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Assessing operational risk in coal mining enterprises – Internal, industrial and international perspectives

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ABSTRACT

This paper aims to assess and compare operational risk in coal mining enterprises in Central and Eastern Europe. It also provides framework for combined internal and industrial risk assessment using fuzzy logic. The fuzzy logic is used to assess the operational risk from two perspectives: internal and industrial. In this context, five mining enterprises from Central and Eastern Europe are examined. Operational risk related to the specifics of the business, due to the geopolitical and progressive globalization of the coal market, is analyzed through mining enterprises that are comparable in value. For individual operational risk diversification in mining enterprises, the assessment of resource potential plays a key role. In terms of the risk associated with the specifics of business, the lowest partial risk assessments relate to customer relationships.

1. Introduction

Risk, traditionally understood as the possibility of deviations from a planned target, is an immanent feature of every business decision. An enterprise is therefore exposed to many simultaneously emerging risk sources associated with individual decisions and actions. At the same time, in modern, highly turbulent economic realities, we can observe intensification and the emergence of unprecedented sources of risk. This means that companies are facing new challenges and being forced to constantly seek more efficient and effective methods of risk management (Zielinski, 2013; Gordon et al., 2009; Taleb et al., 2009).

The increased interest in risk management among researchers and practitioners – following a period of research on risk essence run by, among others, by Knight (1921) and Arrow (1971) – occurred in the early 1990s. Research interests were then focused on the design of risk management systems and the improvement of their effectiveness (Kloman, 1992; Jędralska, 1992). It should be emphasized that risk was analyzed primarily in terms of quantity, which implied that the main trends in the research of risk was in the fields of accounting and finance (McShane et al., 2011).

The global economic crisis in 2008 (Gorczyńska, 2011) negatively verified a significant part of risk management methods, which failed to protect even the most market-experienced enterprises against the effects of the downturn. Investigation into causes of the ineffectiveness of risk management instruments reactivated and intensified research on uncertainty in business (Crotty, 2009; Hubbard, 2009; Power, 2009). As a result of the above-mentioned works on risk management systems, new research threads were introduced (Koletar, 2010; Thamhain, 2013), including (among others) the psycho-social aspects of risk management (Greco, 2012), referring to the psychological theory of decision-making (Nielsen et al., 2013), the concept of holistic risk management systems implemented in the form of enterprise risk management (ERM) (Chapman, 2003; COSO, 2004; Lam, 2008; Arena et al., 2010; Hoyt and Liebenberg, 2011; Marchetti, 2011) and integrated risk management (IRM) (Wu and Wu., 2014), and the extension of accounting and financial research based on elements of strategic management (Kaczmarek, 2006; Van de Ven, 2007; Bromiley et al., 2015).

In studies on risk and uncertainty, there are several key problems that need to be taken into account by each decision-maker in the company. First, the uncertainty and risk due to their referencing of future events are not always fully foreseeable. Thus, none of the assessment methods for risk minimizing guarantee both certainty and effectiveness (Zwikael and Ahn, 2011; Verbano and Venturini, 2011; Pyka and Wieczorek-Kosmala, 2012; Oehmen et al., 2014). Therefore, you cannot build a false vision for the total protection of a company against risk through the use of fashionable and commonly used management methods. The uncritical and mechanical use of risk management approaches leads to ignoring much of the non-quantifiable or hard-to-quantify sources of risk, and the mistaken belief that using complex techniques and computational tools can predict the future (Russo and Schoemaker, 1992).

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Risk assessment is the first step in risk management. Once this procedure has been carried out, the selection of risk management instruments and risk control can take place. The result of the risk assessment therefore affects the scope and intensity of protection. This means that the holistic identification of risk sources is an extremely important element in risk assessment, relating as it does to all areas of the enterprise's business and the environment in which it operates. Such an approach implies, however, that there can be problems in risk measurement, as many pre-identified sources of risk are non-quantifiable in nature. The assessment is very often limited to only those sources that provide statistical data and allow for the probability of occurrence of a given hazard to be determined, as well as those losses related to its occurrence (Callon et al., 2009). As a result, with the exclusion of non-measurable risk sources, a false sense of complete risk assessment and prevention can result (Deaves et al., 2010).

Incompleteness of risk assessment and consequent ineffectiveness in hedging against the risk also result in the imitation and uncritical duplication of assessment methods without their adaptation to the needs and characteristics of the company and the sector (Bort and Kieser, 2011). This effect is very likely due to the complexity and strong mathematical basis of most quantitative methods of risk assessment (Mikes, 2009), which managers do not fully understand. This makes it difficult for them to interpret the feedbacks between risk sources, as well as in understanding their individual nature.

Mathematization and informatization of risk assessment hinders access to risk management in those enterprises (Wu and Olson, 2010) that do not have sufficient human, financial and information potential to use advanced risk management methods. This applies particularly to small and medium-sized enterprises (Verbano and Venturini, 2013; Kim and Vonortas, 2014; Grant et al., 2014). On the other hand, for large enterprises the problem is the lack of opportunity to carry out universal, transparent and less mathematical and technological risk assessments by the company's stakeholders – including, first and foremost, the shareholders.

In the hard coal mining industry, the spectrum of risk sources is much wider than in other industries. Mining companies, in addition to the dangers typical to industrial companies, also face natural hazards related to underground operations: such as gas, dust, rock burst, water, seismic, climatic, microbiological and even radioactive hazards (Gu et al., 2010; Khanzode et al., 2011a, 2011b). The frequency and intensity of these hazards can have extremely serious consequences for human life and health that are unheard of in other industries (Fire et al., 2014; Mahdevari et al., 2014a, 2014b).

Due to extremely large threats from geological and mining conditions, the interests of practitioners and theoreticians focus on the methods and means of evaluating and preventing natural hazards as well as the consequences of the production processes and human life. Publications in these areas have concerned mathematical and computer systems for predicting individual and coexisting natural hazards (Khanzode et al., 2011a, 2011b; Pejic et al., 2013; Zhang et al., 2015; Masto et al., in press; Mark and Gauna, in press; Lokhande et al., 2015; Spada and Burgherr, 2016). Many studies have also described the technical threats that are connected not only with geological conditions but with human and machine errors as well (Düzgün, 2005; Michalak and Turek, 2011; Ghasemi et al., 2012; Najafi et al., 2014; Petrović et al., 2014; Wang et al., 2014; Strzalkowski and Tomiczek, 2015; Zhang et al., 2015).

All of the mentioned issues are particularly significant regarding the health and safety of mining crews and for the residents of mining areas. Therefore, some researchers have investigated the negative effects of excavation on human health and life (Mueller et al., 2015; Ruedig and Johnson, 2015; Urbain, 2015; Haas and Yorio, 2016) in connection with accidents at work and occupational diseases. Based on the results of these studies, the methods of preventing employee injury have been designed and implemented (Sari et al., 2009; Mahdevari et al., 2014a, 2014b; Nakazawa et al., 2016; Obiora et al., 2016). It is an area of risk management dedicated to human resources in mining.

The methods of risk management presented in the literature can be divided into two groups. In the first group, the universal statistical and econometrical techniques are adapted according to sector needs (Sari et al., 2009; Strzalkowski and Tomiczek, 2015; Spada and Burgherr, 2016). In the second group, the methodology is created by authors and is their individual contribution to risk management in mining (Pejic et al., 2013; Najafi et al., 2014).

A prominent aspect of those methods is that they allow only one selected source, one that is typical for a mining company and usually concerns natural hazards, of risk to be examined. They overlook the holistic and economical approaches as well as managerial risk sources.

Meanwhile, currently, mining enterprises also suffer from increased risk of sectorial exposure. In the last decade, the energy resources market has been subject to intense transformation, which is reflected in the increase in price volatility, changes in the structure of meeting the demand for electricity and the progressive correlation of observed changes (Jang et al., 2012; He et al., 2013; Liu et al., 2013). This market is also exposed to the elements of uncertainty in the form of supply shocks (e.g., revolution in the field of shale gas in the US) and abrupt climate change (e.g., floods in Australia).

Despite the intensification of characterized threats, there are only a few publications that concern holistic risk management, including the economical and managerial conditions of mining functioning and development in turbulent surroundings (Michalak and Turek, 2011; Michalak and Nawrocki, 2015). They generally discuss risk management in mining in the context of capital market or sustainable development, but they regard risk more than articles that describe only technical and natural. Meanwhile, increasing the scale of research in this area could support and improve the decision making processes for mining companies that are currently exposed to a growing industrial risk.

As mentioned above, many mining enterprises focus their efforts in risk management primarily on the prevention of natural hazards (He and Song, 2012) as a source of the most important consequences for operational continuity and financial performance. To a large extent, this happens in economies that have recently started to operate in a free market economy, which, in Europe includes Poland, the Czech Republic, Slovakia and Romania.

In light of the above, the main reasons for elaborating this paper are the intensification of sectorial risk sources, the need to make changes in the approach to operational risk management in the hard coal mining industry (mainly in economies following economic transformation) and the need to improve risk assessment methodology (Kaplan and Mikes, 2012; Yan et al., 2012).

The article is divided into four sections: (1) Introduction, (2) Methodology, (3) Research Results, and (4) Conclusions and Policy Implications. The introduction includes literature studies on risk assessment methodology with a particular emphasis on risk management in the coal mining industry. In the methodological section, the concept of fuzzy sets is described first. Then its implementation in risk assessment in mining companies is defined. The research section covers the results of risk assessment carried out in five mining enterprises from Central and Eastern Europe. The conclusions and policy implications section includes a summary of this research and discusses the usefulness of designed methodology in risk assessment and in the industrial, internal, and international aspects of risk exposition in mining companies.