DEVELOPMENT AND IMPLEMENTATION OF TECHNICAL AND ECONOMIC MODEL OF THE POTENTIAL OF OPERATION SCHEDULES OF COAL MINES

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ABSTRACT

The purpose of this research is to determine parameters concerning development of the perspective time program to extract reserves providing complete predictability of the progress of mining operations within the sequent areas of a mine field. The conditions are those under which any mine can provide rather stable mining of the intended coal volumes; labour productivity increases within the prescribed limits as a result of its production and economic activities the mine raises the amount of money required to provide resource potential. Methods. Algorithm, relying upon economic and mathematical model to determine values of basic parameters within the coordinate system of technical and economic potential of a mine, is the basis to form such an algorithm for the determination of a potential of operation schedule of a mine as well as strategic parameters of its implementation. The priority obviousness of the basic parameters, identifying a level of operation schedule, depends upon their closeness to the factors being arguments of lower orders. That is why optimization process involved the development of a system of additional restrictions reflecting interconnections between factors of the first order and lower orders. Findings. Analysis of functional relationships and correlation relationships between variables in the context of corresponding equations has helped determine new analytical dependences which, together with the available functional dependences between production characteristics of a mine, make it possible to develop a model to determine values of basic parameters of operation schedule of a mine. In this context, the obtained model is completed with additional restrictions, certain meanings of each variables and the problem solving is limited by Pareto set for the selected variables. Scientific novelty. As for the mines, which standing is characterized by the optimization indices, priority of effect on strategic parameters of their production activities, should be as follows: first, effect on the parameters which actual values excess their critical value, determined in terms of zero value of economic added value under formation, corresponds to relative deviation of the parameter actual value from its critical value (maximum to minimum); second, effect on the parameters, which values do not excess their critical values but differ from their optimum ones, determined for the reference economic potential, should be performed in accordance with a coefficient of the parameter elasticity as for such integral index as “economic added value” (greater to lesser). Practical relevance. Implementation of the model, intended to determine technical and economic potential of mines with the development of Pareto sets, has made it possible to obtain both minimum and maximum values of longwall advance for a group of anthracite mines in Shakhtarsk and Dolzhansk-Rovenky regions to be analyzed. Selection of a reference level of technical and economic potential of a mine, which is less than zero, makes it possible to make a decision concerning closing of certain mines based upon economic expediency, i.e. added value creation. Owing to the abovementioned, two groups of Ukrainian anthracite mines have been identified which are determined as profitable or unprofitable relying upon objective indices. That also helped specify a status of “depressive territories” where underdevelopment in social and economic sphere takes place.

Keywords: operation schedules, production potential, economic indices, optimization model, Pareto rule, coal mining.

INTRODUCTION

Under the market conditions, which have dominated recently in Ukrainian economy, chances to implement the shaped plans, inclusive of alternative ones, become by an order or two lowers to compare with the centralized planning. That is favored by the uncertainty of market relations in terms of which competition of mining enterprises, supply, and demand for coal product often disagree. The latter determines production capacity as well as longwall advance, labour productivity, prime cost of a ton of coal etc. (Fomychov, Sotskov, 2018).

If the problem of uncertainty of mining progress planning is considered formally (i.e. from the mathematical viewpoint), it can be represented as unsolvable system of equations where the number of unknowns is more than the number of equations. Another purely mathematical comparison makes it possible to say that mining and geological conditions as well as the conditions, depending upon unsteadiness of a mine output, are of the unlimited degree of freedom of the unknown variables which can vary differently (i.e. become greater or lesser) for choice (Fomychov, Mamaikin, Pochepov & Sotskov, 2018; Fomychov, Pochepov, Fomychova & Lapko, 2017).

Mathematically, the only solution is to restrict degrees of freedom of the observed object in such a way to have finally such number of equations which will be equal to the number of the unknown parameters. From the mathematical viewpoint, restriction of degrees of freedom of the observed subject is formalized with the help of

VOL. 16, NO. 18, SEPTEMBER 2021 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

interconnecting of the parameters by means of different coefficients and functional dependences.

Probable coincides of the analysis results have been named "risks" which means possible deviation of the shaped plans from actual outcomes of their implementation. In this context, investment risk, being the most important component to support a mine output, has two components, i.e. risk, connected with demand for coal, and risk of certain project of mining progress (Fomychov, Mamaikin, Demchenko, Prykhorchuk & Jarosz, 2018). Minimum risk level corresponds to indicators, calculated according to standard mathematical formulas involving well defined set of technical and economic indices.

As it has been mentioned, from the viewpoint of management of a potential of operation schedules of mines, their progress in time and in space is the objective necessity; first of all, it is stipulated by essential characteristic of coal seam, i.e. their being exhaustible. All the multiplicity of specific development forms of progress of certain mines can be reduced to output conservation and changes in mining allotment boundaries if several mines are integrated by mineral extraction operations. Temporal reject from mining of complicated areas of mine allotment or high-ash coal mining is probable.

Such a necessity is stipulated by prevalence of certain set of procedures, corresponding to the tendency, since output conservation or variation depends upon operations aimed at simple output support or narrowed production (i.e. decrease in a mine output). Varied output always concerns either all operation schedules or certain basic ones. That can be followed by changes in other mine elements and mine allotment boundaries; however, they are subordinated to the key tendency, for instance, the planned mine output decrease or support may involve equipment conservation of any element of the mine (Knysh & Karabyn, 2014; Karabyn, Popovych, Shainoha, Lazaruk, 2019; Starodub, Karabyn, Havrys, Shainoga & Samberg, 2018; Lazaruk & Karabyn, 2020).

Reject from mining within certain areas of a mine field depends upon various reasons: exhausted reserves of a seam being mined; desire to mine coal reserves under more favourable conditions in the near future, for instance, thicker seams are meant which are dimensioned and sized; seams occurring within more stable wall rocks etc. (Moldabayev, Sultanbekova, Adamchuk & Sarybayev, 2019; Moldabayev, Adamchuk, Toktarov, Aben, & Shustov, 2020; Krzak, 2013; Adamchuk, Shustov, Panchenko & Slyvenko, 2019; Pavlychenko, Adamchuk, Shustov & Anisimov, 2020). Such a transition is always followed by changes in various mine components; among other things, it concerns development operations, underground transport, and maintenance of mine workings. Probable, it will concern ventilation schemes. It is important fact that purposes of the forced output control may differ while involving different alternatives. Among other things, it is possible to consider alternatives of 10-30% decrease in a mine output or alternatives to apply various facilities in stopes etc. Different goals and approaches to achieve them always depend upon certain resource volumes and, hence, expenses, connected with coal extraction, i.e. its prime cost. It follows from the above mentioned facts that any tendency of mine progress is a multivariant problem considering various initiatives with ensuing sequences and the necessity to find perfect solution follows from it directly (Naghadehi, Mikaeil & Ataei, 2009; Balusa & Singam, 2018; Bakhtavar, Shahriar & Mirhassani, 2012).

Forming a potential of technological networks of mines is the interaction symbiosis of factors of a level of mining concentration, ventilation stability as well as interaction between product flows of an enterprise and separate subsystems of the mine (i.e. transport, degassing, drainage, hoisting, and rock mass). Each of the factors is characterized by one of such indices as "correlation of capacity of technologic units", "output limitation in terms of ventilation factor", "density of product flows" etc.

It is common knowledge that the largest reserves to increase output are in loss reduction due to coal shearer and conveyor failure and in terms of a "seam" component particularly. The best approach is to shorten a period of failure removal. Several ways, being under the discussion now, are possible (Hrinov & Khorolskyi, 2018; Lozynskyi, Medianyk, Saik, Rysbekov & Demydov, 2020; Medianyk, Netecha & Demchenko, 2015). It is an increase in the thickness of seams, being mined, which anticipates the improvement of manufacturing process management, and more concentrated mining operations in time and in space. The above involves a possibility to accelerate significantly coal shearer feed with no increase in the failure intensity. The technical approach may be applied while planning and forecasting mining operations; first of all, it may concern more objective determination of the projected outputs (Khorolskyi, Hrinov, Mamaikin & Fomychova, 2020). Moreover, operation of longwalls cannot be considered in isolation from the basic technological chains of a mine. Such chains as hoisting, ventilation, and surface complex have sufficient reserves in terms of capacity, while mine workings and transportation system, neighbouring the longwall, should experience regular upgrading, maintenance etc. It is of principal importance since under the conditions of the restricted centralized investment it can be attracted only from the enterprise profit or at least at the expense of the reduced production cost (Khorolskyi, Hrinov, Mamaikin & Demchenko, 2019; Khorolskyi, Hrinov & Kaliushenko, 2019; Fomychov, Fomychova, Khorolskyi, Mamaikin & Pochepov, 2020).

MATERIALS AND METHODS

It is obvious that all the factors, effecting a level of internal potential of technological network, are synthetic themselves. They result from interaction of a number of manifestations of natural components as well as production and economic activities of a mine (Salli & Mamaykin, 2012). Practically, all the factors, characterizing mining and geological conditions, operating conditions, and indices of economic activities of a mine depend heavily upon specificity of the mine operations as well as its sectoral affiliation which stipulates availability of functional connection between the factors as well as analytical ones being rather essential. Establishing of such connections will help identify internal components of a performance potential which form directly performance potential of topological network of the mine. Thus, it is possible to state that internal potential of technological network of a mine is a result of simultaneous action of both available and interdependent factors of 1st, 2nd, 3rd, 4th, and following orders.

To identify their effect on the parameter formation, it is expedient to use a method of statistical analysis and determine dependence between performance potential and a number of independent indices of engineering level of the mine (Petlovanyi, 2016; Kuzmenko, Petlyovanyy, & Heylo, 2014). Obtaining of the dependences, describing "internal potential" index, relies upon the analysis between the indices as resultative ones, and mining and geological as well as performance indices as factorial ones.

Studies of the dependences and obtaining of regressive equation of "internal potential" index as integral evaluation of innovative level of technological networks of mines are based upon the use of optimum programming and making decisions under the conditions of uncertainty.
Such indices as a level of mining concentration, labour productivity, longwall advance, and prime cost of a ton of coal extraction have been selected as background factors to study a formation of "internal potential of operation schedule" parameter.

It is senseless to introduce "operation schedule" category in the context of a certain mine since it involves no new ideas to compare with reconstruction. It is another thing when a large region (like Western Donbas or anthracite regions of Luhansk and Donetsk Regions) is considered. In this context, increase in output and improvement of technical-and-economic indices can be achieved by means of other approaches, i.e. two-stage construction of mines, their reconstruction or even closing down of productive mines. In the context of such regions, an idea of "a potential of operation schedules" takes on a new meaning; thus, it is appropriate to give evidence of progress when modernization of certain mines and production concentration and intensification, closely connected with the process, is one of the progress components (Petlovanyi, Malashkevych, Sai & Zubko, 2020).

In the most common sense, production concentration is understood as concentration of production output or output within certain mines or their chains resulting in the increased economic effect. Such a definition concerns concentration in space (i.e. increase in a mine output, mining extracted area, hoisting etc.), and in time (increase in output per shift). As for the coal mines, it means increase in longwall output or increase in the mine workings driven per time unit (with the help of technical measures and organizational measures). The increased concentration level may result from intensive factors and extensive ones. The circumstance is the boundary separating intensification from concentration (Kwilinski, Zaloznova, Trushkina, & Rynkevych, 2020; Horoshkova, Volkov & Khlobystov, 2019).

One more mine working adding to operating longwalls (if available facilities allow that) is the increased concentration rather than reconstruction; it is an example of better use of the available capacities. Decrease in the number of longwalls, if equipment should be replaced by more productive one, or increase in section of mine workings is reconstruction resulting in the increased concentration. Index of absolute concentration is not sufficient for a group of mines or objects since one and the same average output may be achieved in terms of their different distribution between objects factoring into different economic outcomes. In other words, if all the objects (i.e. mines, longwalls) are of similar output (capacity) then relative concentration coefficient is equal to one. In all other cases, it is more than one. Moreover, the higher degree of irregularity is, the greater the coefficient value is (Astafiev, Shapovalov, Kaminski & Herezy, 2014).

Planning of mine workings and transportation schedules, i.e. degree of compactness of underground facilities, should be considered as one of the conditions in terms of which corresponding concentration level is achieved. Compactness of underground facilities can be characterized by means of various indices. In the context of the indices, length of mine workings per 1000 tons of daily or annual coal extraction and length of mine workings per one stope are often used. Index one depends directly upon seam thickness and specific coal weight. It is of great importance for economic evaluation of a mine performance; however, it is less convenient to characterize spatial concentration. For two mines with similar planning of mine workings, differing in the seam thickness, the index varies; however, it would be more natural to assume it comparable. Index two is more appropriate to characterize compactness of mining facilities since it has not direct dependence upon seam thickness; however, difference in the length of stopes cannot be reflected.

Desirable tendency to make changes in concentration coefficient is as follows: as a rule, coefficient of absolute concentration (output) should increase tending to optimum value; coefficients of relative concentration and length of mine workings should tend to one; and coefficients of underground transport gradation and compactness of underground facilities should tend to zero. Use of a system of the coefficients makes it possible to evaluate objectively reconstruction effect on the improvement of planning of underground facilities. System of the listed coefficients is especially useful if there are several mines and simple comparison of certain indices becomes more challenging.

As it is known, the key feature of a coal mine, i.e. spatial development, determines all components of its activities. The feature is of an objective nature since it is stipulated by a fundamental characteristic of mineral raw inclusive of coal, i.e. its non-renewability. Any mine is developed in three dimensions but in different ways. If rather long time period is taken (decade or several decades), a mine is developed in three dimensions; if short time period is taken (a year or two), a mine develops along the strike. In terms of two other dimensions, location may stay stable during similar time period.

VOL. 16, NO. 18, SEPTEMBER 2021 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

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In the context of the output and natural conditions, rate of advance along the strike is inversely proportional to a line of stopes; i.e. the rate of advance is a production figure. In the context of the varied output and the natural conditions, rate of advance is a primary factor determining the mine progress along the strike. A mine progress across the strike is discrete since it depends upon transition from one seam to another. That is its difference from along the strike progress being continuous.

Taking into account the abovementioned, ten factorial characteristics, determining formation of performance potential involving features of a mine network topology, have been considered at the stage of modeling of internal performance potential management of operation schedules as an integrate evaluation of a mine potential in terms of innovation. The task has been reduced to the selection of the least number of factors which are the most adequate to reflect the key characteristic of a potential of a network of mine workings - composite index of internal potential characterizing length and structure of mine workings k_K as a cost EVA parameter (i.e. consequences of interaction between factors of economic activities of a coal mine under the specific mining and geological as well as operating conditions) rather than functional dependence. As for the parameters of labour productivity, monthly longwall advance, and prime cost of a ton of coal mining, their values were taken according to actual data of activities of anthracite mines being a part of DTEK Sverdlovantratsyt PJSC, DTEK Rovenkyantratsyt PJSC, Torezantratsyt SE, and Donbasantratsyt SE during 2010-2012.

RESULTS

Step-by-step approach for introduction of variables into regression equation has been applied to derive an equation of a multiply regression describing "internal potential of operation schedule" index. As a result, following regression equation has been obtained:

$$k_k = 416P + 41V - 1970L - 12222$$

where

k_k is composite technical and economic index of the technological network potential;

P is labour productivity, t/month;

V is annual advance of a stope line, m;

L is coefficient characterizing length of mine workings as well as the stope line length.

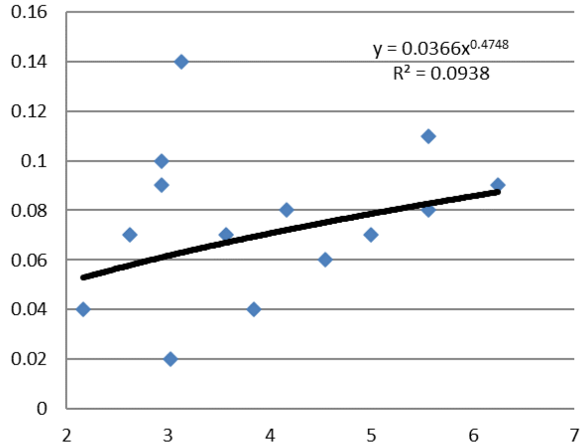

Figure-1. Labour productivity dependence upon longwall advance.

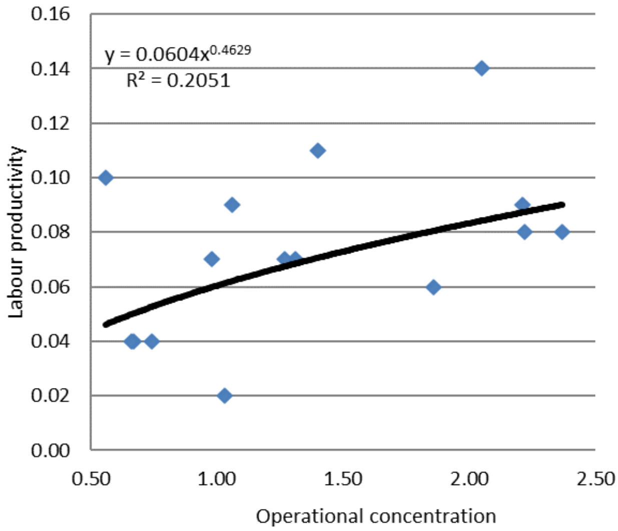

Figure-2. Dependence of labour productivity upon concentration level.

Since formation of internal potential of technological network of a mine is described by equation, it is obvious that its maximum achievement first depends upon ratio of *L*, *P*, *V*, and *S* values. Moreover, the fact that maximization of the "internal performance potential" index is achieved when minimization of the "capacity ratio of technological chains", "output limitation in terms of a factor", and "density of production flows" in accordance with takes place.

Relying upon technical content of the four key indices, it is understood that they are inter depended inversely. Figures 1-3 demonstrate experimental analytical dependence between the indices for Donbas anthracite mines.

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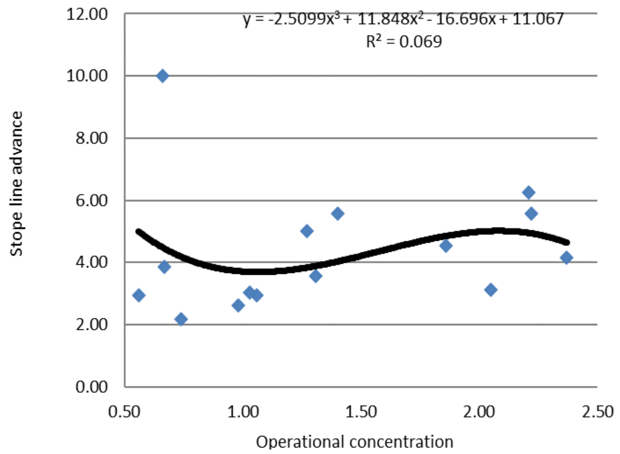

Figure-3. Dependence of longwall advance upon concentration level.

Hence, the problem to maximize internal potential of operation schedule, being the key indicator of economic potential of a mine, is to reach compromise between values of the four main factors, forming it:

$$k_k = 416P + 41V - 1970L - 12222 \longrightarrow max$$

It is expedient to take the following as limitations for corresponding variables X_1, X_2, and X_3:

$$X_1 \geq 30; \;\; X_2 \geq 50; \;\; X_3 \leq 7$$

Table-1 explains technological content of limitations.

Table-1. Technical and economic content of the limitations

Limitation	Internal content of the limitations
X_1,	Labour productivity of a miner involves following labour-intensity level: 0.5 man-shift per a ton of mining or 50 t/month.
X_2	In the context of the perfect level of mining concentration and average 1 m seam thickness, annual longwall advance is 1000 m a year.
X_3	Actual level of mining concentration should not exceed boundary value being 7 m of a stope line per 1 km of the supported mine workings.

Thus, determination of maximum achievable value of "internal potential of operation schedule" parameter in the form of EVA parameter, developed by anthracite mine, is one of types of multictireria problem with 3 criteria (2) which should be reduced to a single-criterion one with a target function:

$$X_1 \rightarrow max; \; X_2 \rightarrow max X_3 \rightarrow min$$

Compromise solution of the problem is to select one variant not from the whole admissible set *S* but from its minor part, i.e. set of effective solutions which reflections are within the compromise curve. When the absolutely worse points are excluded, a set of "Pareto points", being geometrically compromise curve *E* within a criterion plane, are remained. Q_1 and Q_2 points are effective; thus, their prototypes (i.e. B_1 and B_2 points) are "Pareto points" within the criterion plane. They are within the compromise curve. Hence, the solution variant, corresponding to Q_1 point, differs in slower longwall advance and higher prime cost of a ton to compare with Q_2 variant.

Method of testing points should be applied to determine nature of criteria behavior within the prescribed area of changes in the required parameters. It is necessary to prove that analysis of changes in criteria behavior is more expedient if rating tests are applied. While specifying both lower and upper boundaries of each discrimination criterion value, varieties in different directionality of the criteria are not important. It depends on the fact that compromise solution is sought, containing the best combination of criteria values (probably, even contradictory ones), rather than extreme value of each criterion.

The mathematical formulation of the problem assumes that at one point, coal mining conditions reach certain boundary stipulating the necessity to implement more effective techniques for coal extraction.

Within the multidimensional space, Pareto area is k-vertex *n*-dimensional simplex with vertices, edges, and ribs. The simplest example Pareto area if k=2, n=1 it is a straight line segment between the points of local optima. In terms of $k = n = 2$, such an area is implemented in the form of a flat curve. In terms of $k = 4$, $n = 3$, the area has a shape of triangular pyramid.

Since optimum solution should belong to a subset of not the worst variants, it is a point belonging simultaneously to the set and having such a ratio of indices being similar to coordinate centre. Geometrically, its location can be determined at the intersection of not the worst points and vector of coordinate centre because all the points within the vector have similar ratio of characteristics.

In the context of a discrete set, optimum point will be abstract one; i.e. neither of points of the initial set corresponds to it. Thus, optimum solution has to be sought as a point being next to it (Figure-4). In such a case, it is convenient to represent Pareto set in the form of vectors originating from zero point and ending within the set points corresponding to them.

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In terms of multicriteria approach, optimization of economic added value is achieved owing to use of the generalized (i.e. integral) criterion (2).

In the context of the problem, integral criterion has been determined on the basis of correlation-regressive analysis of indices characterizing mining and geological as well as technological conditions of anthracite mines located in Donetsk and Luhansk regions of Donbas. To derive equation of a set regression, describing “internal potential of operation schedule of a mine” index as an integral evaluation of economic potential of anthracite mines, step-by-step approach of introduction of variables into regression equation has been applied.

In general, different approaches may be used to combine partial criteria and to obtain generalized (i.e. integral) criterion depending upon the fact how the partial criteria are combined to become the generalized criterion. Following types of the generalized criteria are recognized: additive criterion, multiplicative criterion, and maximin (i.e. minimax) one. Criterion selection is rather complex task; in this case, additive criterion is preferable since absolute criteria values in terms of the selected vector of parameters of the unknowns are of great importance.

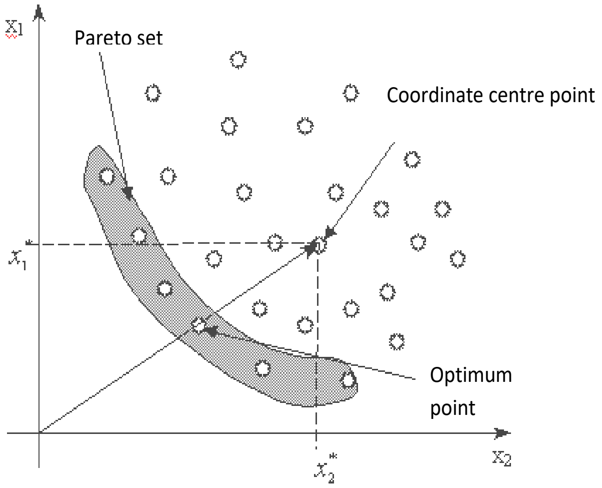

Figure-4. Selection of the optimum point

Determination of the most adequate ratio of X_1, X_2, and X_3 values makes it possible to identify maximum achievable EVA value being an indicator of economic potential of operation schedule of a mine. Implementation of the economic potential is connected with the achievement of the determined X_1, X_2, and X_3 ratio by means of effecting proper areas of a mine performance.

The operation cannot be performed simultaneously due to various objective and subjective reasons while differing in time duration. Hence, achievement of the determined X_1, X_2, and X_3 parameters takes place in a definite order by means of determination of correspondent priorities in the context of a strategy of perspective extraction planning.

It would be expedient to take elasticity coefficient as a criterion of the effect on X_1, X_2, and X_3 parameters since it characterizes relative effect of each of them on the integral index k_k (EVA) describing internal potential of the operation schedule of a mine.

Elasticity coefficient is determined according to formula:

$$\varepsilon_{x_k} = \frac{x_k}{\bar{y}(x_k)} * \frac{d\bar{y}(x_k)}{dx_k}$$

where x_k is value of k^{th} factorial characteristic in terms of which elasticity coefficient is being determined;

$\bar{y}(x_k)$ is value of resultative character in terms of corresponding value calculated according to a pure regression equation.

As for the linear regressive model to describe integral index, formula is represented in terms of formula:

$$\varepsilon_{x_k} = \frac{x_k}{A_0 + a_k x_k} * a_k$$

where a_k is absolute value of regression coefficient:

$$A_0 = a_0 + \sum_{r=1}^{k-1} a_r \bar{x}_r + \sum_{r=k+1}^{m} a_r \bar{x}_r$$

where

a_0 is free term within a multiply regression equation;

a_r is regression coefficient in terms of factorial characteristic;

$\bar{x}_r$ is average value of r^{th} factorial characteristic.

Table-2 demonstrates the calculation results.

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Table-2. Effect of factorial characteristics on the resultative characteristic in terms of the regression equation.

Factorial characteristic	Specification	Average value	Regression coefficient	Elasticity coefficient	Priority of effect on the factorial characteristic
Labour producti-vity of a miner	X_1	26.93	416.26	-4.54	1
Annual longwall advance	X_2	45.59	41.84	-0.72	3
Actual level of mining concen-tration	X_3	1.65	1970	1.31	2

Thus, the determined priority of effect on the basic factors, stipulating k_k (EVA) formation, should become the basis to implement internal mine potential. Implementation of a mine potential, connected with the achievement of optimum values of its three components, is rather complex since each of X_1, X_2, and X_3 parameters is determined by means of a system of 2nd, 3rd, and following factors (i.e. seam thickness, formation dip, mining depth, output of mining etc.).

Hence, it is right to state that k_k (EVA) implementation depends upon optimization of a number of production parameters of a mine being identified by the three basic factors, namely X_1, X_2, and X_3. Determination of the optimum values of factors, identifying X_1, X_2, and X_3, is possible basing upon the principles of optimum programming with a functional represented by condition (2).

The experimental results as well as the obtained economic and mathematical model to determine optimal strategic parameters of technological scheme of a mine, priority of their achievement, and coordinate system of technical and economic potential make it possible to form algorithm determining a potential and strategic parameters of its implementation.

That helps determine technical and economic potential of a mine as maximum achievable EVA, created by it, in consequence of which decision is made as for the expediency of further operation of the mine or the necessity to close it down.

The model determining technical and economic potential of mines has been implemented in terms of its use for a group of anthracite mine in Shakhtarsk and Dolzhansk-Rovenky regions being analyzed. Pareto set, developed within the coordinate system of technical and economic potential is characterized by following values: minimum longwall advance (V_1) is 40m/month and maximum longwall advance (V_2) is 125 m/month. It has been identified that there is no solution for *Partyzanska* and *Luhanska* mines. Since certain reference level of technical and economic potential of the mines is lower than zero, it is required to make decision to close them down due to their impossibility to create EVA.

In the context of other considered mine, reference level of technical and economic potential is higher than critical one. Priority of the effect on the strategic parameters of their commercial activities is determined relying upon the comparison of actual parameter values with their critical and optimal values.

Table-3 represents calculation results of technical and economic potential of mines. From the viewpoint of the research object characterization, emphasize that among other things, anthracite mines have been operated for a long time during which their underground facilities experienced substantial complication. As a rule, the mines need costly reconstruction; however, their remaining reserves are comparatively inconsiderable such a reconstruction is not efficient economically.

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Table-3. Technical and economic potential of mines

A mine	Output, thous t/year	EVA, UAH thous		Effect, UAH thous
		Actual, 2012	expected	
Shakhtarska-Hlyboka	449	-3459	436	3895
Progres	466	1284	3352	2068
Zoria	418	-2278	233	2511
Komsomolska	1322	1387	2996	1609
Partyzanska	257	-9923	0,0	9923
#81 Kyivska	545	2342	3345	1003
Named after Frunze	1663	2987	3216	229
Kosmonavtiv	491	986	1765	779
1-2 Rovenkivska	234	-9281	203	9484
Named after Dzerzhynsky	251	-3977	110	4087
Tsentrosoiuz	582	349	693	344
Luhanska	222	-10051	0,0	10051
Total	6900	119634	16349	45483

Accordingly, many anthracite mines in Ukraine belong objectively to a class of unpromising ones. Due to it, such mining towns as Torez, Snizhne, Shakhtarsk, and Chervony Luch, where anthracite mines are concentrated, are among “depressive territories” being behind the others substantially and stably in terms of the basic socio-economic indices in particular regarding development rates.

Regional depressive state is characterized by the impossibility of a simple restoration of a mine fund without mentioning of the expanded restoration of economic, demographic, and other processes. Processes, connected with restructuration of a mine industry are especially topical since they are followed by the closing down of unpromising mines in the context of almost complete nonavailability of vacancies and recreated jobs. That is why the first thing, required by the deeply unprofitable mines, is to determine their technological potential.

CONCLUSIONS

a) The problem to form a potential of operation schedules of mines is to select the factors which would reflect in the most adequate way the basic characteristic of a network of mine workings, i.e. internal potential index characterizing length of mine workings and their structure k_K not as a functional dependence but as EVA parameter being a result of interaction between factors of a coal mine activities under the specific mining and geological as well as technological conditions.

b) Formation of internal potential of operation schedule of a mine is described with the help of multifactor equitation which components are: P - labour productivity of a miner, t/month; V - annual advance of a stope line, m; and L - coefficient characterizing both length of mine workings and a stope line. Moreover, the fact that maximization of “internal performance potential” is achieved when minimization of “ratio of capacity of technological chains”, “output limitation in terms of a factor”, and density of “product flows” takes place, has been taken into consideration.

c) Zero value of integral index “economic value added”, meaning impossibility of survival, is the critical level of technical and economic potential of a mine. Negative value of operations schedule potential is the infeasibility of a mine operation under the market conditions and its bankruptcy with the required closing down. The experimental results, obtained while analyzing parameters of anthracite mines, as well as optimal values of strategic parameters of operation schedule of a mine, priority of their achievement, and coordinate system of technical and economic potential make it possible to form an algorithm to implement technological resources.

d) Calculation results, concerning technical and economic potential of mines, operating for a long time during which their underground facilities were complicated essentially, have shown that reference level of technical and economic potential of many of them is quite higher than critical one. Priority of the effect on strategic parameters of engineering activities is determined relying upon the comparison of actual parameter values with the critical and optimal level.

ACKNOWLEDGEMENTS

The study has been carried out within the framework of research project of the NAS of Ukraine for young scientists “Resource-saving techniques to support mine workings under the complex hydrogeological conditions”; Agreement #29-04/06-2020; official registration # 0119U102370.

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