

INFLUENCE OF A TURBULENT ENVIRONMENT ON THE MANAGING OF A MINING ENTERPRISE

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Abstract:

Motivation: It should be taken into consideration that classical planning methods that worked well at the end of the 20th century are often not effective in a turbulent environment. The article presents planning methods that can be applied in such conditions.

Problem statement: The article presents methods of planning of the future in a variable environment. There are constant changes in the macro-environment of mining enterprises in Poland. Therefore, it is extremely difficult to create an appropriate plan for the company's core business i.e. extracting hard coal deposits.

Approach and results: The scenario-based planning and SARIMA mathematical model and the forecasts for the demand for hard coal based on them have been presented. The scenarios are used to verify the potential company strategy.

Conclusions: It should be noted that the strategy must be created in several variants which finally will enable the company to choose the one that will let it gain a competitive advantage. Only then will the mining company be able to stay ahead of its competitors. In order to allow decision-makers in companies to make the right decisions, appropriate methods and tools for managing the company should be used.

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Introduction

Mining enterprises in Poland operate in a variable environment. It is a natural phenomenon which is becoming visible among the extraction and other types of enterprises worldwide. This refers to the growing number of industries and service providers. What is more, this phenomenon has grown in recent years. Changes appear with increasing frequency. This is mainly caused by so-called megatrends. Megatrends mean long-term and of global ranging phenomena covering many different business sectors or different segments of consumers. The base of these phenomena are profound social, demographic, technological and other similar changes (Naisbitt, 1997). These are global forces – influencing the whole population, changing societies, culture and the economy. In 2015 Ernst and Young (EY) published a report on megatrends (Megatrends 2015, 2019) where there were outlined the six most important trends which are most likely going to determine the fate of the world in the near future. These are: digitization, globalization, changes in demand for mineral resources, development of entrepreneurship, urbanization and health care. All these factors affect the energy commodity market influencing the economic situation of mining enterprises. On the one hand, the increase in primary energy stimulates the demand for coal, on the other, however, the need to reduce greenhouse gas emissions and health concerns lead to the search for alternative energy sources, such as renewable ones. Globalization, in turn, increases the competitiveness level. In the case of Polish coal companies, the major problem is the increasing import of hard coal from the Russian Federation. For the first time Poland turned from a coal exporter into a coal importer.

The need to use new planning methods is somehow forced by changes in the environment. Actions aimed at avoiding the consequences of negative changes and taking advantage of the benefits of positive changes must be very fast, which is why a traditional approach to business management is impossible here. The enterprise must be flexible, and one of the expressions of this flexibility is the so-called emerging strategy enabling the use of emerging opportunities. The so-called optimal strategy is no longer sought - only the optimal scope for shaping the strategy. Planning therefore takes the form of a continuous process of responding to environmental changes and customer requirements. At this point, scenario planning should be mentioned.

Data and methodology

The purpose of this article is to present an effective planning method in a turbulent environment. A turbulent environment is meant to be a complex, uncertain and unstable environment (Krupski, 2005). Due to the fact that it is a relatively new phenomenon which has become more significant in recent

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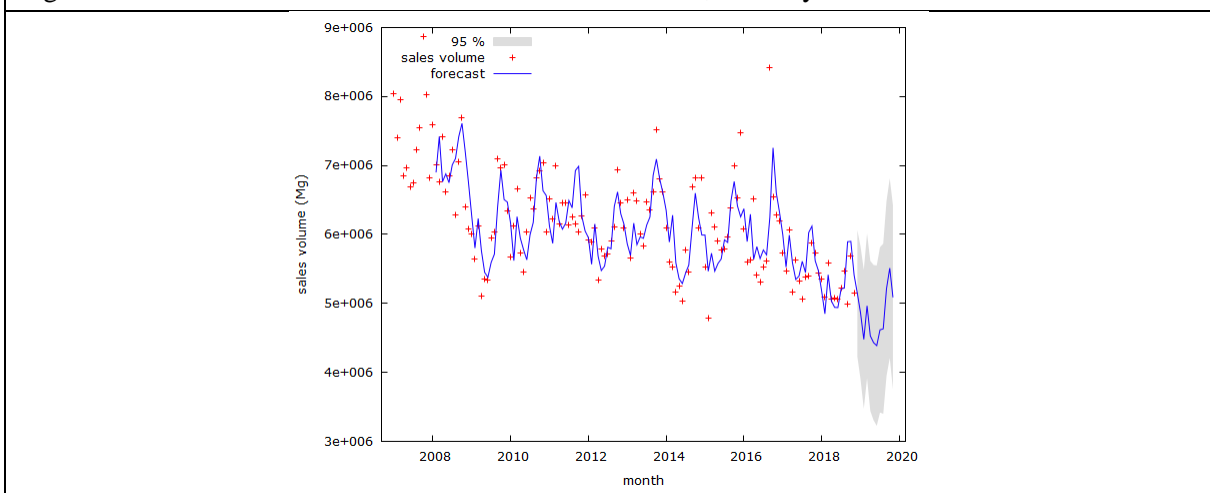
years, there should be appropriate planning methods applied to it. Methods that were used, for example, in the 1980s are no longer appropriate, because they do not let the company to introduce simultaneous changes adjusting to the varying environment. The turbulent environment means that the enterprise does not have sufficient information about the macro-environment. The volume of hard coal extraction in Poland is systematically decreasing. Its reason is mainly the lack of investments over the last dozen years or so. Another reason was an economic crisis and the high costs of hard coal production combined with a simultaneous falling commodity prices. Therefore, it is necessary to apply such management methods that will enable using chances in the company's environment and limiting the risks that may affect it. An additional problem for hard coal mining is the seasonality of coal demand and production. One should look for such applications of the produced goods which, during the period of falling demand for the product, will allow producing of so-called complementary goods.

The prerequisite for the survival of an enterprise in a changing environment is therefore its ability to respond flexibly to emerging changes. It is also necessary to choose a planning horizon that allows the enterprise to create accurate and reliable plans. The methods that can be applied in such difficult conditions are:

- planning by analogy (with the highest degree of uncertainty)
- forecasting in a number of possible scenarios and this method is presented in the article.

Scenarios enable the elimination of a major deficiency in strategic management which is the necessity to formulate rigid strategies and schemes in order to achieve company goals. Thanks to this the company will be able to follow the requirements of coal customers. Scenario-based planning is based on creating a number of alternative versions of the future environment of a coal company. It is a method of creating many different, possible future events and determining their probability in order to reduce uncertainty related to the planned project (Ziarkowski, 2004). Scenario-based planning can also be conducted without determining the probability of an event. It is a variant used in a very turbulent environment, when determining the probability is no longer possible. It is recommended that there should be created at least four scenarios, so that the attention of the decision-making person responsible for the future of the enterprise does not focus on the central scenario. Scenarios for which there is a possibility to estimate their probability are created in the following variants: the most likely, surprise, optimistic and pessimistic. During the creation of these scenarios one can use the help of experts, but it is also advisable to apply mathematical models when possible. It supplements the heuristic method with numerical methods. One of these methods is trend extrapolation (Borodako, 2009). If the environmental factors which are going to be analysed are quantitative, not qualitative, it is possible to use forecasting. Definitely, traditional forecasting is only possible in cases of enterprises operating in a stable environment. On the other hand, extrapolation means predicting the value of a variable or function out of the scope for which past observations are recorded by adjusting a function to the available data and then calculating its value at the sought point (Hajdas & Szabela-Pasierbińska, 2016).

Figure 1: Sale volume of hard coal and a forecast for 2019, monthly data



Source: Author

Resource planning is also an important problem when operating in a turbulent environment. Again, the forecasts presented here are helpful. Knowledge about the volume of future demand enables proper planning of the level of production means necessary in a given month, also when using the JIT method.

Hard coal production planning

In order to create respective and accurate hard coal production plans one should have not only a reliable forecast burdened with the smallest prediction error, but a forecast that may be the basis for creating scenarios of future demand for hard coal.

The author created forecasts for mining ranging for a period of 13 years. Therefore, he used many models, such as for example ARIMA models, exponential smoothing, harmonic analysis, logistic models, sigmoidal models, X-12 ARIMA and many others (Rybak & Manowska 2018, Rybak & Manowska 2019, Rybak & Manowska 2019). The article proposes a model that is ideal for hard coal sales forecasting. The SARIMA models created in the past were characterized by a very small ex post error, and the forecasts proved to be very accurate and consistent with the actual level of sales in subsequent years. The components of the model can be determined as follows:

SARIMA (p, d, q) (P, D, Q)

It includes the ARIMA model, a seasonal component, where P is the seasonal AR lag, D - Seasonal difference order, Q - MA seasonal delay (Brockwell & Davis 2002).

Figure 1 presents the use of the SARIMA model in order to extrapolate time series of sales volumes of hard coal. The SARIMA (0 1 1) (0 1 1) model was used, which is a model taking into account the seasonality of the series. It was created on the basis of monthly actual data of coal sale between Oct.2007 and Nov. 2018. The forecast was created for 12 months. In order to select the model with the highest reliability, the following information criteria were used: Bayesian information criterion of Schwarz, AIC (Akaike information criterion) and Hannan Quinn criterion (Piłatowska M. , 2010). The criteria values are:

- Hannan Quinn – 3801,
- AIC – 3798,
- BIC- 3806.

In order to determine the forecast error, the mean absolute percentage error (MAPE) was used, among others (Gruszczynski & Podgórska, 2007; Witkowska, 2006):

$$MAPE = \frac{1}{m} \sum_{t \in I_{ep}} \left| \frac{y_t - y_t^P}{y_t} \right| \cdot 100 \quad (1)$$

where:

y_t - is the forecast value,

y_t^P - forecasts expired during the empirical verification of forecasts,

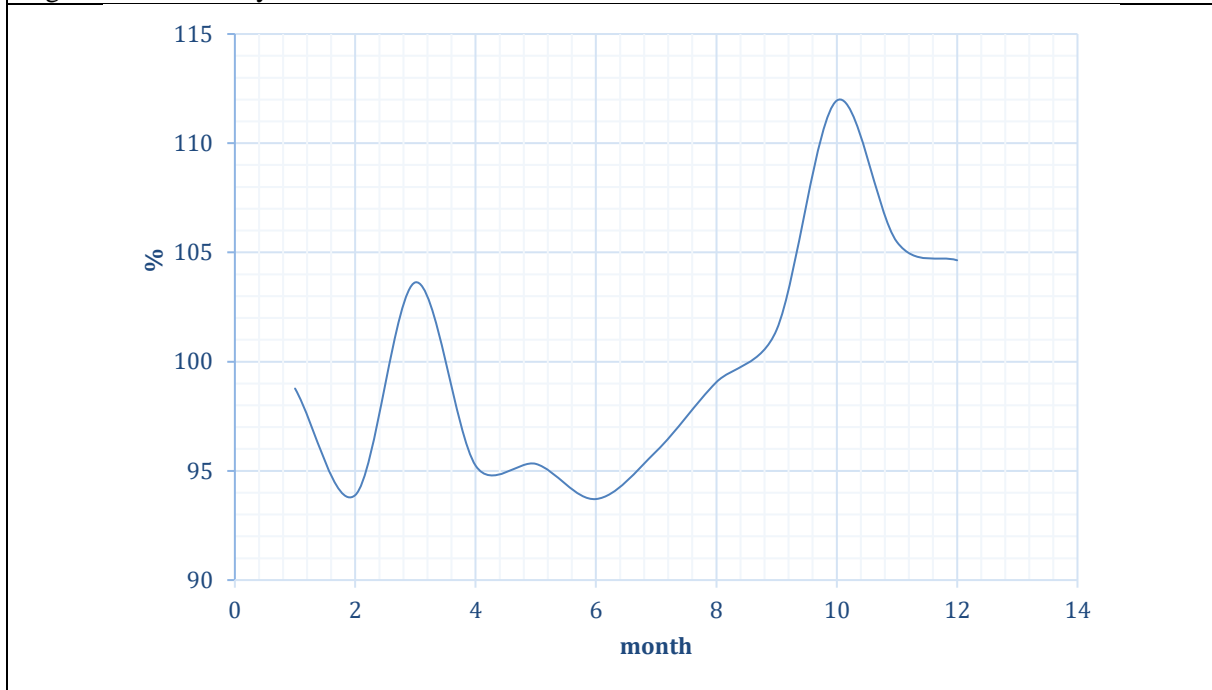
m - number of periods.

The error is 5.4%. The forecast is therefore very accurate. The lack of autocorrelation of the time series residues was confirmed by the Ljung-Box Q test. The multivariate normality of the distribution was respectively confirmed by the Doornik-Hansen test. The presented forecast can be used to create scenarios of the environment of the enterprise. The confidence interval of the forecast determines the range in which with 95% probability the predicted value is. This range represents a pessimistic scenario when sales volume is lower than forecasted and optimistic when it is larger than forecasted. The forecast itself is the scenario which is the most likely. Owing to this, we do not have only a point forecast. This way a range is obtained in which the amount of coal demand is dynamic.

A very important component of the time series of sales of hard coal is the seasonal factor. It shapes the demand for this raw material. Seasonality indicators can significantly facilitate the production planning process which becomes adapted to the requirements of coal recipients. The indicators are presented in Figure 2. Due to the fact that the analysed series is a multiplicative one, the indicators show how much the sales volume is higher or lower than the level of sales that would be achieved when the time series would not be affected by fluctuations. Thanks to this knowledge the company can plan in advance such level of production factors as will be necessary in a given month. This is particularly important because the analysed time series is characterized by a downward trend, which

additionally makes it difficult to predict the future fuel demand. According to the information included in the historical data, in the most probable scenario, one should expect further declines in the demand for coal.

Figure 2: Seasonality ratio of the sales volume of hard coal in 2017



Source: Author

Conclusion

Mining enterprises in Poland operate in an extremely difficult environment. In such complicated conditions, the clients are the ones who mainly decide about their survival. It is therefore necessary to manage the production properly which will meet the needs of customers at a given moment and place in a manner coherent with their expectations. An enterprise must demonstrate an appropriate level of flexibility in its objectives, strategy, structure and resources. Only then will it be able to stay ahead of its competitors. In order to allow decision-makers in coal companies to make the right decisions, appropriate methods and tools for managing the company should be used. Such tools enable obtaining information necessary in the decision making process in each time horizon. This involves scenario planning in the first place. In the article, the author presented one of the methods of foresight, a method based on the so-called active prediction of the future. As scenario methods are rarely used in Poland, and relying only on expert opinions raises controversy in our country, using mathematical models has been suggested which as a result can effectively complement and authenticate the scenarios created. The article presents the SARIMA time series analysis model. It is an extension of the classic model of autoregressive integrated moving average (ARIMA). In other words, it is an ARIMA model which takes into account the component of seasonality. Models (S)ARIMA are amongst the most often used and the most effective methods of forecasting time series. The presented model has been built on the basis historical data on hard coal demand. It made it possible to determine the forecast of demand in a 12-month time horizon. The applied model takes into account seasonal fluctuations which have a significant impact on the level of demand for coal in a given month. Proper decomposition of the series guarantees making a minor forecast error. In the case of the presented model the error is below 6%, which guarantees that the forecasts produced will have a high probability of implementation. Additionally, the forecast has been extended by the so-called confidence interval which can be the basis for building the scenarios of the environment in optimistic, pessimistic and most likely variants. Knowing future needs we can plan the required level of production factors in advance. The scenarios are used to test potential company strategies in the conditions they represent. The strategy adapted to the environment allows for the elimination of unnecessary costs, the optimal use of machinery and equipment, and production capacity.

Summarizing:

- A changing environment requires special business management methods.
- Planning in turbulent environments is an extremely complicated but a necessary task.
- One of the best methods of such planning is scenario planning.
- It is usually based on heuristic methods, which often arouse a lot of controversy.
- Reliable mathematical models for scenario planning can be used.
- The article presents the SARIMA model, which is one of the most reliable models when planning the volume of sales and production in hard coal mining in Poland.
- The forecast together with the confidence interval is the optimal scope for shaping the company's production strategy, which allows increasing the level of flexibility so desired in the conditions of a turbulent environment.

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