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Review Article

PROJECT RISK ANALYSIS AND MANAGEMENT DECISION-MAKING IN DETERMINING THE PARAMETERS OF ORE QUARRIES

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ABSTRACT

Project risk management decisions are processes related to identification, risk analysis, and making design decisions, which include maximizing the positive and minimizing the possible negative impact of their implementation.

All these routines interact with each other and with other ways. Each procedure is executed at least once in each project. Despite that the procedure presented as separate elements with well-defined characteristics, in practice they may overlap and interact.

The problem of precision and reliability design solutions characteristic feature of the current phase of development in all spheres of material production, including the mining industry. Improvement of design reliability of quarries there is a wide range of outstanding issues.

Uncertainty of first information leads to uncertainty in decision-making, uncertainty is determined by the approach to solving the problem and may be caused by ignorance. This situation is typical of transactions in which the natural environments play a role of uncontrollable factors. In other cases, uncertainty arises as a result of organized resistance.

The uncertainty of the reference information the greater the farther removed the time period that you want to consider it a problem. In justifying the decision in terms of the stochastic nature of the source of project information always remains an element of uncertainty. In this connection, unwise to exactly such decisions of high requirements. Instead, to uniquely identify a single solution, it is advisable to select proper solutions, within which it is possible to conduct the last choice of specialists.

INTRODUCTION

Psychological theory of design solutions selects algorithmic and heuristic strategies: the first are the mathematical algorithms, the latter represent a system of rules, principles and heuristics intuitive nature (Semenov and Kuznetsov, 2016). In the decision, three factors play a part: external environment; human personality and his penchant for risk; social group in which the person operates. Selection of alternatives is made primarily by a comparison of expected values, utility functions. These functions are derived two variables - the probability of outcomes and their values.

In the works (Arsentiev, 2010; Burenina, 2009; Kerzner, 2009), the authors used a utility function to analyze the impact of psychological aspects in the choice decisions made when designing the quarries. They introduced the concept of a function of the risk implications of increasing fears that the meaning is the opposite utility function. Use of these functions more convenient for analyzing the impact of the psychological relationship to risk when choosing rational solutions of the mountain of tasks.

In the modern theory of decision-making has developed a number of approaches to cut the level of uncertainty of the source information. In some cases it is possible to use expert methods, where subjective probabilities are evaluated the views of professionals. Moreover others, the most rational use of the probabilistic, guaranteed or Bayesian approaches.

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Moreover some cases, through rational simplification algorithms for solving the problem, you can cut the number of source data and thereby cut the total error at the output. Compliance with the requirements of viability, unbiasedness and efficiency also provides the best conditions for correct determination of properties used in the tasks of the source data. One way to discuss uncertainty source of project information is the use of models and methods of stochastic programming (Kruk and Nikulina, 2016).

Research, design and manufacturing practice demonstrates that between source data, indicators and results there has been some mining operations, and sometimes significant discrepancy. This discrepancy is due to the lack of an exhaustive source of information on projected or forthcoming field opportunities created on its base the mining enterprise, the stochastic nature of baseline geological data, and so on.

Risk taking specific project decisions derives from factors such as the ratio of accuracy and uncertainty in the source data; the reliability of methods of its decision and of the adequacy of the criteria for the assessment of actual conditions. Improve the accuracy of these parts in each moment there is a certain economic threshold (Qi, 2013; Zhang, 2010).

It is omitted necessary to prove the level of correlation of accuracy and uncertainty in each case to the decision on this matter was ideal. In the case where it is not possible to cut the uncertainty, it is proper to decide the level of risk and the possible consequences of failing to see the scheduled project solution in this case. Decision making is the process of conscious choice one of several alternatives. Though solving particular tasks creates a situation model of choice. This model includes multiple solutions and description of selection criteria. Like any model, it simplifies and worsening research facility. To study these stochastic systems, where along with certainty there are random and uncertain factors, now use mostly probabilistic and statistical methods.

In the theory of risk methods of probability theory, mathematical statistics, factorial analysis, decision theory. At risk in this case refers to an event or group of related random events prejudicial object with this risk. Damage to property interests expressed as a loss or declining profits.

The most adverse events have the property of probability of their implementation, i.e. the mathematical sign, meaning the ability to calculate the frequency of the occurrence of the event with sufficient statistical data. Risk as the combination of events has a set of implementations, each of which has its own probability and extent of damage (Meredith and Mantel, 2012; Semenov, 2014). Risk complexes are mutually intersecting sets. Implementation of the project takes place in two stages: in the first stage of the risks associated with possible given the design or mountain-building part of the project. The second stage is provided by ROI as a result of the exploitation of the deposit.

Consider an example where the drilling unit may contain career well conditioned and unconditioned content of mineral part in ore. Data on the structure and composition of the rocks composing the drilling units are stochastic in nature. The more drilling blocks is treated, the greater the likelihood of success is the probability that in the well containing conditioned declension, the content useful component is approaching established in draft average for career value, satisfying the requirements of ore averaging.

METHODOLOGY

The probability of failure for one of the parameter values of the career, for example, exceeding of the average established in the project design the content of useful component in the ore contained in one of the explosive blocks.

$$V = (1 - p_1)(1 - p_2)(1 - p_3) \cdot \ldots \cdot (1 - p_n) \quad (1)$$

where p_i - i-th value of the probability of success for the parameter career, (i = 1, 2, 3, ..., n).

In case of equality of success probability values for the career of the equation (1) can be represented as follows

$$V = (1 - p)^{n}, \quad (2)$$

or $V = (1 - p)^{[C/x]}$, (3)

x - the operating costs necessary to achieve a given value of the parameter career;

C - the maximum possible costs necessary to achieve a given value of the parameter career.

The ratio of [C / x] - specifies the number of parameter values that can be obtained within the allowable costs (initial investment). Expression (3) represents the probability of depletion of eligible costs without achieving a given value of the parameter career.

Taking the mean value of the probability of success for the parameter career (p) remaining constant working out a definite period, the process can be considered as binomial (Hill, 1993).

The likelihood of achieving m set point setting career, when the total number of values of the parameter n,

$$P(m/n) = \frac{n!}{m!(n-m)!} p^m (1-p)^{n-m} \quad (4)$$

0 < m ≤ n.

As a result of achieving a given value of the parameter career net present value can be obtained (*R*), then the number of parameter values career satisfying the inequality (5), n_m

$$\frac{C + mR}{x} \le n_m \le \frac{[C + (m+1)R]}{x} \quad (5)$$

The probability of exceeding the allowable cost to achieve a given career option and not exceeding the value of *m* - lack of profitability

$$V_H = \sum_{i=0}^{m} P(\frac{i}{n}) \quad (6)$$

Note that if n_m = [C / x] when *m = 0*, formula (6) is transformed into formula (3).

The probability of exceeding the maximum possible cost to achieve a given value of the parameter career

$$V_H = \sum_{i=0}^{m+[C/R]} P(\frac{i}{n}) \quad (7)$$

The main limitation for the expressions (6) and (7) is to assume the continuation of the production program even in the case of exceeding the marginal cost of its implementation.

In the case where the probability of absence of profitability - failure is unacceptable high, to reduce it, you can use a factor of production interest (F_{PI}). If the designer is given the maximum possible under the given conditions the value of the probability of failure, then the determination of the maximum possible under the given conditions of the production value of the factor of interest (F_{PI}).

Expression (3) can be represented as follows

$$V = (1-p)^{C/(F_{PI} \cdot x_{\tilde{n}})} \quad (8)$$

F_{PI} - factor of production interest;

x_c - total operating costs necessary to achieve a given value of the parameter career.

Factor of production interest

$$F_{PI} = \frac{\tilde{N} \log(1-p)}{x_c \ \log V} \quad (9)$$

Thus, the expression (9) production factor of interest can be determined by the set value V_H - probability of failure.

RESULTS

Supposes that for the preparation of a number of drilling units career, providing design volume of ready-to-recess reserves (drilled and exploded), mining company has current assets in the amount of C = 10 mn.rub. Preparation of one block will require an average operating cost of x = 1 mln. rub., The probability of exceeding the design average content of useful component in the block p = 0.15, i.e., 15%, meeting the requirements for the averaging of ore.

Taking the value of the production factors of interest to 100% (FPI = 1), determined by the formula (8), the probability of exceeding the maximum possible expenses: VH = 0.196.

Consequently, the probability of failure of the production program will be about 20%. Such a high enough probability of failure may be unacceptable to the mining company. For example, the designer decides to reduce this probability to 5% (VH = 0.05), while using the formula (9) we obtain FPI = 0.542 or 54.2%, while the ratio [C / (FPI xc)] = 18.45 be rounded to the nearest whole number of units, i.e., 19.

Thus, FPI = 10/19, or 52.63%, VH = 0.0456, it was found that the maximum possible value of the production factor of interest is 52.63% for non-exceeding 5% probability of failure.

The values of the maximum possible factor of industrial interest for different values of the probability of failure in the performance of the production program of the ore quarry are shown in Table 1 and Fig. 1.

THE DISCUSSION OF THE RESULTS

Consider the implementation of programs to provide career ready for recess reserves. The probability of exceeding the design average content of useful component in the ore drilling unit - S (success), the probability of exceedance of a predetermined average grade - D (failure).

In addition, for simplicity, assume that the implementation of the production program of the ore quarry for each drilling unit equally probable success.

Table 1. The maximum possible production factor of interest

Probability failure (V_H),%	Maximum of factor of production interest,, (F_{PI}),%	Amount blocks, C / (F_{PI} x_c)
20	100	10
10	66.7	15
5	54.2	19
2	41.7	24
1	34.5	29
0.5	30.3	33

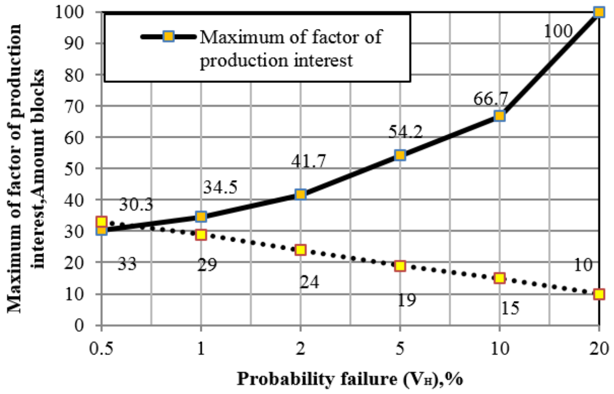


Fig. 1 Graph of the production factor of interest (FPI) and the number of blocks on the probability of failure of the project parameter career (VH).

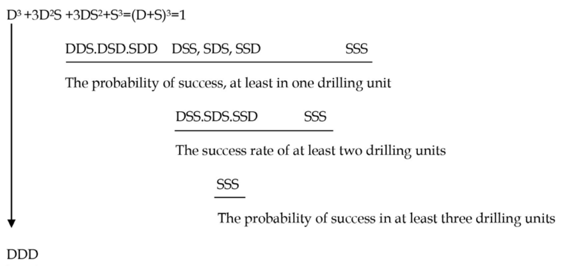
Evaluation of possible results is conducted from the binomial expression:

For a single drilling unit

$D + S = 1$

or $D + S = (D + S)^1$ (10)

For two drilling units



The probability of total failure

A binomial expansion is used when the number of blocks is negligible.

For example, if we take the probability of success and failure of 50% (success rate), for a possible result of two drilling units is characterized by the expression:

$DD + DS + SD + SS$.

At the same time we get

25% - probability of failure for 2 blocks (DD);

50% - likelihood of success only in one block (DS + SD);

25% - likelihood of success in the two blocks (SS);

75% - likelihood of success in at least one block (DS + SD + SS).

However, if we consider a larger number of blocks and other probability values for D, and S, the mathematical expression evaluation of possible results:

For five drilling units

$D^5 + 5D^4S + 10D^3S^2 + 10D^2S^3 + 5DS^4 + S^5 = 1$.

In many publications dealing with statistics (A Guide to the Project Management Body of Knowledge, 2010; Surface and underground mining, 2013; Hill, 1993) tables are the probability values depending on the number of parameters (in this case, blocks). These tables allow you to build a graph of the cumulative probability (Fig. 2) and characterizing the probability of success only at a different number of blocks for a given rate of success (10%).

The value of the probability of success provides additional information about the magnitude of risk for a given rate of achievement of the project parameter.

As a means of predicting the possible range of oscillations parameters and indicators used various kinds' career distribution. The mining of particular importance are the normal and log-normal distribution of the random variable. This is due to the fact that studied random variables are the sum of numerous random variables.

These random variables may be subject to any laws of distribution, and among these terms do not have much evolved in size and dispersion values.

The level of profitability and the risk of loss as a result of design decisions can be monitored through the development of the project strategy.

An example of action of this strategy is a temporary cessation of development of the deposit in case of non-confirmation of the actual parameters and indicators of career design or the use of production factors of interest for a possible increase in the

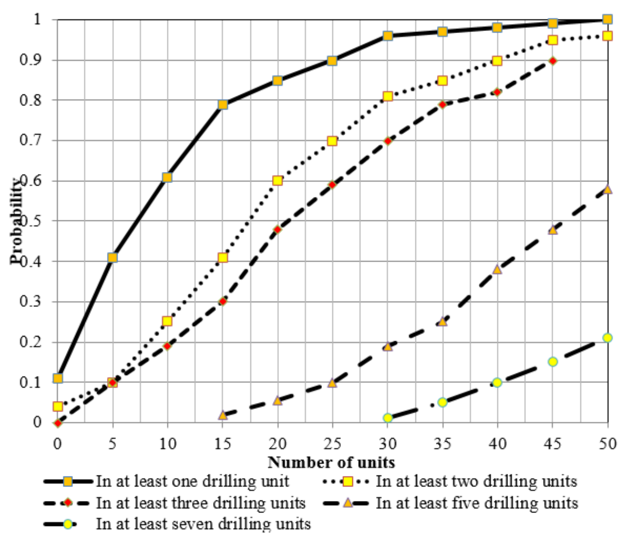


Fig. 2 The cumulative probability of schedule design decisions at a rate of success of 10%.

profitability of the mine; controlling the amount of quarry parameter values involved in the evaluation.

For the initial analysis of the acceptance of design solutions possible risk it is advisable to use simple matrix allows you to compare risk levels, for example to assess the potential volumes of ready-to-recess stocks or career average content of useful component in the ore blasting units.

CONCLUSION

The adoption of reasonable designs solution only, taking into account the probability of achieving the specified parameter values or the target impossible. An economic risk assessment design solution allows you to avoid serious consequences of possible mistakes due to the lack of profitability of the project. The definition of expected recoverable value, risk and net present value of the project realization allows us to estimate the return on investment in the development of the field.

Managing project risk based on the indicator of production interest allows increasing the probability of achieving the specified parameter values career and profitability of the project.

REFERENCES

A Guide to the Project Management Body of Knowledge. 2010. In Project Risk Management. Project Management Institute. Vol. 11.

Arsentiev, A.I. 2010. Performance quarries. Saint-Petersburg: State mining institute (technical university). 85.

Burenina, G. 2009. Strategic analysis of the risks of industrial enterprise. Saint-Petersburg: SPBGUEF.

Hill J.H. 1993. Geological and economical estimate of mining projects. London.

Kerzner, H. 2009. Project management a systems approach to planning, scheduling, and controlling (10th ed.). New York: John Wiley. 1122.

Kruk M.N. and Nikulina A.U. 2016. Economic estimation of project risks when exploring sea gas and oil deposits in the Russian arctic. *International Journal of Economics and Financial Issues*. 6(2) : 138-150.

Meredith, J. and Mantel, S. 2012. Project management a managerial approach (8th ed.), Hoboken. New Jersey: Wiley. 589.

Qi, E. 2013. Proceedings of 20th International Conference on Industrial Engineering and Engineering Management theory and apply of industrial engineering. Heidelberg: Springer.

Semenov, A. 2014. Assessment of project risk in the hierarchical organization of the process of design of complex technical systems. *World Applied Sciences Journal*. 30(8) : 1080-1082.

Semenov A. S. and Kuznetsov V. S. 2016. Assessment of level of risk in decision-making in terms of career exploitation. *International Journal of Economics and Financial Issues*. 5(1) : 165-172.

Surface and underground mining. 2013. In Bureau of Mines cost estimating system handbook (p. 631). U. S. Bureau of Mines.

Zhang, J. 2010. ICLEM 2010 logistics for sustained economic development: Infrastructure. information. integration : Proceedings of the 2010 International Conference of Logistics Engineering and Management : October 8-10. 2010, Chengdu. China. Reston. Va.: American Society of Civil Engineers.