

## The Concept of Operational Risk Identification and Evaluation in a Sector Depiction

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### Abstract

*Risk management is a complex and multi-thread issue. In many cases the methods and tools of risk management need to be adjusted to the individual needs of a company and specificity of the activity conducted by them. Therefore, in the hereby paper there is the concept of operational risk identification and evaluation on the basis of a mining enterprise. On the one hand, it has universal features as it derives from literature studies, on the other hand it is of a highly applicable character because it includes the specificity of mining activity.*

**Key words:** operational risk, risk identification method, risk evaluation method, mining enterprise.

### 1. Introduction

Research process presented in this paper includes two main trends, methodical and research. Each of them was divided into successive stages. Their sequence is presented in Figure 1.

**Figure 1. Stages of the undertaken research process in the methodical area**



Source: own work

Formulation of research concept was launched by determination of the scope of research and stating the research problem. Thus, the area of the undertaken research refers to risk management in the company and is considered in general as well as in detailed approach. The first one refers to universal problems connected with risk management in the company while the latter is a detailed description of the conducted considerations and research and refers to risk management in a mining enterprise.

On the basis of the identified research area, the basic research problems were defined which, in turn, enabled targeting of the further research. The problems stated took the form of the following questions:

*What sources of operational risk accompany the functioning of the mining enterprise?*

*How a comprehensive identification of the sources of operational risk in the mining enterprise may be made?*

*Which methods enable a holistic evaluation of operational risk in the mining enterprise?*

*How the existing management system of the operational risk in the mining management may be improved and rationalized?*

Research problems defined in such a way allowed to explicate research purposes expressed in the form of the following objectives:

1. Identification of the sources of operational risk in the mining enterprise.
2. Description of comprehensive method of the sources identification of operational risk in the mining enterprise.
3. Creation of method aiming at holistic evaluation of operational risk in the mining enterprise.
4. Indication of the directions of changes in the process of operational risk management in the mining enterprise.

The objectives mentioned above were realized in a cognitive dimension, referring to all mining enterprises, and in a practical dimension, referring to the peculiarity of the examined mining enterprise – Mining Corporation JSC. (Kotarbiński, 1961; Zaborowski, 1973).

The choice of the conceptual apparatus was made on the basis of considerations led in the theoretical part of this monograph. Each of the points presented in this part includes a summary concerning the most important notions, definitions, theories and models, which create the conceptual apparatus of the research (Frankfort-Nachmias & Nachmias, 2001). It is worth to repeat at this point the understanding of the fundamental elements of this paper.

In reference to risk, the definition of L. Osiatyński shall be adopted, according to which **risk** is “a possibility of total or partial failure of the ventures or interests threatening a business entity, in relation to which the business entity is aware of all the dangers, however, it does not have a priori certainty of the occurrence or the size of losses caused by these dangers, and as to which it bears all responsibility for the possible consequences resulting from them” (Osiatyński, 1963; Richardson, 2009). While considering the operational risk, the category of the investigated ventures will be restricted. It will be exclusively the activities of current and operational nature realized in the course of the basic activities of the company. In relation to **risk management** the concept of C.A. Williams, M.L. Smith and P.C. Young was adopted. It defines risk management as “broadly understood management actions aiming at identification and assessment of risk as well as uncertainty and fight against their causes and influence on the organization” (Williams, Smith & Young, 2004; Holt, 2004). Taking into consideration permanent presence of risk in the activities of the company, so understood risk management has a long-term and strategic nature (Alexander, & Sheedy, 2004), which in current activity is translated to the sequence of operational activities (Ahmed, Kayis, & Amornsawadwatan, 2007).

**Identification of risk** shall include activities aiming at the fullest possible determination of the risks that threaten company. Within the range of this stage, the determination of the possible consequences of the disclosed types of risk is also planned. **Risk assessment** shall be connected with the determination of the level of risk, however, there is no requirement for the risk threatening a given business entity to be measurable. It is sufficient that the likelihood of the result different than the expected one shall be included in the range (0;1) (Vaughen i T. Vaughen, 1999). In the light of the above, at this stage it is, first of all, indispensable to state that a given risk is possible without any necessity to assign to this risk a determined value of probability.

The largest European coal extracting company – Mining Corporation JSC. was examined. The choice of this company was predetermined first of all by the size of its business which enabled a broad and comprehensive identification of the sources of operational risk. The activity of Mining Corporation JSC. on the international stage was an additional circumstance that influenced the choice of this company for the research. Within the framework of this research, the current organizational structure of Mining Corporation JSC. including 16 mining enterprises was used. The research was carried out in the period of 2003-2009. It is the period of functioning and development of activity of the investigated mining enterprise.

**2. Methodology of operational risk identification in the mining enterprise**

The process of operational risk identification in the mining enterprise included the stages presented in figure 2 (Baskerville, 1991). Research methods used were ascribed to the stages (Olson, & Wu, 2009).

**Figure 2. Research methods used in risk identification in the mining enterprise**

Research Sequences	Research Methods	Effects
Total determination of risk factors	Creativity techniques	Division of risk factors
Qualitative ranking of risk factors	Cooperation with external environment Agreements analysis Financial account	Control list of risk factors Descriptive method
Analysis of threats and losses	Information network method supported by reports Risk chain method Historical data analysis	Catalog of threats and losses

Source: own work

In the first research stage based on the creativity techniques (brainstorming), there was a general classification of risk factors determined in the mining enterprise (Jedynak, Teczke, & Wyciślak, 2001). Having conducted the consultation with the executives of mining enterprises and experts from the Central Mining Institute it was decided to adapt the following division of risk sources:

1. **natural** – connected with occurrence of the aforementioned natural threats specific for mining enterprises,
2. **managerial** – connected with conducting the operational processes realized mainly in frames of managing the working capital of a company and next they display effects in the area of sales operation.

Such classification of risk sources in a company allows for a separate analysis of risk factors linked to the sector specificity and of factors linked to the operational company management (Olson, & Wu, 2010). The second research stage, corresponding to a qualitative subordination of risk factors, was realized on the basis of cooperation with the external environment, analysis of contracts and financial result. It was additionally supported by literature studies concerning the performance of mining enterprises in Poland. In the method of financial account the financial results were used of the examined mining enterprise. The cooperation with environment meant in this case conducting the consultation and interviews directed on particularization, arrangement and building hierarchy of risk factors in frames of the groups selected before. On the grounds of the analysis of reports on the situation of natural threats in hard coal mining as well as the analysis of insurance contracts signed by the mining enterprises, the control list of risk factors was made which includes:

**natural sources:**

- ❑ usual: gas, ash, tremor, fire,
- ❑ unusual: water, rocks and gases eruption, climate, seismic and micro-biologic,

**managerial sources:**

- ❑ working assets management including: inventories, short-term receivables, short-term investments,
- ❑ short-term payable,
- ❑ operational management of immaterial resources (human, market and organizational) (Jonek-Kowalska, 2011a).

In the third stage of risk identification, the analysis of threats and losses was conducted using the method of information network which bases on written and oral descriptions of the proceedings of the process of operational risk realization in the mining enterprises. In turn, in order to determine cause and result effects between the threat occurrence and its realization the method of risk chain was used. In both these methods the historic data was applied concerning threats and losses in the hard coal mining from years 2003-2009. The effect of this stage of risk identification was the creation of threats and losses catalog connected with the realization of operational risk in the mining enterprise.

**3. Methodology of operational risk evaluation in the mining enterprise**

The next stage of the research on operational risk in the mining enterprise was risk evaluation, which aim was to provide the characteristics of measurability for the established risk factors (Wu, Kefan, Gang, & Ping, 2010). Risk evaluation is an intermediate stage between gathering information about risk – its identification, and transformation of this information in relevant decisions – activities in the field of risk (Carolan, 2007). A review of the methods used in risk evaluation is presented in figure 3.

**Figure 3. Research methods used in risk evaluation**

Research Sequence	Research Methods	Effects
Valuation of risk	Statistic methods Random sampling Questionnaire research	Individual assessment of particular threats
Risk selection	Analysis of the weakest cells	Indication of significant and insignificant risk sources for company
Categorization of risk	Risk metrics Risk matrix Questionnaire research	Determination of risk categories for each of investigated threats
Determination of the admissibility limits	Indicator analysis	Indication of admissibility limits of risk within the range of particular threats
Structure of risk model	Sectional method Model method	Report describing where and how much the company is exposed to risk

Source: own work on the basis of: Nahotko, S. (2001). Economic risk in economic activity. Bydgoszcz: Oficyna Wydawnicza Ośrodka Postępu Organizacyjnego Sp. z o. o., pp.60-90 and P Jedynek, P., Teczek, J., & Wyciślak, S. (2001). Managing risk in the internationally-oriented enterprises. Kraków: Księgarnia Akademicka, pp.40-48.

Risk evaluation in the mining enterprise was started from risk valuation aimed at assigning to operational risk the qualitative or/and quantitative features (Jonek-Kowalska, & Wawiernia, 2007). At this stage, each of the factors of natural and managerial risk was analyzed by means of description and quantification. In the process of operational risk measurement in the mining enterprise, the statistical methods were used, employing: structure measures, increments, dynamics index, arithmetic mean, standard deviation as well as coefficient of variation and data scatter.

In the next stage of the research on operational risk in the mining enterprise, the categorization of risk was conducted, which constituted a completion to the process of risk valuation. This categorization was carried out on the basis of risk metrics and risk matrix. Risk metrics allowed to classify the examined risk factors and to determine them as: “small”, “average”, “large” or “extremely high” (Jonek-Kowalska, & Wawiernia, 2007). The determined matrix classes of risk from I to IV – separate for natural and managerial threats, were then assigned to risk classified in that way (Klimczak, & Staniec, 2008; Mauermann, & Oktem, 2002). In the process of ranking and creation of individual classes of operational risk, the questionnaire research conducted among experts in the field of management of mining enterprise was very helpful.

Information about range, norms, frequency and importance of particular threats gathered in the previous stages of the research enabled realization of the next stage of evaluation of operational risk in the mining enterprise which is a determination of admissibility risk limits. In the process of identification of admissibility limits, random sampling based on the choice of indicators determining the level of a given risk was used. According to these measures, limit values of particular risks were determined in an individual approach. In turn, in holistic approach the admissibility of risk of natural and managerial nature allowed to determine risk classes assigned to these groups of threat.

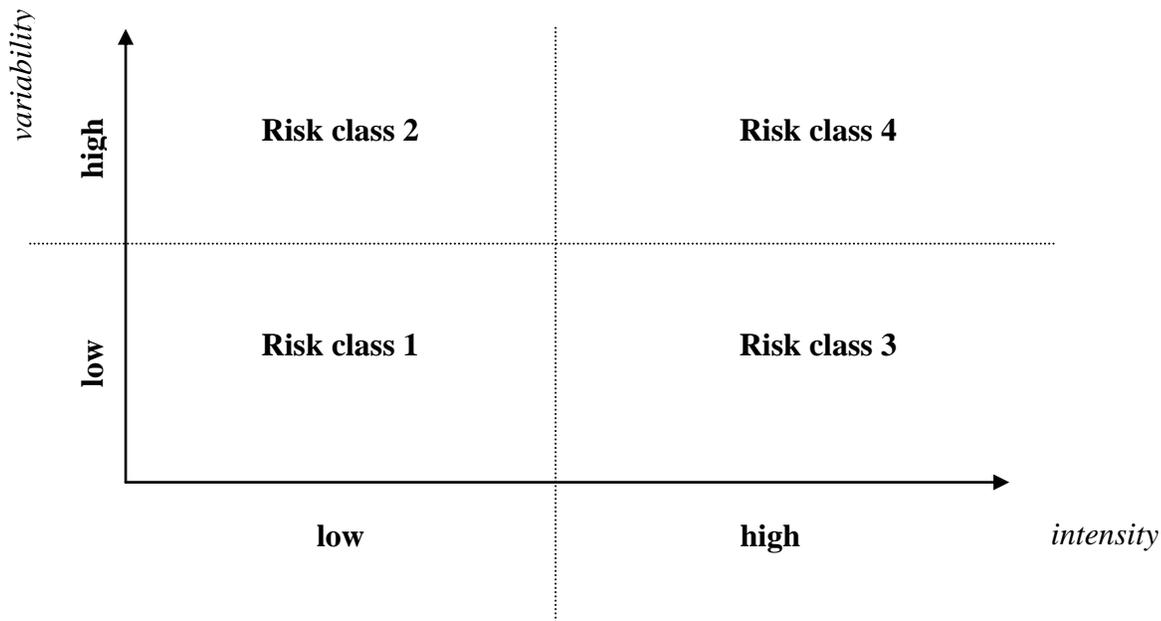
The process of assessment of operational risk in mining company was finished by structure of risk model (Alter, & Sherer, 2004). Sectional method, based on identification of strengths and weaknesses of the company (Polak, Rogers, & Sweeney, 2010), constituted the basis for determination of this model. The strengths are helpful in creation of company’s strategy while the weaknesses are the basis for indication and monitoring of areas prone to risk (Łuczak, 2003). Risk model finally took the form of a report describing where and how much mining company is exposed to the occurrence of operational risk (Nahotko, 2001).

#### ***4. Aggregation of operational risk identification and evaluation in the mining enterprise***

In the first stage of aggregation, the evaluation of operational risk was made in the view of natural threats which in a clearly significant way affect the entirety of mining enterprises' performance. The examination of intensity and variability of the aforementioned threats was conducted in the years 2003-2009 on the basis of statistical methods of risk measurement grounding on arithmetic mean, standard deviation and variation coefficients. Next, there was the attempt made concerning the aggregation of the results obtained in the form of operational risk matrix in terms of natural threats (Bandyopadhyay, Mykytyn, & Mykytyn, 1999). When creating the risk matrices there was the intensity and variability of the examined natural threats studied. On the basis of these two features, there were the four elementary operational risk classes obtained in frames of the various types of the examined threats (Jonek-Kowalska, 2011b):

1. **risk class 1**, specific for a low intensity of the examined threat as well as low variability,
2. **risk class 2**, referring to a low intensity of threat but with the character of a high variability,
3. **risk class 3**, corresponding to threats of low intensity and high variability,
4. **risk class 4**, specific for both high intensity and variability of the examined threats.

A graphic depiction of the aforementioned classes of operational risk is presented in figure 4.

**Figure 4. Matrix of operational risk concerning natural threats**

Source: own work on the basis of Klimczak, K.M., & Staniec, I. (2008). Operational risk. In Staniec, I., Zawila-Niedzwiecka, J. (Eds.), Operational risk management. Warsaw: C.H. Beck Publishing p.42. See also: A. Mauermann, U. Oktem, *The near-miss management in operational risk*, op. cit., s. 25-38.

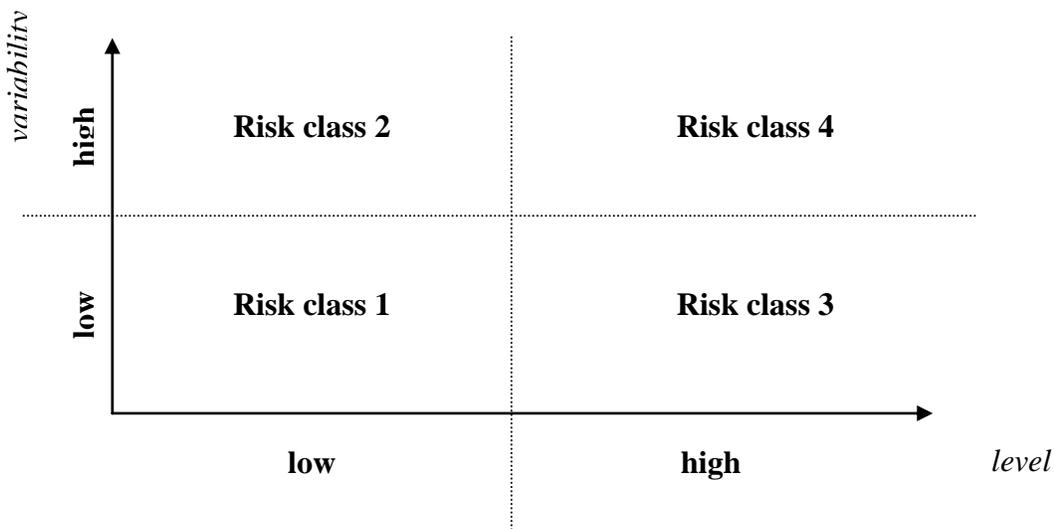
The matrix of operational risk was created in a few options for the separate types of natural threats. The results obtained were aggregated through ascribing weights to the particular threats on the basis of the interviews with experts on the hard coal mining. The final result of the first research stage is one compiled yearly class of operational risk referring to natural threats for the examined mining enterprise (Gorczyńska, & Kowalska, 2009). In the second stage of research there was the identification of operational risk made linked to the managerial activity undertaken in the mining enterprises. By the operational activity, in this case, the actions taken in order to manage the working assets of the mining enterprise were meant, which includes inventories, receivables and short-term investments. A vital part of this activity is also short-term payable management as their level affects the financial liquidity of a company (Jonek-Kowalska, 2010).

In order to identify the operational risk in the managerial area, a method of financial account was used. In years 2003-2009 the basic average and variability measures were calculated concerning inventories, short-term receivables, short-term investments, short-term payable and sales revenues. For these calculations the monthly data of the examined mining enterprise was adapted. Grounding on the results achieved, the matrices of operational risk were created referring to the managerial area, distinguishing, similarly to the previous method, 4 risk classes. Differentiating features in this case were the following:

- ❑ level, measured by the share in the balance sheet sum (values considered as high or low were determined on the basis of questionnaire research),
- ❑ variability, identified on the basis of variation coefficient.

The risk classes indicated in such way are presented in figure 5.

Figure 5. Matrix of operational risk concerning managerial threats



Source: own work on the basis Staniec, I., Klimczak, K.M., *Ryzyko operacyjne*, [w:] *Zarządzanie ryzykiem operacyjnym*, pod red. I. Staniec i J. Zawily-Niedzwieckiego, op. cit., s. 42. See also Mauermann, A., & Oktem, U. (2002). The near-miss management in operational risk. *The Journal of Risk Finance*, Vol.4 (1), pp. 25-38.

For each of the examined groups – inventories, short-term receivables, short-term investments, short-term payable and sales revenues the individual risk class was obtained, taking into consideration the subsequent research periods. After assigning weights identified in the questionnaire research to the aforementioned groups, the results were aggregated to one yearly class of operational risk regarding managerial actions (Williams, 1999).

5. Evaluation of operational risk according to natural threats

After the identification, description and evaluation of separate natural threats in the hard coal mining, there was a risk selection made. Its purpose was to indicate the most important sources of risk in the operating activity. These were considered to be the natural threats regarding the following threats: methane, ash, tremor and fire. The ranks assigned to these threats in the questionnaire research are presented in table 1 (Jonek-Kowalska, 2011d)1.

Table 1. Rank of typical natural threats in generating operational risk in the mining enterprise

Threat	Average weight on the basis of questionnaire research
Gas	0.33
Ash	0.22
Tremor	0.21
Fire	0.24

Source: own work on the basis of questionnaire research

The interviewees indicated as the most important source of operational risk among the typical natural threats to be gas threats. The interviews allowed to determine that this type of threats is especially dangerous due to the scale of possible losses in human and capital resources and to the commonness of its occurrence as well as to the possibility of triggering other threats, what increases the amount of losses. The three remaining groups of threats are characterized by similar weights - from 0.21 to 0.24.

The average operational risk according to natural threats was calculated in the following formula:

$$R_{ON} = \sum_{i=1}^n w_i \times c_{ron}$$

where:

R<sub>ON</sub> – average operational risk concerning natural threats,

$w_i$  – weight of threat of i-number,  
 $c_{rom}$  – class of threat of i-number.

Next, the obtained results were rounded and the resultant class of operational risk was received in Mining Corporation JSC. concerning natural threats. In table 2 there are the results presented of the research stages characterized in the hereby point as well as the resultant class of operational risk regarding natural threats in Mining Corporation JSC. in years 2003-2009.

**Table 2. Aggregation of operational risk resulting from natural threats in Mining Corporation JSC. in years 2003-2009**

Specification	2003	2004	2005	2006	2007	2008	2009
<b>Gas threats</b>							
Risk class	4	4	4	4	4	4	4
Weight	0.33	0.33	0.33	0.33	0.33	0.33	0.33
<b>Ash threats</b>							
Risk class	2	2	2	2	2	2	2
Weight	0.22	0.22	0.22	0.22	0.22	0.22	0.22
<b>Tremor threats</b>							
Risk class	1	4	4	3	3	1	4
Weight	0.21	0.21	0.21	0.21	0.21	0.21	0.21
<b>Fire threats</b>							
Risk class	2	3	2	4	2	1	2
Weight	0.24	0.24	0.24	0.24	0.24	0.24	0.24
<b>Average operational risk according to natural threats</b>	<b>2.45</b>	<b>3.32</b>	<b>3.08</b>	<b>3.35</b>	<b>2.87</b>	<b>2.21</b>	<b>3.08</b>
<b>Class of operational risk according to natural threats</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>

Source: own work

Finally, it was determined that in the examined period Mining Corporation JSC. was specific for operational risk according to natural threats on the level of class 2 and 3. Undoubtedly, the highest influence on this risk had the gas threats of a high rank, characteristic for high variability and intensity. The level of ash threats was stabilized and average, the level of fire and tremor threats was quite varied, though.

## 6. The evaluation of operational risk concerning managerial threats

On the basis of the research stages presented in the introduction, there was a summary made regarding the classes of managerial operational risk in frames of the four analyzed groups: inventories, short-term receivables, short-term investments and short-term payable. The results of evaluation of managerial threats were aggregated by assigning ranks specified by experts. The effects of summary in the form of the classes of operational risk referring to managerial threats are presented in table 3. The average operational risk concerning managerial threats was calculated, similarly as before, according to the following formula:

$$R_{OM} = \sum_{i=1}^n w_i \times c_{rom}$$

where:

$R_{OM}$  – average operational risk concerning managerial threats,  
 $w_i$  – weight of threat of i-number,  
 $c_{rom}$  – class of threat of i-number.

The compilation of results is enclosed in table 3.

**Table 3. The classes of operational risk resulting from managerial threats in Mining Corporation JSC. in years 2003-2009**

Years	2003	2004	2005	2006	2007	2008	2009
Risk class - inventories	2	1	1	1	1	1	2
Weight	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Risk class – short-term receivables	3	1	1	1	1	1	1
Weight	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Risk class – short-term investments	2	2	2	2	1	2	2
Weight	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Risk class – short-term payable	3	3	1	1	1	1	1
Weight	0.4	0.4	0.4	0.4	0.4	0.4	0.4
<b>Class of managerial risk</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>

Source: own work

The highest risk classes of managerial feature were specific for the first two years of functioning of Mining Corporation JSC., that is years 2003-2004. In the next periods, both level and variability of inventories, short-term receivables and short-term payable were low, what allowed to assign risk class 1 to the enterprise. A higher variability was only specific for short-term investments and inventories in year 2009, what caused that they were assigned the risk class 2. In the first two years, the functioning of Mining Corporation JSC. in the area of operating activity was characterized by an increased risk – class 2 and 3. In the subsequent years, due to the share decrease of short-term payable and low level as well as variability of working assets, Mining Corporation JSC. was qualified to the operational risk class 1 in the area of managerial threats.

### 7. Holistic evaluation of operational risk in the examined mining enterprise

In the last stage of research on the evaluation of operational risk in the mining enterprises, there was an aggregation of results made concerning the stages of natural and technical threats identification as well as the determination of risk in the area of operational management. It was assumed that the final aggregation would be assigning one yearly aggregated class of operational risk to Mining Corporation JSC. being a resultant of threats of natural and managerial character.

The basic problem in this matter was determining the rank of natural and managerial threats in operational risk of the mining enterprise. In order to ascribe weights to the separate threats, there were the questionnaire research used which was described before. The interviewees were asked about the influence strength of natural and technical threats on the result of operational activity of the mining enterprise. In the experts' opinion, definitely, the biggest impact on the result of operational activity have the natural threats. Threats that stem from the mistakes in management of the operational activity strongly affect the operational result of mining enterprises in 22%. Therefore, such rank was assigned to the managerial threats (0.22) in the final aggregation of operational risk in Mining Corporation JSC. The natural threats received the weight of 0.78 in the final evaluation of operational risk.

The results of aggregation of natural and managerial threats are presented in table 4.

**Table 4. Aggregation of operational risk resulting from natural and managerial threats in Mining Corporation JSC. in years 2003-2009**

Specification	2003	2004	2005	2006	2007	2008	2009
Class of natural risk	2	3	3	3	3	2	3
Weight of natural risk	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Class of managerial risk	3	2	1	1	1	1	1
Weight of managerial risk	0.22	0.22	0.22	0.22	0.22	0.22	0.22
<b>Class of operational risk</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>

Source: own work

The aggregated operational risk in Mining Corporation JSC. is of class 2 and 3. The influence on such result has mainly the risk connected with occurrence of natural threats, as their level is high in the examined period, similarly to the share in the weighted average of risk. Managerial operational risk does not affect significantly the final level of operational risk – (weight 0.22), moreover, in the last four years it remains in the lowest risk class.

## 8. Conclusions and implications

The research presented in the paper on the identification and evaluation of operational risk in the sector context allowed to form general suggestions for the system of operational risk management in the mining enterprise (Pender, 2001). Such system should:

- ✓ cover the whole mining enterprise,
- ✓ include the specificity of departments composing the mining enterprise,
- ✓ identify internal as well as external sources of operational risk (Baskerville, 1993),
- ✓ categorize threats of natural character (typical and untypical) as well as managerial character,
- ✓ quantify individually (for separate departments) and holistically (for the entire mining enterprise) the level of natural threats,
- ✓ evaluate holistically the level of managerial threats,
- ✓ enable the determination of a collective class of operational risk including both natural and managerial threats,
- ✓ create backgrounds for a universal identification and evaluation of operational risk, possible to adapt in every mining enterprise and used in the comparison analysis of separate mining enterprises,
- ✓ direct the actions taken in the area of operational risk according to material control (preventive measures) and financial control (risk stoppage and transfer),
- ✓ provide maximal protection from the results of realization of separate operational risk sources,
- ✓ enable, on each stage of the process of operational risk management, the control of actions taken as well as the information transfer about the results of control,
- ✓ adapt to changing internal and external conditions (Jonek-Kowalska, 2011c).

Mining Corporation JSC. is the biggest company among the three working mining enterprises in Poland. It consists of 16 mines extracting hard coal. These are the mines of a high and very high level of natural threats, especially gas threats, what causes that the risk connected with the mining specificity is very high. These threats cannot be minimized. Therefore, within the instrumentation of risk management, there are only left the preventive measures and insurance covering capital and human losses.

In the area of managerial risk it is currently suggested to implement the modern systems of cost management, enabling medium- and long-term planning as it may be beneficial for risk reduction in this area.

In future, the conducted research should be extended by a versatile analysis of strategic risk, including threats caused by a closer and remote environment of mining enterprises, also in terms of risk factors of economic character. Such actions could facilitate the creation of the complex system of risk management in the mining enterprise.

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