enterprises (250 and more)	1,035.5	1,121.2	1,227.9	21.3%	↑ 109.5
<b>SMEs</b>	<b>379.86</b>	<b>401.56</b>	<b>453.01</b>	<b>78.7%</b>	<b>↑ 112.8</b>
Together	4,834.1	5,136.9	5,758.1	100.0%	↑ 112.1

**Source:** Statistical Office of SR, processed according to SBA. Data does not include the production of construction plants of non-construction enterprises

In a year-on-year comparison, the construction production of SMEs (including sole traders) at current prices increased by 12.8% in total, which represents the most significant growth of the construction production by SMEs in the last decade.

When compared with 2017, the construction production of sole traders increased very little (by 2.3%). By contrast to the mentioned, the high dynamics of growth was discovered in the construction production of small (0-49 employees) and medium-size enterprises (50-249 employees) where it increased by one fifth (by 18.3 % or 20.3%, respectively). Within the frame of large enterprises (250 and more employees), the growth of construction production achieved 9.5 %.

## 17.2. PESTEL Analysis of Investment Environmental in Construction Sector

### 17.2.1. Political Environment

Since there is presently the deficit of public finances not exceeding the level of 3% of GDP, the government suggested a law, the goal of which is to consolidate public finances and decrease the deficit to a desired level. The new Labour Code, which is to introduce several changes or amendments, also brings a repeated increase in taxes. The changes are mainly connected with sole traders, but they also cover enterprises. The legal entity income tax increased to 23%, for managers and partners of limited companies taxed in Slovakia medical contributions from dividends increased from previous 10% to 14%. The question is if such reforms make Slovakia less attractive for foreign investors. The TASR62 research evaluates changes in tax burden as a negative factor. Other existing shortages and weaknesses of the Slovak business environment are ineffective public administration, high level of bureaucracy, and insufficient law enforcement.

### 17.2.2. Economic Environment

The economic environment of the country has a great influence on SMEs activities. Among the factors that influence products and price policy most are those related to employment in individual regions.

The economic growth at constant prices in the fourth quarter of 2018 slowed down to 3.6%, which also influenced the development of employment; once having excluded seasonal influences, the GDP in the fourth quarter of 2018 showed an increase of 0.8%, compared to the preceding quarter; this represents a slightly slowed down development of the economics compared to prognoses. The 2018 GDP expressed in constant prices increased by 4.1%.

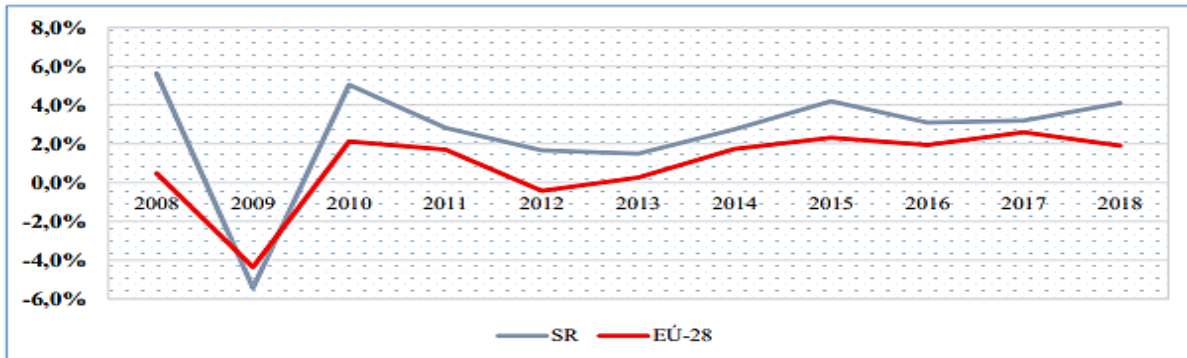
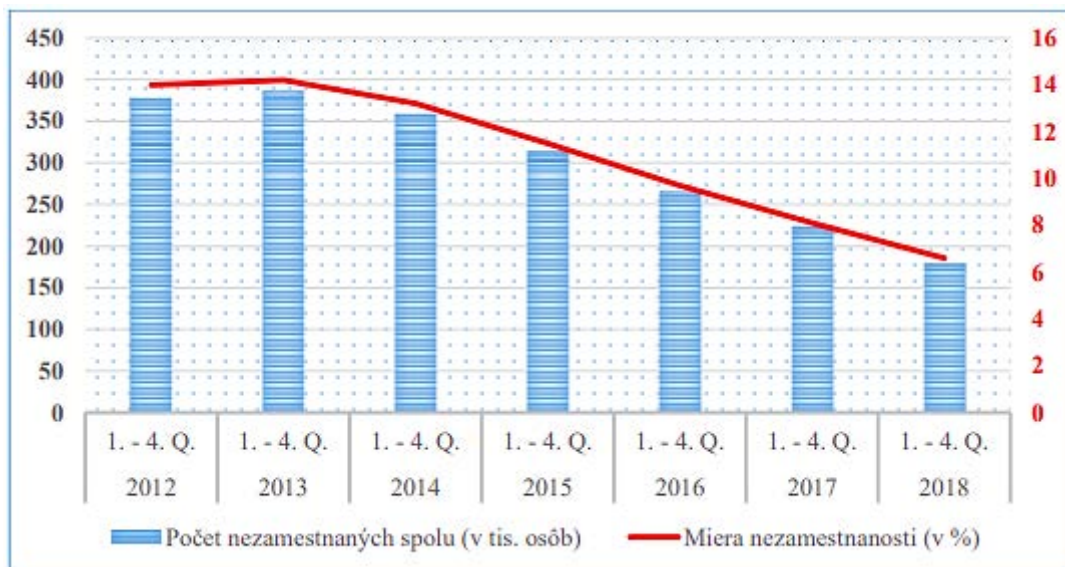


Figure 50 Development of GDP growth in SR compared to EU28

The second most crucial factor is employment. The development of employment in the construction sector depends on the development of the demand for construction works and on the achieved level and demanded work productivity development.



*Figure 51 Number of unemployed and unemployment rate*

### **17.2.3. Social Environment**

One of the most significant factors of the social environment is the demographical development of inhabitants, which can considerably influence SMEs' activities in the construction sector. It mostly focuses on the factors describing demographical development; this means, for example, the total growth of population, age structure, educational level, structure of society or cultural environment. Presently, the main goal of a number of construction enterprises is to maintain their position in the market and to win customers from their competition, which could bring a competitive advantage.

### **17.2.4. Technological Environment**

More and more modern technologies are being used in the construction sector. However, compared to other countries, there has been, a lower level of availability and development of technologies in Slovakia. In the construction sector, technological progress is another crucial factor. Companies are trying to produce high-quality products and increase the effectiveness of their production, or to achieve a competitive advantage by the way of differentiation or cost reduction through modern technologies.

The fact that Slovakia is an EU member increases the importance of the above factor even more since the Slovak companies are facing not only domestic but also foreign competition.

There have been numerous improvements of technological processes in production. One of the examples is the process of laying concrete, which was previously done by pouring it on one place and then manually spreading it out. Presently, it can be done by the machine called Laser Screed, which pours concrete from a certain height and, at the same time, vibrates and consolidates the concrete so as to make it dense. Once concrete hardens there is a need to add ceramic, metallic or corundum infills designed to ensure resistance against abrasion. Up to now, the companies did not have this technology available, and everything had to be done manually, which was very strenuous and inaccurate.

### **17.2.5. Ecological Environment**

To determine the ecological correlations and environmental influences on the living environment it is necessary to follow up the whole life cycle of a building. All the ecosystem elements are interconnected and

depend on each other. The same applies to the construction sector, which is dependent on the natural ecosystem; therefore, the development of the sector depends on people and natural sources.

A building's life cycle is usually very long which means that it also has a long-term effect on the living environment. The environmental performance of buildings depends on whether such a structure is able to function effectively during its whole life cycle, i.e. whether it is of no burden to the living environment during its construction and removal. The impact on the living environment mainly depends on the sources chosen for construction and the sources of energy necessary for its operation. The construction process and its use of buildings demands a vast number of sources. However, only a small volume of sources is repeatedly used for its further development or other industrial activities.

Construction activities considerably influence the quality of the environment, both positively and negatively. In the negative sense it contributes to the production of all main types of pollutants. Such an increase in pollutant emission is mainly caused by industrialization, by the growth of mechanization. One of the most negative impacts of construction activities performed mostly in populated localities is excessive noise to which their inhabitants are directly exposed. The permissible values stipulated by health regulations are sometimes exceeded by over 20 dB. Apart from noise, there are also impacts and vibrations to face.

#### **17.2.6. Legislative Environment**

This environment includes the factors that are influenced by law-enforcement changes, i.e. by legislative activities. Such activities influence the functioning of SMEs and that is the reason why the enterprises must permanently react on changes in taxes, laws, Labour Code, environmental policy, etc. SMEs must follow the legislation and laws specific for this area of business.

They include, for example, Act No. 50/1976 Building Code or Act No. 608/2003 Coll. on zone planning state administration, building regulations and housing.

## 18. Potential Entrepreneurs

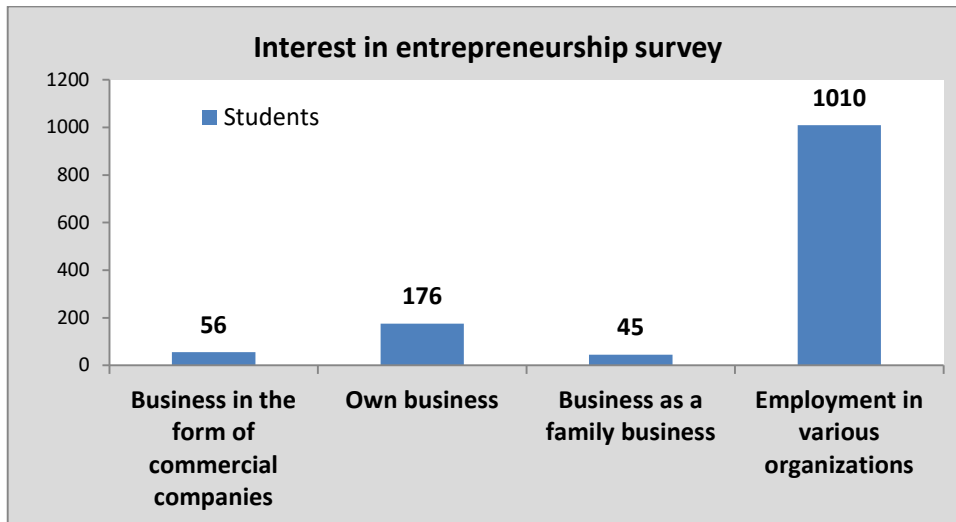
As part of their own entrepreneurship and employment in the labour market, we recommended that students focus on the sectors that are closely related to their field of study with the emphasis on the use of raw materials. Our priority areas are, for instance, construction, transportation, metallurgy, mining, electro technical industry, and other. Construction in Slovakia is a priority area when considering the use of minerals. Construction offers a wide range of construction products and solutions for the projects engineering the road, railway, maritime and aviation infrastructures. Many potential entrepreneurs want to live their dream of independence by founding a company; for others having their own business is the way of preventing them from becoming unemployed. The motivation for one's own business can be both negative and positive. A negative motive is, for example, a situation in which a person does not plan to start a business but because of not being able to find a job he/she decides to start his/her own business. A positive motive can be a situation when a person voluntarily decides to start their own business or to take over their family business.

As part of the implemented project, we used a questionnaire survey to find out three basic hypotheses focused on students' interest in entrepreneurship in general, students' interest in working in the field they have studied, and their opinion on whether they have gained sufficient knowledge for their own business, i.e. how effective the form of provided education is.

### **H1: Students' general interest in entrepreneurship in Slovakia is very low.**

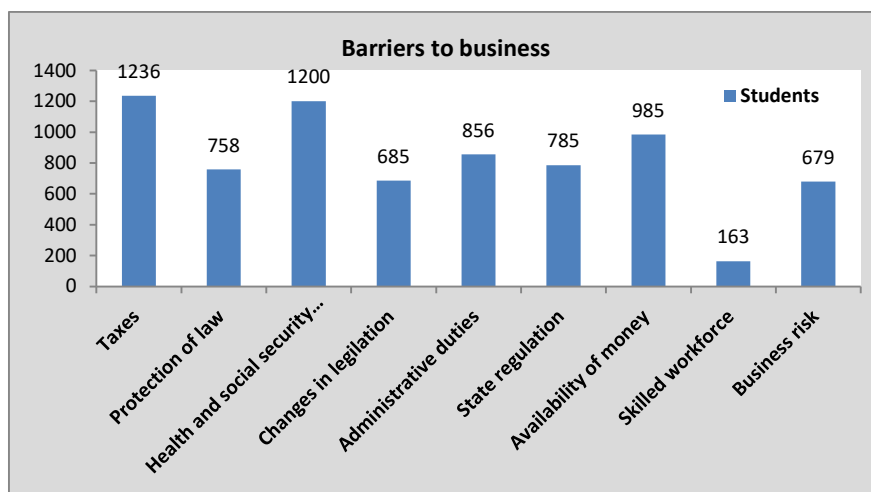
The results of the survey pointed to the fact that potential entrepreneurs (graduates - university students) are not interested in running their own business due to a number of factors forming barriers to business in Slovakia. The survey sample consisted of 1,236 Technical University students from various fields of study and study programs with a focus on the use of minerals in different industries. The university students' interest in various forms of employment of in the labour market is presented in Fig. 52. The results of the survey indicate the lack of their interest in entrepreneurship. Only 23% of the interviewed showed interest in various forms of business. This fact indicates a problem in the development of the Slovak economy and therefore the strategic incentive of the state should be to support the business environment and entrepreneurship in the form of, for instance, start-up projects.

**H1: The hypothesis was confirmed. Out of 1,236 students, only 226 students (18%) showed interest in entrepreneurship.**



*Figure 52 Students interest in running a business.*

Based on the results of the survey, we have identified the main factors that significantly affect students' decisions about their own business. The factors that students consider to be obstacles to business in Slovakia are presented in Fig. 53. The critical factors are taxes, health and social security contributions, and the availability of funds.



*Figure 53 Factors influencing business in Slovakia.*

**H2: About a half (50%) of the graduates are interested in working in the field of study that they studied.**

The results of the survey pointed to the fact that potential entrepreneurs (graduates - university students) are not interested in working in the area they studied and in running their own business in their field of expertise. The survey sample consisted of 54 BERG Faculty graduates of various study programs with the focus on the use of raw materials. The students' interest in working in the field they studied is presented in Fig. 54. The results of the survey point to the lack of university students' interest in the employment in the field they studied and in the implementation of their own business in the field in question; only 10 out of 54 students showed interest in the field studied representing 19%. Thirteen interviewed students (24%) showed interest in other areas of business. They showed the greatest interest (30%) in construction, which is a priority area for entrepreneurship and application in Slovakia with a focus on raw materials.

**H2: The hypothesis was not confirmed. Out of 54 students, only 19 students showed interest in the employment in the field they have studied, which represents only 19% of students, i.e. definitely less than half (50%).**

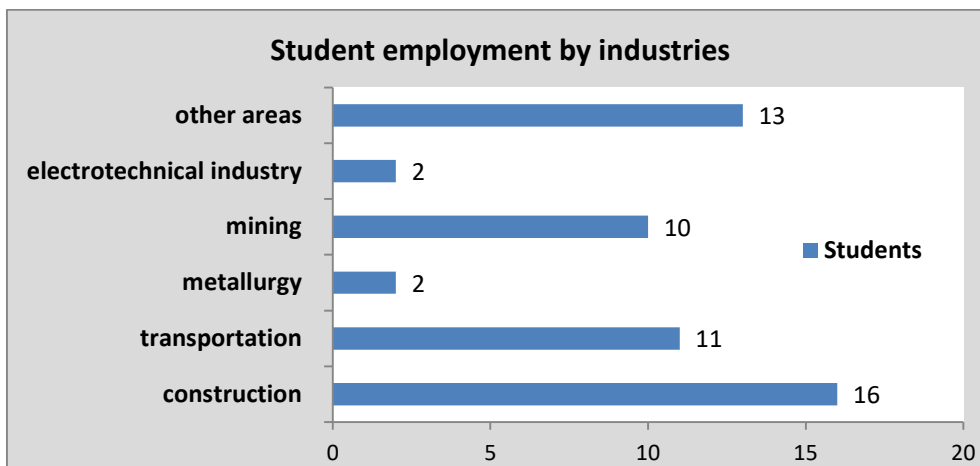


Figure 54 Employment of student in different areas of industry.

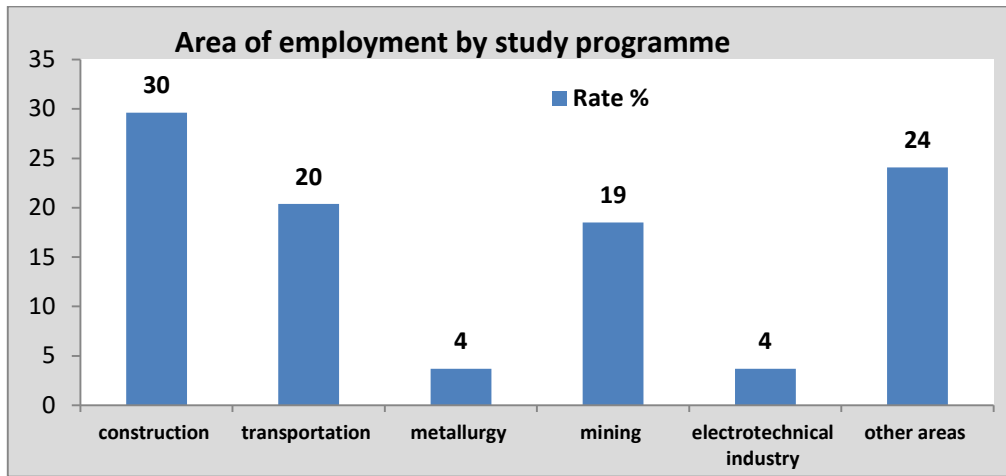


Figure 55 Area of employment according to study programs

**H3: The acquisition of sufficient knowledge for one’s own entrepreneurship, i.e. the effectiveness of the form of education in the field of entrepreneurship was not ensured by technical universities’ study programs**

The results of the survey pointed to the fact that potential entrepreneurs (graduates - university students) are not sufficiently prepared for entrepreneurship. The study programs at technical universities have not been succeeded in providing sufficient education concerning all the basics for starting a business.

**H3: The hypothesis was confirmed. Out of 1,236 students, only 465 students confirmed a high level of education and sufficient knowledge for their own business, 62% of students do not consider education at technical universities to be sufficient for running their own business.**

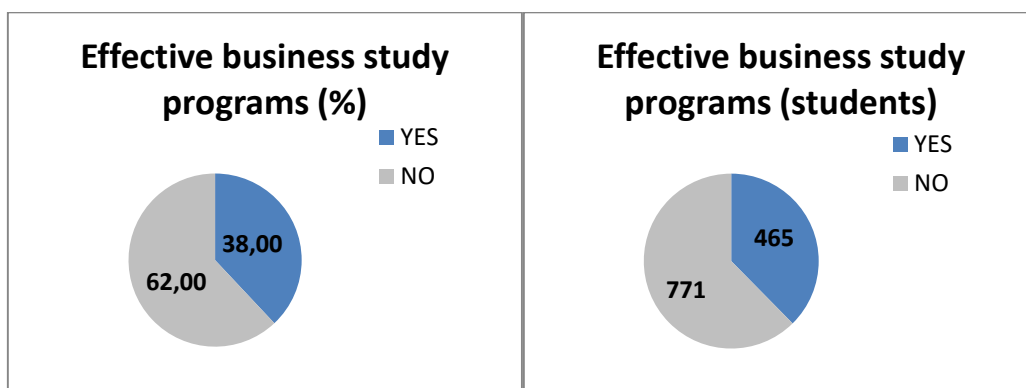


Figure 56 Effective business study programs

At the beginning of any business there is a good idea that will allow you to take an advantage of the opportunities existing in the market. A good idea needs to be translated into a business plan, the task of which is a thorough preparation for the establishment and development of a new company by considering the following:

- Technical side of business – suitable line of business, technology, financial, material, and human resources needed for business;
- Legal and organizational side of business - choosing a suitable form of business;
- Economic side of business – costs, revenues, expenditures, profitability indicators, and possibilities of raising capital.

All the knowledge and skills that students have to gain should be part of their study programs. Study programs have to reflect on the requirements concerning the knowledge university graduates are to have (Table 35) and must include business-oriented modules – such as economy, ethic, finance, management, marketing, and communication. The knowledge-based economy is part of education at technical universities, and education models must incorporate the demands for information, economic, social and knowledge society. The basic precondition for increasing the quality of education at Technical Universities is the incentive of Entrepreneurship Action Plan 2020, which is based on business education requirements.

*Table 52 Top required knowledge for university graduates*

YEAR 2014	YEAR 2020
Advanced English	Advanced English
Ability to work in a team	Learn new things
Learn new things	Analytical and logical thinking
Initiative, creativity	Ability to work in a team
Communication	Loyalty
Analytical and logical thinking	Initiative, reliability, helpfulness
PC knowledge	Positive thinking
Responsibility	Responsibility

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Driving license	Active approach to work
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The aim of education is to point out new forms of educating at technical universities, which must include the foundations of entrepreneurship education, financial literacy, information and communication technologies and soft skills that need to be integrated into the fields of study and programs. Implementing new forms in the education process is a prerequisite for meeting the global goals of education. The new model of education will increase students' competences and their employment opportunities. Education is an important social value and a prerequisite for sustainable economic growth and a high standard of living for the country. It is based on creating a suitable model of teaching with the use of innovative elements and information technologies in order to reflect on the requirements of the labour market and the intentions of the European Commission in the field of education with the orientation towards knowledge economy. Education should focus on the use of new innovative elements, and the evaluation of the benefits of implemented innovative elements on students' knowledge and skills. The new teaching model will enable students to acquire quality knowledge in terms of business skills, financial literacy, and soft skills. At the same time, the requirements of the labour market concerning university graduates and of their succeeding in such a market will also be met.

Entrepreneurship education means developing knowledge in the field of entrepreneurship, which will be reflected in the growth of productivity and competitiveness in Europe. The benefits of entrepreneurship education at universities are entrepreneurial knowledge, skills, attitudes, creativity, initiative, perseverance, the sense of responsibility, the ability to work in a team, and the understanding of risks. In practice, entrepreneurship education manifests itself in the form of educational programs that are provided by non-profit organizations in combination with state support. The JA Firma educational program (Fig. 57) is taught as part of some study programs at technical universities in Slovakia. The benefits of educational programs and specifically the “Ja Firma” program lie in the fact that students acquire knowledge, business skills, attitudes, and creative thinking and problem solving, communication and presentation skills, self-confidence, teamwork and team leadership, negotiation and decision making skills, goal setting and time management skills and risk management skills. With this project, students will learn how to raise funds by selling shares,

open and use a bank account, conduct market research, collaborate on a business plan, develop, promote and sell their own products or services, manage corporate finances, and participate in trade fairs.



Figure 57 Education program JA FIRMA in Slovakia.

## 18.1. Application of JA FIRMA Program at Technical University

The project focused on preparing and solving problems in practice. The main objectives of the project were specified as follows:

The first idea was to improve students' communication, organizational leadership, task planning and time management skills. Technical university students have problem with their hard and soft skills. Therefore, it is very important to introduce new subjects into student programs. The praxis requires from students to have their hard and soft skills developed. As part of the project, the students had to manage the organization of the project first, communicate with project teams, and appoint student company managers. Choosing one student from a project team for a manager's position was very challenging for them. Despite the challenges of this task, they managed to select the managers in the student companies very quickly and to agree on the most important positions in the company. Defining key competences was not a big problem either and it has

been shown that the new innovative form in the learning process brings about a change in students' behaviour and a growing interest in a particular topic of the subject.

The second idea was to prepare complete accounting documentation and a proper agenda. The students had to prove their ability to prepare the documentation from the very first moment of company establishment, when they had to draw up the application for a business license and find the forms of documents on the Trade Office website. Moreover, they prepared some other documents concerning the areas of business law, investment decision making, double-entry accounting, management accounting, taxation, and marketing. It was very demanding for students to arrange for all the prescribed documentation, which had to be prepared in accordance with applicable laws. In this area, students were trained to prepare documentation in compliance with the prescribed laws of individual business departments and with the valid legislation. Students have acquired new entrepreneurial skills. This second idea of the project has brought new possibilities for students' improvement in the education process. Within this part of the project, students tried to use the book-keeping software available at the university, to be more precise the JMP software. The business plan was prepared on the basis of the procedure provided by the labour office. The calculation and budget-related documents had to be elaborated on the basis of the knowledge of the subjects completed in the first stage of the bachelor study.

The third part of the project was focused on the preparation of a trade show and on the associated marketing campaign. Students had to prepare a comprehensive marketing strategy for attracting customers. The marketing campaign was aimed at preparing a in the university's Mining Pavilion. The marketing campaign included the preparation of information leaflets, posters with the company logo, information on the website and social networks, personal addressing of potential customers before the exhibition, preparation of brochures for the university's bulletin board. The overall aim of the project was to put the knowledge the students acquired from the studied subjects of the study they had completed. The students were given an opportunity take the knowledge from various subjects and use it in practice. In addition to the above objectives, students were encouraged to become involved in the student activities organised by the university, which were to motivate students to participate in various school events, conferences, competitions, workshops, seminars, lectures.

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The work on the project started with the creation of 4 student firms, where 40 students of the program named Management of Earth Resources had to be divided into 4 groups, 7-13 members each (Fig. 58).



*Figure 58 Students' firm at the trade show*

Following their incorporation, they faced demanding tasks focused on determining the company manager, company employees, company name and logos (Fig. 59), company organizational structure and business plan, Gantt chart of the tasks assigned to individual employees, description and design of the products made by the company, product prices, company cash register, i.e. registration of expenses and income, advertising leaflet for the trade show, company marketing campaign, company annual report and, after the show, the sale, and termination of the company activities. The named activities were the basis of the company operations. The students had to master the knowledge and skills acquired in 10 subjects that they had already completed. Within each 'company', the students had to communicate on everyday basis by meeting in the University library for the purpose of troubleshooting. Thus, their communication competencies were constantly improving throughout company operation. The results were visible in practical tasks concerning the actual application of management tools.



Figure 59 Logo of firm: BEADS - bracelets for every day

Marketing brochures (Fig. 60) contained information for the trade show, i.e. the name of the brochure (Christmas Trade Show), date and time of the show, firms' logos, and the place of exhibition. This marketing brochure was available at all the university faculties where they could be found, for example, in the library, canteen, hall of residence and classrooms. Some marketing brochures were placed in public means of transport and at bus stops. Moreover, the brochures were distributed amongst the university project participants who then personally invited the students to the trade show. The brochure was prepared by all student firms together. Team communication was another positive step in the project, where the students succeeded and gained team communication skills.



Figure 60 Marketing brochure

These tasks were performed throughout the entire semester; communication took place during lectures, and individual exercises were limited to 30-minute duration. The goals set were met from the first step of the project - from the creation of companies. All the tasks had to be solved and implemented on a continuous

basis. The innovative tool of the educational process was the student firm and its operation throughout the semester and the exhibition of the student firms, which concluded the activities of our firms by selling their products (Fig. 61). The students made various products and used the Christmas time for their selling in the form of presents, which was a really interesting marketing strategy. Products were made from their own resources or purchased material. Financial resources were obtained at the start of the project, but they had to be returned after the trade show at the end of the project.



*Figure 61 Product of student firms*

The media selected to support the project were the BERG faculty's web page and Facebook page, where the information was placed before the show. The regional television Košice also attended the show (Fig. 62). High school guests were also invited. Their invitation was an opportunity for the faculty to reach new potential students. Through the regional television, the public could see how the school is preparing their students for the labour market and potential students had the opportunity to see how university students work and study. The regional TV also conducted interviews with individual student companies and with the teacher organising the project. This all has brought back positive feedback from the public.



*Figure 62 Regional TV– guest of the show*

Equally interesting was the reaction of the invited high school students from Poprad (Fig. 63). The students were impressed by the event and learned about the possibility of studying at Technical University.



*Figure 63 Visit of students from high school P. Olivu*

The overall results of the subject study were communicated by the tutor through the Moodle TUKE e-learning tool. There, the students were regularly assigned various activities during lectures and exercises in addition to their work in the student firms. The survey of the results highlighted the students' excellent knowledge of the subject, which was reflected in their overall assessment. The greatest achievement represented the area of management, i.e. managerial accounting and decision-making where they gained 17 out of 20 points (Fig. 64). The results indicate the mastering of the practical and theoretical competences of

the students to 85%, which the teacher considers to be an excellent result in terms of the preferences of the students studying at universities.

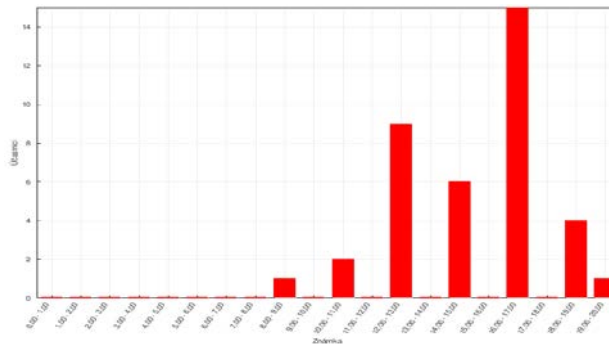


Figure 64 Exam results (Moodle)

The economic efficiency in the student firms is very important, too. This area gives a competitive advantage to the firms whose indicator of success in this field was their profit and the volume of the products sold demonstrated their attempt to sell as many of their products as possible. The students have improved their communication, organizational, and social competencies. The students are better prepared for problem solving, teamwork, and goal achievement. They have adopted an ethical code and the ability to make compromises. They have also developed their aesthetic sense and their attitude towards education and study has changed. The work in student companies has shown them what business is about and what they are to do to become successful.

## 19. Executive summary

In the course of our research, we examined which area of the Slovak raw material sector could be an attractive entrepreneurial target for young people participating in raw material-related education. Increasing students' interest in the topic from the very beginning and raising awareness of career opportunities in the sector can increase the chances that students will not leave the region and will try to become entrepreneurs after completing their studies instead.

The role of the raw material and construction sector in industrial value chains is not negligible. In our analysis, we examined raw materials used in the construction sector and its contribution to sustainable development. We have discovered there is a high potential for raw materials to be used in the construction sector.

Having reviewed the possibility of becoming an entrepreneur, we can state that in Slovakia, in general, very few students intend to be entrepreneurs with this number being even lower among students in the technical fields of study. This situation results from the challenging and improper business environment, tax burden and high level of bureaucracy. However, the students are interested in working in the area they studied as employees of the companies in the field. Perhaps it could be recommended to students to consider the joint establishment of a company after finishing their study, thus reducing the risk of running a sole business or to run their business in cooperation with an existing company which requires more intensive communication and cooperation between the faculty and the companies in the field.

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