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A METHOD OF MINING ENTERPRISES EVALUATION IN THE RESTRUCTURING PROCESS OF THE HARD COAL INDUSTRY[1]

Abstract

In the article there is presented a methodology of mining enterprises evaluation that currently perform in Poland. The process of assessment and selection of these enterprises was treated as the necessary provision for the continuation of restructuring processes in Polish hard coal mining industry. The cognitive objective of the hereby article is determining the criteria of assessment and selection of mining enterprises, however, practical objective is conducting the choice of the most effective hard coal mines in term of defined assessment conditions. During the research, in 28 mining enterprises the following factors were evaluated: sufficiency of operative resources, the level of natural threats, existing technical infrastructure and unit excavation costs. Basing on these criteria there were 8 mining enterprises indicated in Poland of the best prognosis. The considerations are concluded by the suggestion of the set of actions in order to improve effectiveness in Polish hard coal mining industry.

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1. Introduction

Restructuring is a complex and multi-aspect process. Its final result mostly depend on the proper planning regarding the sequence of activities. Therefore, the stage of restructuring preparation should be considered as *esentialia negotii* of the restructuring success in the industry as well as in the enterprise itself.

Industry restructuring in hard coal mining industry in Poland has been systematically conducted since the beginning of 90s. Then there were 70 mines functioning in Poland that belonged to the state. In the next few years the action was mostly directed on debt liquidation of contemporary mining enterprises

[1] The paper presented the results from the research project of the National Center for Science – *Investment in coal mining in terms of its financing* (N N524 464836), which is financed by the Polish Ministry of Science and Higher Education

and on their effectiveness improvement[2]. Among other objectives of the ongoing restructuring there were also indicated such as: excavation adjustment to market demand, capital increase and modernization of mining enterprises.

The aforementioned aims were realized mainly due to the simultaneous restructuring of industry and mining enterprises in all possible dimensions[3]. The inner industry and enterprises organization was changed by conducting organization[4] and asset[5] restructuring. In the frames of financial[6] restructuring the capital structures of mining enterprises were altered[7]. Finally, by making personnel decisions employment restructuring was conducted.

As a result of undertaken restructuring actions, there were some of aforementioned conditions successfully realized. The employment was reduced, few non-profitable mining enterprises were closed down and the extraction of hard coal was limited. Unfortunately, permanent improvement of mining enterprises performance was not fully achieved. Thus, industry restructuring objective is still important and valid, as without its full completion, the future of hard coal mining in Poland may be endangered.

One of the basic reasons for the lack of effectiveness improvement of mining enterprises is the functioning in the structures of mining partnerships consisting of enterprises that indicate very different financial results. In result, in the scale of the whole mining enterprise, financial results of mines that do well are compensated by the losses of non-profitable enterprises. In order to stop this process, it is necessary to select and retain only these mining enterprises in the structures of mining partnerships that function effectively and may continue the excavation in future, that is at least until year 2030. The first stage of the continuation of explained above restructuring in the industry and in separate mining partnerships is determining the methodology of mines evaluation and selection.

Basing on the arguments stated above, in the hereby article there is a suggestion presented in terms of methodology of mining enterprises assessment and selection, treating it as the preparation stage for further restructuring of Polish hard coal mining industry and mining enterprises. The cognitive objective of the hereby article is to determine evaluation and selection criteria of mining enterprises, however, practical objective is to conduct the evaluation and choice of the best hard coal mines in Poland grounding on evaluation criteria defined.

In the other parts of the article the evaluation of 29 mining enterprises existing in Poland was conducted in the context of the following criteria:

- sufficiency of operative resources,
- natural threats and geological-mining conditions,

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[2] Compare: A. Karbownik, M. Turek, E. Pawełczyk, *Effects of realization of hard coal mining reform government program in years 1998-2001.* /in:/ *Global and regional modernity conditions of industry and services*, J. Pyka (ed.), University of Economics in Katowice Publishing, Katowice 2001, p. 212-213.

[3] See: I. Jonek-Kowalska, *Concentration and restructuring of companies.* /in:/ *Relations and value in strategies of businesses management,* J. Pyka (ed.), TNOiK, Katowice 2008, p. 103-112.

[4] *The program of restructuring hard coal mining industry in Poland in years 2003-2006 with the use of anti-crisis acts and initiation of privatization of some mines*, Ministry of Economy, Warsaw 2002, p. 2. See also: M. Turek, *Technical and organizational restructuring of hard coal mines*, Central Mining Institute, Katowice 2007.

[5] See: I. Durlik, *The restructuring of economic processes*, Placet, Warsaw 1998, p. 45-46.

[6] See: M. Rochoń, *Financial effectiveness of restructuring of Polish companies on the basis of legal procedures- synthetic approach*, „Organization Review", 2006, no 12, p. 34-37.

[7] See: S. Podczarski, *Restructuring processes effectiveness in industrial enterprises – the attempt of identification*, 'Organization Review', 2006, no 6-7, p. 51. More: M. Turek, I. Jonek-Kowalska, *Financing of restructuring processes in hard coal mining industry in years 2003-2006.* /in:/ *Restructuring management in the processes of integration and new economy development*, R. Borowiecki and A. Jaki (ed.), Cracow University of Economics publishing, Kraków 2008, p. 561-573 and also M. Turek, I. Jonek-Kowalska, *Companies concentration and its effects on the example of Kompania Węglowa S.A.* /in:/ *Restructuring management in the processes of integration and new economy development*, R. Borowiecki and A. Jaki (ed.), Cracow University of Economics publishing, Kraków 2008, p. 573-589.

- existing technical infrastructure,
- unit excavation costs of hard coal.

The first of above mentioned criterion ensures the continuation of coal excavation in a long perspective that is adopted as year 2030. It is the necessary condition of researched mines functioning. The conditions in terms of natural threats and geological-mining activities allow to assess the reason for excavation continuation and the level of permissible threats connected with this process. The existing technical infrastructure is the criterion stating the level of potential investment resources securing the continuation of excavation. The last criterion enables to indicate such mining enterprises among the examined ones which are specific for the best geological-mining and infrastructural conditions and at the same time are characteristic for low unit excavation costs. This is the assumption that allows to make the final choice of mining enterprises performing the most effectively. The research was conducted in 28 hard coal mines working in the structures of the three biggest coal partnerships. To maintain the legibility and logicality of conducted study, in all combinations created the mining enterprises chosen in the final stage of research are marked as K1-K8.

2. Evaluation of resource conditions in mining enterprises

In the first stage there is the evaluation and selection of mining enterprises made in terms of hard coal deposits possessed. The basic criterion in this process became the life length of mines. In table 1 there is a detailed combination of sufficiency of operative resources in all Polish hard coal mines, including the date of their predictable liquidation.

From the sample containing 28 mines – 10 shall be closed down until year 2030. In the further analysis these mining enterprises were marked in yellow color, as due to the prognosis horizon reaching year 2030, they are not qualified for further evaluation and selection despite some favorable conditions taken into account in the frames of other criteria.

According to data included in table 1, the life length of mines in Polish hard coal mining industry hesitates in the range from 10 to 70 years. The mines chosen for analysis are specific for sufficiency of operative resources in the range from 34 to 69 years. The mines of longer life than 34 years were indicated in the combination, however, these are the mines of high intensity of natural threats and difficult geological-mining conditions – therefore they were not qualified for research sample in spite of the fact that their life length should be considered as important[8].

The other factors examined in terms of resources were: the amount of balance sheet resources and their cognition. In table 2 there is the list of deposits characteristics that belong to 28 functioning mines, also regarding the state of deposits management as well as balance sheet and industrial resources management.

All chosen mines possess high balance sheet working deposits of hard coal. The share of these resources in balance sheet resources among all hard coal mines in Poland equals from 2 to over 7%.

A great majority of these resources are the deposits well and very well recognized belonging to categories A, B and C1. Thus the maximal estimation error of deposit parameters in the chosen mines currently does not exceed 30%. Only in mine K1 the share of resources well recognized in total resources is lower than 50%.

[8] Natural threats shall be described in details in the further part of the article.

Table 1. Sufficiency of total operative resources and the year of mines liquidation in Polish hard coal mining industry (state on 31.12.2005.)

Mine		Sufficiency of total operative resources	Liquidation year (until year 2030)
1.		21	2029
2.		10	2018
3.		16	2024
4.		35	–
5.	K7	37	–
6.		70	–
7.		32	–
8.	K6	34	–
9.	K8	35	–
10.		70	–
11.		15	2023
12.		61	–
13.	K2	49	–
14.	K3	37	–
15.	K4	29	–
16.		25	–
17.	K5b	50	–
18.		10	2018
19.		12	2020
20.		20	2028
21.	K5a	49	–
22.		24	–
23.		16	2024
24.		13	2021
25.		13	2021
26.		22	2030
27.		38	–
28.	K1	69	–

Source: *Strategy of hard coal industry development in Poland in years 2007-2015*, Document approved by the Council of Ministers on 31st July, 2007, p. 11.

Table 2. Deposits characteristics in hard coal mines in Poland (state on 31.12.2008.)

Mines	Finally chosen mines	The share of operative resources in total balance sheet resources of the mines	The share of A+B+C1 resources in balance sheet resources	The share of C2 resources in balance sheet resources
1.		1.62%	82.38%	17.62%
2.		0.34%	99.89%	0.11%
3.		1.51%	46.80%	53.20%
4.		4.72%	60.04%	39.96%
5.	K7	6.54%	61.36%	38.64%
6.		4.78%	63.18%	36.82%
7.		6.12%	61.12%	38.88%
8.	K6	7.32%	96.75%	3.25%
9.	K8	6.97%	58.40%	41.60%
10.		3.98%	91.21%	8.79%
11.		1.05%	98.95%	1.05%
12.		3.93%	92.90%	7.10%
13.	K2	4.89%	50.61%	49.39%
14.	K3	1.90%	96.65%	3.35%
15.	K4	1.97%	87.49%	12.51%
16.		1.58%	45.51%	54.49%
17.	K5b	3.36%	78.49%	21.51%
18.		6.45%	84.18%	15.82%
19.		0.96%	95.35%	4.65%
20.		1.22%	83.54%	16.46%
21.	K5a	4.91%	83.73%	16.27%
22.		0.95%	90.23%	9.77%
23.		2.44%	56.45%	43.55%
24.		1.72%	84.22%	15.78%
25.		1.28%	62.68%	37.32%
26.		2.09%	68.33%	31.67%
27.		2.95%	78.16%	21.84%
28.	K1	6.36%	30.74%	69.26%

Source: own work basing on the data from the examined mining enterprises.

3. Analysis and evaluation of natural threats and existing infrastructures

Another criterion that was taken into account in the process of mines selection was natural threats regarding the following threats: methane, ash, tremor and fire.

Methane threat is mostly connected with methane presence in the working pit (deposits of hard coal) and its release due to the mining activity conducted. This threat increases with the rising depth of exploitation, methane capacity of coal beds and decreasing permeability of the rocks. By methane capacity it is meant the methane volume of natural origin contained by the weight unit in the depth of coal body.

Methane threat in Polish hard coal mining is still very high because of the following circumstances:

- conducting exploitation in the lower layers,
- methane contents increase of coal deposits with the rising depth of their position,
- occurrence on very low depths, unfavorable for safety, the dynamic effect of releasing free methane captured in the areas of tectonic activity (faults, clefts) that is under high hydrostatic pressure of the rocks above,
- high concentration of excavation.

In table 3 there is the combination of absolute methane contents presented in million m^3 CH_4/year in the examined 28 hard coal mines in years 2006-2008.

According to the data included in table 3, absolute methane contents in mines of life length exceeding 2030 year were placed in the range from 0 to 137,10 million m^3 CH_4/year. The chosen mines in 2008 do not go over 50 million m^3 CH_4/year. Two of them are non-methane mines. In three of them methane contents do not exceed 10 million m^3 CH_4/year. On the other hand, the mines of a bit higher intensity of methane contents should be considered as K1 and K7 mine. On this stage of analysis, from the basic number of 28 mines the mines 7, 26 and 27 were excluded because of the highest level of absolute methane contents (in table 3 they were marked in light blue color).

The mines where the methane threat does not appear in the whole examined period are mines K8 and K6. Until year 2005 this threat did not appear in mine K5a either, and in the examined years, the level of absolute methane contents is very low in this mine with a decreasing tendency. The low volume of methane contents is also specific for mines K2 and K7b. The mines where the level of methane contents increases in time are K1, K3 and K7. Absolute methane contents visibly decrease in mine K4.

In the underground hard coal mines the range of technological processes connected with deposits exploitation, drilling underground passages and mining spoil transportation are accompanied by unfavorable phenomenon of ash occurrence and emission which is the source of ash threat. The level of ash threat in Polish hard coal industry is still considered to be high. Alongside with the developing process of exploitation concentration in the recent years, being the consequence of decreasing number of coal faces and increasing their production capacity, the sources of ash threats emission decrease indeed, however, the intensity of its release rises. In the next few years the diminishing of ash threats is not predicted though. The state of coal ash explosion danger may only be reduced by conducting constant and efficient ash-proof preventive measures.

Using stone ash in hollow working pits is connected with maintaining preventive areas. This ash is used as the extinguishing measures on anti-explosion ash barriers and also is meant for working pits scorching. Since the year 1999, the level of stone ash used in hard coal mines in Poland has been rising. The reasons for the increase are the following:

- activities intensification connected with ash anti-explosion preventive measures (mines 'Jas-Mos' and 'Rydułtowy'),

Table 3. The value of absolute methane contents in hard coal mines in years 2006-2008 in million m^3 CH_4/year

Mine		2006	2007	2008
1.		0.00	0.00	0.00
2.		0.00	0.00	0.00
3.		1.00	1.51	1.20
4.		12.80	21.61	15.80
5.	K7	**52.00**	**59.62**	**48.80**
6.		42.80	61.97	35.30
7.		134.40	134.52	137.10
8.	K6	**0.00**	**0.00**	**0.00**
9.	K8	**0.00**	**0.00**	**0.00**
10.		36.10	34.66	21.60
11.		0.20	0.95	0.30
12.		25.00	21.39	24.30
13.	K2	**7.94**	**6.52**	**9.30**
14.	K3	**21.66**	**20.76**	**37.30**
15.	K4	**15.33**	**16.12**	**15.80**
16.		33.32	22.66	26.60
17.	K5b	19.67	29.72	39.70
18.		8.86	55.42	49.90
19.		18.49	16.59	14.60
20.		4.76	10.43	16.10
21.	K5a	**5.30**	**4.35**	**0.90**
22.		0.00	0.00	0.00
23.		40.21	30.71	34.90
24.		21.71	24.90	19.0
25.		65.42	62.74	99.70
26.		133.96	134.84	128.40
27.		62.63	67.99	59.00
28.	K1	**43.60**	**39.00**	**45.30**

Source: own work based on *Yearly reports on the state of natural and technical threats in hard coal mining*, W. Konopko (ed.), Central Mining Institute, Katowice years 2007-2009.

- recommendation of after-accident committees regarding the construction quality and maintenance of preventive areas obtained by stone ash scorching (mines 'Halemba' and 'Mysłowice-Wesoła').

Basing on the conclusions above concerning ash threat, there are individual characteristics presented in table 4 of stone ash usage in 28 examined mines.

Table 4. The quantity of stone ash used in hard coal mines in years 2006-2008 in tones

Mine		2006	2007	2008
1.		677.9	570.9	597.8
2.		668.7	534.0	791.1
3.		30.0	39.0	25.6
4.		1 652.6	1 496.7	1 937.2
5.	K7	3 564.4	3 651.7	3 534.2
6.		1 730.0	1 624.0	2 107.0
7.		2 684.6	2 751.4	2 830.1
8.	K6	12.0	20.8	30.1
9.	K8	37.5	41.6	49.2
10.		1 483.5	3 969.6	3 777.4
11.		1 016.1	1 267.8	1 267.6
12.		736.0	1 710.6	2 598.0
13.	K2	2 266.0	2 300.0	1 869.3
14.	K3	1 687.0	1 909.0	2 014.0
15.	K4	2 223.2	2 562.3	2 774.0
16.		4 091.0	4 348.0	4 287.0
17.	K5b	45.0	10.00	25.00
18.		2 213.5	2 070.0	2 648.6
19.		1 727.1	1 587.3	1 548.5
20.		2 784.0	2 931.1	3 131.8
21.	K5a	2 440.9	2 770.7	2 687.3
22.		93.7	104.0	320.0
23.		950.0	1 532.0	2 309.0
24.		5 842.3	5 452.1	4 867.1
25.		2 919.7	3 471.6	3 561.8
26.		5 167.6	5 646.0	5 725.2
27.		4 808.9	5 268.2	5 957.8
28.	K1	2 376.7	1 730.0	1 950.0

Source: own work based on *Yearly reports on the state of natural and technical threats in hard coal mining*, W. Konopko (ed.), Central Mining Institute, Katowice years 2007-2009.

In this moment it should be emphasized that for anti-explosion preventive measures the stone ash is used in all Polish mines. In a very low scale it is used in 5 mines: K5b, K6, K8, and K3. These are mining enterprises where natural humidity conditions in hollow working pits decide about using water washing as the basic method of fighting explosion danger of coal ash. The biggest usage of stone dust occurred in the recent years in mines of Jastrzębska Coal Partnership JSC, especially: 27 (5 957.8 tons in year 2008) and 26 (5 725.2 tons in year 2008)[9].

The value of stone ash usage in the examined mines is placed in the range from almost 6 000 tons to 10 tons. The chosen mines K1-K8 are specific for much lower usage, in the range from 3 700 to 10 tons. A very low usage, not exceeding 50 tons is characteristic for mines K5b, K6 and K8. Because of the high amount of ash threats, the mines of number 16 was excluded from the remaining group (it is marked in green color in the table).

The next group of examined threats are tremor threats. Tremor threat is the possibility of occurrence of so called tremor, that is the dynamic phenomenon caused by working pit quake and in result, this pit or its part is subjected to a rapid damage or becomes destroyed. In consequence of this, the total or partial loss of its functions or safe work appears.

The characteristics of tremors for the examined mines are included in table 5. Due to the infrequency of examined threats, the analysis covered longer period of years 1999-2008. Also the characteristics of the basic parameters of tremors was added.

Table 5. Characteristics of tremors in years 1999-2008 in hard coal mines

Mine	Layer	Thickness of the layer / height of the face [m]	Tremor energy [J]	Depth [m]	Year of occurrence	Total
1.	510	9.0-9.7/2.9	$2 \cdot 10^6$	690	2005	1
2.						0
3.						0
4.						0
5. K7	**504**	**7.9-12/3.0**	**$6 \cdot 10^5$**	**700**	**2002**	**1**
6.						0
7.						0
8. K6						**0**
9. K8						**0**
10.	504	2/2	$1 \cdot 10^7$	600	2008	5
	506	1.4-2.5/1.7	$2 \cdot 10^8$	910	2006	
	415/1	3.5-6.0/2.9	$9 \cdot 10^7$	770	2004	
	415/1	3.5-6.0/2.9	$9 \cdot 10^5$	770	2004	
	502	6.0/3.3	$3 \cdot 10^7$	711	2004	
11.	502	4.2-6.4/3.3	$8 \cdot 10^7$	730	2007	3
	502	5.6-6.4/3.3	$9 \cdot 10^7$	970	2006	
	418	2.0-3.0/3.6	$1 \cdot 10^7$	745	2005	

[9] More: I. Jonek-Kowalska, *Analysis and assessment of operational risk in mining enterprises* /in:/ *Models of financing operational activity of mining enterprises*, M. Turek (ed..), GIG, Katowice 2011, p. 244-268.

Mine		Layer	Thickness of the layer / height of the face [m]	Tremor energy [J]	Depth [m]	Year of occurrence	Total
12.		510	6.9-8.8/3.2	$8 \cdot 10^5$	840	2008	4
		502	2.2-5.5/3.1	$1 \cdot 10^7$	890	2005	
		405/2	7.2-8.0/3.0	$5 \cdot 10^5$	1150	2002	
		507	4.0/3.6	$2 \cdot 10^7$	900	1999	
13.	K2						0
14.	K3						0
15.	K4						0
16.		703/1	1.2-2.3/1.6	$1 \cdot 10^8$	1050	2006	4
		703/1	1.8-2.1/1.6	$9 \cdot 10^7$	1050	2006	
		630/2	2.9/2.9	$6.6 \cdot 10^5$	930	2001	
		629	1.7/2.9	$2 \cdot 10^7$	930	2000	
17.	K5b						0
18.		510	4/3.5	$8 \cdot 10^5$	550	2008	4
		501B	3.5-3.75/3.5	$2 \cdot 10^6$	760	2003	
		501	3.3-4.85/3.5	$4 \cdot 10^6$	760	2002	
		501	4.0/4.0	$8 \cdot 10^6$	820	2001	
19.							0
20.		502	2.6-8.5/3.3	$9 \cdot 10^7$	630	2008	4
		510	4.3-5.2/2.5	$2 \cdot 10^6$	750	2003	
		510	4.3-5.2/2.5	$4 \cdot 10^6$	760	2003	
		510	5.5-5.9/3.0	$9 \cdot 10^6$	720	1999	
21.	K5a	501	4-6.3/3.2	$2 \cdot 10^7$	930	2008	1
22.							0
23.							0
24.		510/1	2.4-3.8/3.1	$2 \cdot 10^5$	970	2007	1
25.							1
26.							0
27.		409/3	1.95-2.6/2.4	$1 \cdot 10^6$	966	2007	1
28.	K1						0

Source: own work based on *Yearly reports on the state of natural and technical threats in hard coal mining*, W. Konopko (ed..), Central Mining Institute, Katowice years 2007-2009.

According to the data from table 5, the biggest number of tremors occurred in mine 10 and in the previously excluded mines 16, 18 and 20. On this stage the mine 10 and 12 were excluded from further selection because of the high tremor threat (marked in grey color).

The last group of examined natural threats are fire threats. Underground fires have always been a big threat for hard coal mines. The gases released during fires contain poisoning and choking substances and their easy spreading in working pits puts the whole crew in danger.

Table 6. Number of fires and fire ratios in hard coal mining in years 1997-2008

Mine		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
1.								1	1					2
2.				1	1							1	1	4
3.														0
4.			1			1						1		3
5.	K7						1	1		1				3
6.													1	1
7.								1			1			2
8.	K6						1							1
9.	K8													0
10.				1					2	2	1		1	6
11.														0
12.					1			1	1	1	1			5
13.	K2													0
14.	K3		1											1
15.	K4													0
16.			1	1			1							3
17.	K5b													0
18.				1						2			1	4
19.														0
20.		1	2											3
21.	K5a													0
22.														0
23.														0
24.														0
25.														0
26.							1						1	2
27.														0
28.	K1						1		1	1		2		5

Fire threat in Polish hard coal industry in years 1997-2008 was identified by the use of fire ratio (table 6).

$$W = \frac{L}{T}$$

where:
W – fire ratio,
L – the number of fires in a year,
T – coal excavation in million tons.

In the examined period, in the analyzed hard coal mines no fires were noted in year 1997 and in 2008. In years 2002-2007 there was fire activity registered in two mines. In mine K1 in years 2002-2007 there were 7 fires altogether, two of them were exogenous and 3 of them endogenous. In mine K7 in years 2002-2007 3 fires were noted – 1 exogenous and 2 endogenous. So these are the mines, in accordance with the other examined ones, that are characterized by a higher fire risk level. It is worth mentioning however, that the fires also occurred in mine K6 (year 2002) and K3 (year 1998). After considering fire threats, mine 4 was excluded from the combination (marked in orange color in table 6). Despite the high fire threat in K1 it was decided to accept it in the combination due to the infrequency of fire threats and the advantage of this mine in the other analyzed categories.

Table 7. The summary of evaluation and selection basing on resource, infrastructural and threat criteria

Mine		**Mine**	
1.		16.	
2.		17.	K5b
3.		18.	
4.		19.	
5.	K7	20.	
6.		21.1.	K5a
7.		22.	
8.	K6	23.	
9.	K8	24.	
10.		25.	
11.		26.	
12.		27.	
13.	K2	28.	K1
14.	K3	-	
15.	K4	-	

Source: own work.

Below there is the key consistent with the stages of selection conducted:
- exclusion of mines of life length under year 2030,
- exclusion of mines of high methane threat,
- exclusion of mines of high ash threat,

- exclusion of mines of high tremor threat,
- exclusion of mines of high fire threat,
- exclusion of mines of weak and old infrastructure.

In the process of mines selection for further research also the state, age and infrastructure affluence of 28 hard coal mines were subjected to the evaluation. After identification of the basic infrastructure, out of the group of 28 mines the mine 22 and 6 were excluded because of the oldest and least developed infrastructure (they were marked in violet color in table 7). In this way, finally, 8 mining enterprises were selected of the best resource, infrastructural and threat conditions. The chosen mines with the sequence of selection stages are presented in table 7.

4. Estimation and analysis of unit excavation costs in the examined mining enterprises

In further research, the analysis included the level of unit excavation costs in the examined hard coal mines in the view of mining industry in total in order to evaluate their final economical effectiveness. The level of unit excavation costs in examined mining enterprises is presented in table 8 and figure 1.

Table 8. Unit excavation costs in examined mines K1-K8 in years 2006-2009 (in zł/t, %)

Mine	Specification	2006	2007	2008	2009
K1	Unit excavation cost	155.62	161.64	185.89	211.67
	Change compared with the previous year	-9.78%	1.36%	10.42%	9.99%
K2	Unit excavation cost	147.57	155.46	189.51	212.50
	Change compared with the previous year	5.80%	2.80%	17.04%	8.31%
K3	Unit excavation cost	136.94	143.43	202.95	217.96
	Change compared with the previous year	1.20%	4.74%	41.50%	7.40%
K4	Unit excavation cost	158.72	163.85	184.58	219.01
	Change compared with the previous year	5.07%	0.74%	8.15%	14.62%
K5[10]	Unit excavation cost	165.89	171.02	209.98	246.64
	Change compared with the previous year	19.37%	3.09%	22.78%	17.46%
K6	Unit excavation cost	141.81	133.29	191.00	203.13
	Change compared with the previous year	2.23%	-8.28%	37.58%	2.73%
K7	Unit excavation cost	160.96	156.82	193.51	230.21
	Change compared with the previous year	0.20%	-4.93%	18.47%	14.91%
K8	Unit excavation cost	115.37	115.28	129.73	165.77
	Change compared with the previous year	5.38%	2.49%	8.04%	23.43%

Source: own work based on the internal reports of examined mining enterprises.

[10] Unit excavation cost for mine K5 was calculated as weighted average (of excavation) and unit excavation costs of mines K5a and K5b.

Figure 1. The level of unit excavation costs in examined mines in years 2005÷2009 in the view of total hard coal mining industry

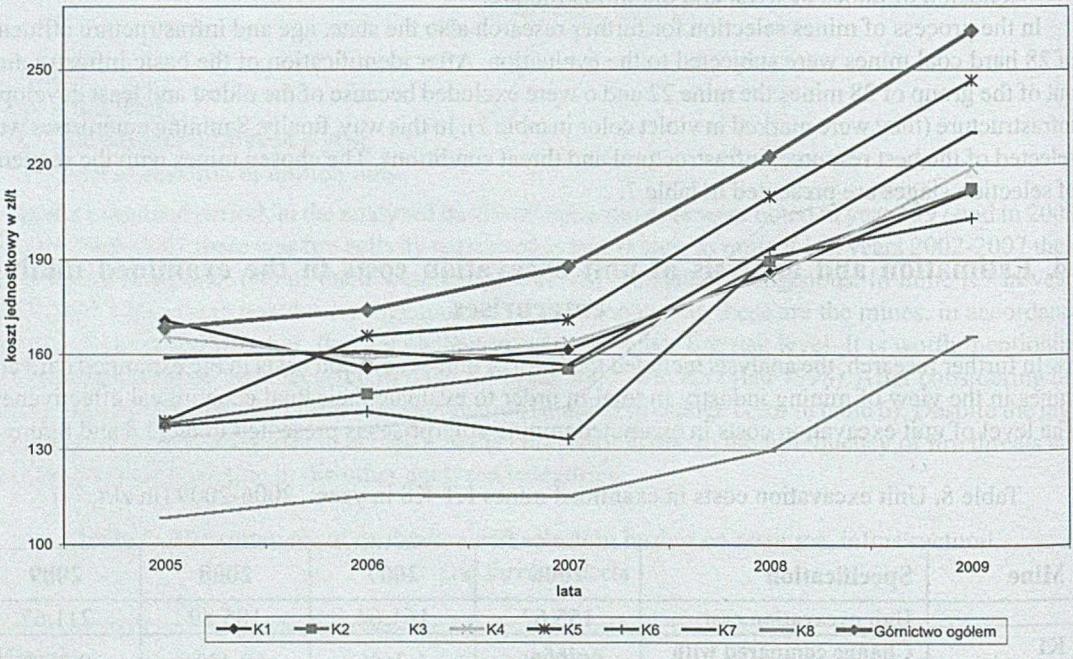

Table 9. Yearly average pace of unit excavation costs changes in the examined mines and in the hard coal mining industry

Mine	Yearly average pace of changes
K1	3.00%
K2	8.49%
K3	10.76%
K4	7.15%
K5	15.67%
K6	8.57%
K7	7.16%
K8	9.84%
Total mining industry	**11.88%**

Source: own work.

In accordance with the data from table 8 and figure 1, in the whole examined period unit excavation costs were much lower in the examined mines than in total hard coal mining industry (the exception is mine K1 in year 2005). The lowest unit excavation costs are characteristic in mines K8, K6 and K3. The highest costs among the examined mines (not exceeding industry average however) were noted in mine K5.

The tendencies regarding changes of unit costs are in all mines similar to the directions of costs transformation in the whole hard coal mining industry. Nevertheless, the pace of such costs increase is much lower. In table 9 there is yearly average pace of costs changes presented in the examined period in the analyzed mines and in the hard coal mining industry.

Only in the mine K5 the pace of unit excavation costs increase was higher than in the whole hard coal mining industry, nonetheless, it should be emphasized that the basic level of these costs was much lower and in year 2009 the costs in this mine are still about 6% lower than the average for hard coal mining industry. Only in two mines yearly average pace of costs increase in years 2005-2009 did not exceed 10%. The slowest costs rise was observed in mines K1, K4 and K7.

In the view of presented considerations, it should be stated that the chosen mines are specific for a very favorable shape of unit excavation costs comparing to the whole hard coal mining industry. Their situation provides then the ground for improvement of performance effectiveness in case of taking actions suggested in the next point of the hereby study.

5. Suggestions of actions to improve effectiveness in the restructuring process in hard coal mining industry

The sources of improving the effectiveness of hard coal production should be sought in the infrastructure, technical, economical and organizational factors. Suggestions of actions in this area are presented in table 10.

Table 10. Possibilities of improving the effectiveness of hard coal production

Infrastructure and technical factors	Economical and organizational factors
Efficiency improvement in the area of basic parameters forming excavation costs, i.e. excavation at a level, layer, wall and shaft.	Reduction of the share of salaries in the overall costs. Introduction of a motivation system to a larger degree connected with economical effects.
Introduction of new technological solutions.	Increase in the range of foreign services.
	Rationalization of energy resources management.
Modernization of existing infrastructure.	Effects of scale realization in the area of transport and logistics.
	Introduction of a process-based costing.

Source: own work.

Infrastructure and technical factors presented in table 10 are mostly dependent on investments on modernization and development of infrastructure of the examined mining enterprises. Appropriately, directed development investments may be treated as an important source of mining costs reduction.

In the area of modernization of the existing infrastructure further actions leading to the simplification of the mine model are possible, encompassing among others:

- Decreasing the number of mine shafts and levels,
- Decreasing the overall length of working passages.

The number of shafts, their placement, function and equipment must provide the optimal use of the transport and ventilation capabilities. Twenty years of experience with the restructuring changes conducted in Polish mining serves as a proof that an actual decrease of mining costs that occurred in the past in Polish mining enterprises was the effect of, among others, decreasing the number of shafts.

Another important element of improving the mining production effectiveness is the consideration of the number of levels. As an effect of actions taken in the area of technical restructuring, the overall number of mine levels was decreased, including the production level. This process should be still realized. The decrease of the number of levels will lead to the shortening of the network of working passages. This will undoubtedly influence the reduction of maintenance costs.

In turn, drilling and maintaining working passages constitutes one of the most important factors in the functioning of the examined mines. A substantial share of costs of making corridor works in the costs of mining production stems from a high – still – number of people employed at these works and from daily material costs. Decreasing the man-hours of works, reduction of material costs will influence a major decrease of costs, on one hand by decreasing the number and extent of works, on the other hand by improving the works organization and a feasible modification of the rebuilding system. In order to provide those conditions, modification of technical and economical planning systems in the examined mines as well as in mining enterprises is necessary.

A serious, because of the potential effects, action should be increasing production capacity focused on the lowest possible number of faces in object mines. The correlation of complexly-mechanized technology of production and its organization form a basis for the further increase of work efficiency and reducing costs.

On the other hand, the most important among economical and organizational factors, from the point of view of costs, is the reduction of the share of salaries in the overall cost. This may be achieved in four main ways, i.e.:

1) Faster increase of efficiency than the increase of salaries.
2) Reduction of the rate of salaries increase.
3) Transformation of the salary system to the one favoring efficiency.
4) Extension of the range of works contracted to external companies.

The most difficult to achieve is the restriction of the rate of salaries growth, if the social order is a priority. In this industry there are many trade unions, mostly with a claim-based attitude. The wage pressure would be weakened, if the wage negotiations were held on the level of single mines.

Introduction of a motivation system, connected to a higher extent with economical effects would be beneficial for the mining industry. In the current motivation system there is a lack of relations between wage and non-wage stimuli with the effects of work done. Furthermore, the multitude of wage elements causes the motivation system to be unclear. Another problem is the lack of communication between the creators of motivation systems and employees who have no awareness of financial and organizational barriers, making it impossible for proper creation and functioning of a motivation system[11].

An interesting attempt of a dialogue between employees, trade unions and managers was taken in Jastrzębska Coal Partnership JSC, where the assumptions were made for a motivation system based on tying the salaries with the effects of work and the financial situation of the company. This is a sign of coming and necessary changes in this area, conditioning the existence of Polish hard coal mining industry.

[11] Compare. I. Jonek-Kowalska, *Problems of motivation in the mining industry enterprises* [in:] *Psychological and sociological aspects of human resources management*, F. Bylok and M. Harciarek (ed.), Monographs no 160, Publishing of Częstochowa Technical University, Częstochowa 2009, p. 171-178.

Some potential also lays in the possibilities of increasing the extent of works contracted to external companies. Most tasks that can be done cheaper and not endangering the continuity of the mining enterprise work have already been contracted to external companies. Possibilities of such actions have not dried out yet. While the increase of tasks outsourced would occur successively, in the mining enterprises environment there is a sufficient number of service companies with proper competencies. Taking into consideration that the majority of the personnel (over 2 thousand people in the examined mines) has pension rights, a possible outsourcing could not be tied to firing employees, who after redundancy would have no means to live. Such perspective would be a strong negotiation argument for an employer in the area of wage solutions (restricting the rate of salaries increase, modification of the motivation system).

To the category of changes directed at improving of production effectiveness, one can also include the actions taken in the areas of transport and logistics. The main goal of those actions should be the realization of the effects of scale and, as a result, reduction of costs in these areas. These possibilities encompass both complex solutions, as well as the enterprises with a limited extent:

1) Creation of integrated logistics systems, servicing without failure and effectively all links of the production process.
2) Integration of the output delivery in particular mining enterprises which enables the reduction of excessive technological capabilities of vertical transport and mechanical processing of output, tied with the reduction of occupancy and the number of repair as well as costs of using materials.

In the last years, works have been conducted to perfect the cost managing system. In year 2007, in Kompania Węglowa JSC, teams of controllers were introduced whose task was to create budgeting procedures. The objective of the changes undertaken was above everything adjusting management instruments to the market conditions and increasing the effectiveness. Currently, multi-year development plans created by coal cooperatives are the starting point for the budgeting procedures. On the basis of those plans, an annual Technical-Economical Plan is made, which is presented to all mines belonging to the cooperative. Then, on the basis of the annual plan, monthly operational plans are developed. Based on them, the management board formulates guidelines for particular units – the take the form of production and economical tasks for a given month.

6. Conclusion

The methodology of evaluation and selection of mining enterprises, presented in this article, allows us to distinguish those mines, that are characterized by the most beneficial resource, geological and mining conditions. These are the criteria allowing to continue the production up to year 2030 in a relatively safe geological and mining conditions. This includes the sufficiency of operative resources, the life length of mines and the identification of resources in the examined mining enterprises. Furthermore the procedure verifies typical natural threats occurring in the hard coal mining industry, taking into consideration gas, ash, tremor and fire threats. Not without its merit for the continuing of restructuring process are infrastructure conditions, also indicated in the presented evaluation and selection method.

The second stage of the presented procedure confirms the exceptionally beneficial shape of unit excavation costs in the eight examined mining enterprises. The chosen mining enterprises are characterized by the unit excavation costs lower than in the total hard coal mining industry. Furthermore, the rate of the costs increase is also lower than the one of the industry. The proposed method of mines assessment is therefore directed on pointing out the most efficient mining enterprises and may become the beginning of further hard coal mining positive changes.

In further perspective, the possibility of reducing the unit excavation costs in the examined mining enterprises and of a permanent effectiveness improvement can be found in:

1. Extension and modernization investments, affecting the improvement of mining technologies.
2. Modernization of existing infrastructure.
3. Restriction of the rate of salaries increase.
4. Modifications of the motivational system, directed on tying it with economical effects.
5. Widening the extent of works contracted to external companies.
6. Introduction of new solutions in the area of logistics and transport.
7. Rationalization of energy resources.
8. Introduction of modern methods of cost management.

Bibliography

1. Durlik I., *The restructuring of economic processes*, Placet, Warsaw 1998.
2. Jonek-Kowalska I., *Analysis and assessment of operational risk in mining enterprises* /in:/ *Models of financing operational activity of mining enterprises*, M. Turek (ed.), GIG, Katowice 2011.
3. Jonek-Kowalska I., *Concentration and restructuring of companies* /in:/ *Relations and value in strategies of businesses management,* J. Pyka (ed.), TNOiK, Katowice 2008.
4. Jonek-Kowalska I., *Problems of motivation in the mining industry enterprises* [in:] *Psychological and sociological aspects of human resources management,* F. Bylok and M. Harciarek (ed.), Monographs no 160, Publishing of Częstochowa Technical University, Częstochowa 2009.
5. Karbownik A., Turek M., Pawełczyk E., *Effects of realization of hard coal mining reform government program in years 1998-2001.* /in:/ *Global and regional modernity conditions of industry and services*, J. Pyka (ed.), University of Economics in Katowice Publishing, Katowice 2001.
6. Podczarski S., *Restructuring processes effectiveness in industrial enterprises – the attempt of identification*, 'Organization Review', 2006, no 6-7.
7. Rochoń M., *Financial effectiveness of restructuring of Polish companies on the basis of legal procedures - synthetic approach*, 'Organization Review', 2006, no 12.
8. *Strategy of hard coal industry development in Poland in years 2007-2015*, Document approved by the Council of Ministers on 31st July, 2007.
9. *The program of restructuring hard coal mining industry in Poland in years 2003-2006 with the use of anti-crisis acts and initiation of privatization of some mines*, Ministry of Economy, Warsaw 2002
10. Turek M., Jonek-Kowalska I., *Financing of restructuring processes in hard coal mining industry in years 2003-2006.* /in:/ *Restructuring management in the processes of integration and new economy development*, R. Borowiecki and A. Jaki (ed.), Cracow University of Economics publishing, Kraków 2008.
11. Turek M., Jonek-Kowalska I., *Companies concentration and its effects on the example of Kompania Węglowa S.A.* /in:/ *Restructuring management in the processes of integration and new economy development*, R. Borowiecki and A. Jaki (ed.), Cracow University of Economics publishing, Kraków 2008.
12. Turek M., *Technical and organizational restructuring of hard coal mines*, Central Mining Institute, Katowice 2007.
13. *Yearly reports on the state of natural and technical threats in hard coal mining,* W. Konopko (ed.), Central Mining Institute, Katowice years 2007-2009.