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GAME-THEORETICAL MODEL APPLICATION'S TO PLANNING AND CONTROLLING OF THE MATERIAL RESOURCES IN MINE INDUSTRY

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Abstract: *The game-theoretical approach to the planning and management of materials needed for the mining enterprise is presented. The hierarchical two-person game with non-zero-sum was developed and justified. For the pure strategies of two persons-players (a government and its laws from one side, and a mining enterprise from another side) a game – decision was selected in a form of the Stackelberg optimal strategies. A scenario of the proposed game has been verified on the example of real data from the coal mine.*

Keywords: *real game theory, scenario, optimal strategies, mathematical modelling, planning and management, mining enterprise.*

The planning and management of materials needs is an urgent problem per each modern enterprise. Among existing models and methods of the resources optimal planning the multicriterion optimization possesses a prime position. Since they are complex and laborious their implementation is reasonable mostly in the tactical or operative levels of the enterprise planning.

Mining enterprises, and coal mines in particular are so specific and therefore mathematical modelling and decision making are not enough investigated there. In the same time there are some attempts to push this problem, for example C. Kowalik [1] described an idea of game theory using in the mining enterprises.

The goal of this work is a background and introduction of the game-theoretical approach in the planning and management of material needs at the mining enterprise on the strategic level. For this purpose we proposed a scenario of the appropriate game and developed a mathematical model of decision making which are described below.

A procedure of a government work plays a primary role in the resources planning of the mining enterprise. A number of government works for a selected material is limited(this is time limits in most cases) by a state law that limits the enterprise manoeuvrability and obligates to the resources optimal planning within manufacturing process. Taking into account time limits above and the existing practice in the mining industry we should propose the following three strategies-actions: (i) unitary full order of necessary material for a term up to one year for example, (ii) a total predicted quantity of a needed material is divided on equal parts(portions) depending on a max quantity of terms order running,(iii)a periodic or even random order of the material definite quantity based on a permanent monitoring of existing resources. In consideration of the game-theoretical approach [2,3] those strategies above are a base for a definite scenario of decision making on the strategic planning of required resources in the mining enterprise. We should introduce here a scenario of the hierarchical two-person non-zero-sum game[4]. For the formulated pure strategies of two players- a government and its laws from one side, a player G1(leader), and a mining enterprise from another side, player G2 (follower)-a game decision was accepted in a form of the Stackelberg optimal strategies.

The proposed game should be described as s bimatrix with the *[mxn]* dimension:

$$[(a_{ij}, b_{ij})] = \begin{bmatrix} (a_{11}, b_{11}) & (a_{12}, b_{12}) & \dots & (a_{1n}, b_{1n}) \\ (a_{21}, b_{21}) & (a_{22}, b_{22}) & \dots & (a_{2n}, b_{2n}) \\ (a_{i1}, b_{i1}) & \dots & (a_{ij}, b_{ij}) & (a_{in}, b_{in}) \\ (a_{m1}, b_{m1}) & \dots & \dots & (a_{mn}, b_{mn}) \end{bmatrix} \quad (1)$$

During the game a leader G_1 selects the *i*-row from $i = 1,2,...,m$ as his pure strategy (elements a_{ij}). A follower G_2 selects the j-*th* column, $j = k(i)$ from $j = 1,2,...,n$ for which the following inequality $b_{ik} \le k(i)$ has to be satisfied. Marking the set of all pure strategies *k(i)* by $R(i)$ we can obtain the Stackelberg equilibrium strategy i_0 for a leader G_1 from the following formula:

$$\max_{j \in R(i_0)} a_{i_0 j} = \min_i \max_{j \in R(i)} a_{ij} = S^*(A) \quad (2)$$

where $S^*(A)$ is the Stackelberg cost. For a follower G_2 his Stackelberg's optimal strategy will be $j_0 \in R(i_0)$.

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