



OPTIMIZING THE BUSINESS PLAN OF PRODUCTION ENTERPRISES BASED ON THE PROBLEM OF LINEAR PROGRAMMING

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Abstract. In this article, the use of the linear programming problem in the optimization of production enterprises is studied. A two-variable linear economic mathematical model was developed using a problem taken as an example of the process of a furniture manufacturing enterprise, and instructions for solving this problem were given.

Keywords. objective function, admissible plan, basic solution (plan), definite basic plan, invariant basic plan, optimal plan, additional variable

Introduction. In the conditions of modernization of the economy, the development of production networks, performance of work and provision of services is one of the priorities of the economic reforms implemented in our country.

This is of great importance in ensuring stable rates of economic growth in our country. In fact, this industry directly participates in the implementation of investments intended for the production sector and the non-production sector of the national economy. This, in turn, allows for free and open competition between product manufacturers, to withstand competition for product production, as well as to improve, modernize, technical and technological re-equipment of the material and technical base. [1] That is why, based on the requirements of market relations, development of the production development network in our country's enterprises,

fundamental improvement of its material and technical base, introduction of new techniques and technologies to the subjects of this network, in turn, is one of the most urgent tasks.

Therefore, optimal planning is required for the development of production enterprises and their economic efficiency. Optimization methods are widely used in the optimal management of production processes and the distribution of limited resources. Optimization methods are linear and non-linear. In most cases, the activities of manufacturing enterprises are brought to the problem of linear programming. An overview of linear programming problems is given as follows.

Linear programming (LP) is a mathematical discipline that is responsible for finding solutions to systems of linear equations. Since the set of solutions can be virtually infinite, the problem of linear programming is reduced to finding extrema (minimums and maximums) that satisfy the conditions of the problem.

The mathematical formulation of a general mathematical programming problem is usually written in accordance with formula (1):

$$f_0(x) \rightarrow \min(\max), x \in \Omega \quad (1)$$

under conditions

$$\begin{aligned} g(x) &\geq 0 \\ h(x) &= 0 \end{aligned} \quad (2)$$

Where

$f_0(x)$ - objective function that quantitatively expresses some optimality criterion and depends on coordinates $x_j, j = 1, n$ (design variables), points $x \in R^n$.

$\Omega \in R^n$ - a set of possible alternatives considered when searching for a solution to a problem.

$g(x), h(x)$ - vectors of constraints imposed on design variables.

In a formalized form, the problem of optimal design in a general setting consists of determining the design variables for which the objective function, which is linear or nonlinear, will take an extreme value, subject to the fulfillment of constraints.

Literature Rewiev. In 1938, Leonid Vitalyevich Kantorovich, as a scientific consultant, began studying a purely practical problem of creating the best loading plan for peeling machines (plywood trust). This problem did not respond to conventional methods. It became clear that the problem was not random [1].

In 1939, Leonid Kantorovich published the work "Mathematical Methods of Organization and Planning of Production", in which he formulated a new class of extremal problems with constraints and developed an effective method for solving them, thus laying the foundations of linear programming. The study of such problems led to the creation of a new scientific discipline of linear programming and opened a new stage in the development of economic and mathematical methods. In 1949, the American mathematician George Bernard Dantzig developed an effective method for solving linear programming problems (LPP) - the simplex method [1].

Methodology. Classification of optimization methods. An optimization method is a strategy for finding the optimal design solution. Optimization methods can be classified according to various criteria.

The basis of any of them is a mathematical apparatus. Depending on the mathematical apparatus used, the following optimization methods are distinguished:

- classical, non-iterative global optimization methods (analytical);
- algorithmic or mathematical programming methods (iterative);
- graphical methods.

Classical methods include: least squares, differential calculus, L.S. Pontryagin's minimax principle. Determining the extremum of a function using classical methods is possible provided that the mathematical model is characterized by continuous and differentiable analytical functions and that the problem does not contain restrictions on control functions and other variables.

The methods of mathematical programming are linear, nonlinear, dynamic, discrete and stochastic programming. These methods imply numerical or

approximate solution of equations in extremal problems using a computer, i.e. machine implementation of the algorithm.

Numerical methods of finding the extremum of functions of many variables underlie algorithms for constructing physically realizable operators and are therefore key to solving problems of optimal synthesis of technical systems.

To correctly formulate and solve problems of optimal design of structures, it is necessary to know:

- the principle of operation of optimization methods;
- the class of problems to which a particular method is applicable;
- the formulation of the problem of synthesis of a structure as a technical system in terms of optimization theory;
- the most effective method for solving it.

Analysys and result. In various spheres of human activity, there are situations when it is necessary to choose one of several available options. If the option is the only one, it will definitely be chosen. However, if there are many options, one of them is not chosen, but in a certain sense it is appropriate to choose the best and most effective one. Usually such options are called optimal. The word optimal is actually Latin and means the best (there is no better within the scope of available possibilities), the most desirable, the most effective. The science of mathematical programming deals with creating a mathematical model of economic problems, finding the optimal solution of the constructed mathematical model, and economic analysis of the found solution.

Mathematical programming relies on many proofs and results of elements of higher mathematics, linear algebra, and geometry. In particular, linear function, linear equality and inequalities and their properties are widely used. Because of this, it is appropriate to mention some of their properties and characteristics.

These, $x_1, x_2, \dots, x_n$ are linear with respect to the unknowns, that is, the unknowns are only involved with their first degree. A function of the form

$F(x) = c_1x_1 + c_2x_2 + \dots + c_nx_n \rightarrow \max$ is called a linear function. Here, $c_1, c_2, \dots, c_n$ are given fixed, real numbers.

Also,

$$\begin{cases} a_{11}x_1 + a_{12}x_2 + \dots + a_{1n}x_n = b_1 \\ a_{21}x_1 + a_{22}x_2 + \dots + a_{2n}x_n = b_2 \\ \text{-----} \\ a_{m1}x_1 + a_{m2}x_2 + \dots + a_{mn}x_n = b_m \end{cases} \quad (3)$$

where $a_{ij}, i = \overrightarrow{1, n}, j = \overrightarrow{1, m}$ are constant numbers. In the algebra course, this system was partially studied, and mainly, different methods of solving the system were considered when $n = m$. Gauss-Jordan method, method of determinants are among them. However, when $m < n$, that is, the case when the number of equalities is less than the number of unknowns, the system did not arouse interest from the point of view of searching for a solution. However, in this case, there are an infinite number of solutions of the system, and among them there is an opportunity to choose the one suitable for a certain purpose. Such features of the system are sufficiently studied in this course. Also consider the following system of inequalities: formul (1).

Here, the inequality sign is made one-sided for clarity, but in fact they can be different. In general, the set of points satisfying the system of inequalities (1) can consist of: an empty set, a single point, a bounded area, and an unbounded area. It is well known that a set x is called convex if it contains any two points of its own and a section connecting them, i.e. $x_1 \in X, x_2 \in X$ and $0 \leq \lambda \leq 1$ for $x(\lambda) = \lambda x_1 + (1 - \lambda)x_2$ also belongs to X . We will discuss convex sets and related results in detail in our course.

Now let's consider the following issue regarding production enterprises.

Suppose a company produces tables and chairs. Let 0.75 cubic meters of wood and 0.3 kg of metal be needed to produce one table, and 0.35 wood and 0.1 kg of metal to produce one chair. The net profit from one table is 10,000 soums, and the net profit from one chair is 3,000 soums. If there are 100 cubic meters of wood and

400 kg of metal in stock, how many tables and chairs should the company produce in order to get the most profit? We make a mathematical model of the problem.

Table 1.

	Table	Chair	Reserve
Wood	$0,75x_1 \text{ m}^3$	$0,3x_2 \text{ m}^3$	100 m^3
Metal	$0,35x_1 \text{ kg}$	$0,1x_2 \text{ kg}$	400 kg
Benefit	$10000x_1 \text{ soums}$	$3000x_2 \text{ soums}$	

The amount of wood required for the production of x_1 table and x_2 chairs should not exceed 100 m^3 , and the amount of metal should not exceed 400 kg , i.e.

$$\begin{aligned} 0,75x_1 + 0,3x_2 &\leq 100 \\ 0,35x_1 + 0,1x_2 &\leq 400 \end{aligned} \quad (4)$$

In this case, the net profit of the enterprise is equal to $F = 10000x_1 + 3000x_2$.

The mathematical model of the considered economic problem is as follows:

$$\begin{cases} 0,75x_1 + 0,3x_2 \leq 100 \\ 0,35x_1 + 0,1x_2 \leq 400 \\ x_1 \geq 0, \quad x_2 \geq 0 \end{cases} \quad (5)$$

$$F_{\max} = 10000x_1 + 3000x_2$$

In general, the mathematical model of the economic question about the net profit of the enterprise is as follows.

Conclusion. Economic efficiency of production enterprises is characterized by optimal management of limited resources. It was found that the optimization of production processes of enterprises is a linear or non-linear problem. Simplex, dual simplex and other methods are used to solve linear programming problems. In our case, the problem of the production enterprise was brought to the problem of two-variable linear programming, and the economic mathematical model was developed in the form (5). This model consists of boundary conditions and an objective

function, and can be solved using the simplex method. It is also desirable to find optimal solutions using the MS Excel software package.

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