ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-5206, Impact Factor: 12,23

American Academic publishers, volume 05, issue 04,2025

Journal: https://www.academicpublishers.org/journals/index.php/ijai

OPTIMAL SOLUTION PLAN FOR MANUFACTURING ENTERPRISES USING THE SIMPLEX METHOD

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Abstract: This article discusses the process of solving linear programming problems using the simplex method. The main steps of the simplex algorithm, their mathematical foundations and practical applications are considered. In addition, information is provided about the advantages and limitations of the method.

Keywords: Linear programming, simplex method, optimization, mathematical model, constraints, basic solution.

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Annotation:V dannoy state rassmatrivaetsya process solution of linear programming problem with simplex method. Description of basic stages of simplex-algorithm, its mathematical basics and practical application. Takje privedeny svedeniya o preimushchestvax i ogranicheniyax metoda.

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Login . Modern economic under the circumstances working release of enterprises main purpose from resources effective use through maximum benefit to take or expenses from minimizing Especially food industry one part was confectionery factories for working release plans right designation , product types between balance storage and there is resources (raw materials , labor) power , time , work release capacities) optimal in a way distribution big importance profession will reach .

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Linear programming is one of the powerful mathematical methods used to solve such problems. In particular, the Simplex method is a widely used and practically effective algorithm in this area. In this article, the problem of optimizing the production process of a confectionery factory is formulated on the basis of a linear programming model and solved using the Simplex method. The goal is to allocate production volumes within the existing constraints in such a way that the total profit is maximized.

Literature analysis

The theoretical foundations of linear programming and the Simplex method were created in the middle of the 20th century by the American scientist George Dantzig, and this method is still used to solve many economic, engineering and logistics problems. Many scientific works and textbooks (for example, Taha XA "Operations Research", R. Hilliyer and G. Lieberman "Introduction to Operations Research") deeply analyze the theoretical foundations and practical applications of the Simplex method.

A number of studies on linear programming have also been carried out by Uzbek scientists. In particular, the effectiveness of the Simplex method is emphasized in articles and textbooks on modeling, planning, and optimal resource allocation in economics. In recent years, the implementation of these methods in software based on computer technologies (such as MS Excel Solver, MATLAB, Python-PuLP) has further expanded the possibilities of research.

Despite the lack of specialized literature on modeling production processes in the confectionery industry, there is an opportunity to apply general linear optimization approaches to real practice by adapting them.

Research methodology

In this study, the simplex method of linear programming was used to optimize the activities of a confectionery factory. The methodological basis of the study is mathematical modeling of the production process, that is, expressing a real problem using equations and inequalities. To do this, first of all, the main types of products produced in the factory, the types of raw materials required for them (for example, sugar, flour, oil and other components), the available resource reserves and the net profit from each unit of product were determined. After that, variables were introduced for each product and the objective function — maximizing total profit — was formulated. Resource constraints were expressed in the form of inequalities. The resulting linear programming model was made ready to be solved using the simplex method. The Simplex algorithm was implemented step by step: first, an initial basic solution was found, and then the pivot elements were used to move towards the optimal point. With each iteration, the value of the objective function was observed to improve. In order to verify and ensure the reliability of the practical results of the study, the model was programmed in a computer program - in particular, using the PuLP library in the Python programming language. Through this automated approach, the optimal production plan was determined, the total profit value was calculated, and the level of utilization of each resource was revealed. Analysis of the results showed that optimizing the production process using the Simplex method not only increases efficiency, but also

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serves to increase the economic efficiency of the enterprise. At the same time, by adding new conditions to the model, it can be adapted to various real situations.

Solving linear programming problems using the simplex method

Solving linear programming problems using the simplex method yields the following We will get to know each other in detail as we solve the problem.

Problem: Optimal production plan for a confectionery factory

A confectionery factory produces 3 different products - energy drink (A), fruit juice (B), mineral water (C) . Production is limited by water, sugar, and labor time (hours). The goal of the enterprise is to maximize profit .

Information provided:

Product	Water (liters)	Sugar (kg)	Working time (hours)	Profit (thousand soums)
Energy drink(A)	2	4	3	5
Fruit juice (B)	3	1	4	4
Mineral water (C)	1	2	2	3

You have 3 main resources for production:

1. Water (liters) – no more than 8 liters
2. Sugar (kg) – not more than 10 kg
3. Working time (hours) – should not exceed 12 hours

Linear programming model:

Variables:

- P_1 – Energy drink
- P_2 - Fruit juice
- P_3 – Mineral water

We are given the following constraints and objective function
let it be:

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Limitations:

$$2x_1 + 3x_2 + x_3 \quad 8$$
$$4x_1 + x_2 + 2x_3 \quad 10$$
$$3x_1 + 4x_2 + 2x_3 \quad 12$$
$$x_1, x_2, x_3 \quad 0$$

Objective function: $Z = 5x_1 + 4x_2 + 3x_3 \to \max$

For each inequality in the given system, one basic variable is used.
We can write these inequalities in equation form by introducing and thereby obtain a linear we get the canonical programming problem:

$$2x_1 + 3x_2 + x_3 + x_4 = 8$$
$$4x_1 + x_2 + 2x_3 + x_5 = 10$$
$$3x_1 + 4x_2 + 2x_3 + x_6 = 12$$
$$x_1, x_2, x_3 \quad 0$$
$$Z = 5x_1 + 4x_2 + 3x_3 \to \max$$

We write the resulting system of equations in vector form:

$$x_1P_1 + x_2P_2 + x_3P_3 + x_4P_4 + x_5P_5 + x_6P_6 = P_0$$

Here

$$P_1 = \begin{matrix} 2 \\ 4 \\ 3 \end{matrix},\ P_2 = \begin{matrix} 3 \\ 1 \\ 4 \end{matrix},\ P_3 = \begin{matrix} 1 \\ 2 \\ 2 \end{matrix},\ P_4 = \begin{matrix} 1 \\ 0 \\ 0 \end{matrix},\ P_5 = \begin{matrix} 0 \\ 1 \\ 0 \end{matrix},\ P_6 = \begin{matrix} 0 \\ 0 \\ 1 \end{matrix},\ P_0 = \begin{matrix} 8 \\ 10 \\ 12 \end{matrix}$$

Basis vectors: $P_4,\ P_5, P_6$ **Base plan:** $X^* = (0,0,0,8,10,12)$

Based on this data, we construct a simplex table, F_0 and $\Delta_i = z_i - c_i$ We calculate the values of the and initial X^* We check the base plan for optimality.

Step 1. Enter initial data into the table

Iteration 1 **Table 1**

Basis	P_1	P_2	P_3	P_4	P_5	P_6	**Right side**
P_4	**2**	**3**	**1**	**1**	**0**	**0**	**8**
P_5	**4**	**1**	**2**	**0**	**1**	**0**	**10**
P_6	**3**	**4**	**2**	**0**	**0**	**1**	**12**
Z	**-5**	**-4**	**-3**	**0**	**0**	**0**	**0**

Step 2. Initial X^* Check the base plan for optimality

Iteration 2 **Table 2**

Basis	P_1	P_2	P_3	P_4	P_5	P_6	**Right side**

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P_4	**2**	**3**	**1**	**1**	**0**	**0**	**8**
P_5	**4**	**1**	**2**	**0**	**1**	**0**	**10**
P_6	**3**	**4**	**2**	**0**	**0**	**1**	**12**
Z	**-5**	**-4**	**-3**	**0**	**0**	**0**	**0**

The base plan is inevitably not optimal, because row 5 contains negative elements, which by convention must all be nonnegative. So, we look for a new base plan. To do this, we first find the leading column and leading row in this table.

To find the reference column, look in row 5 of table 1. we take the modulus of the values, choose the value with the largest modulus, and

We mark the cell (cell) where this number is located, the column where the cell is located is the reference column. In our example, it will be and the reference column is located

Step 1: Choose the most negative value

Our goal is to maximize Z, so we need to choose the most negative value in the Z′ column. In the table:

- P_1 value in column: -5 (most negative)
- P_2 Value in column : -4
- P_3 Value in column : -3

Therefore, **the pivot column** P_1 will be the top.

Step 2: Select the pivot row

To select the pivot row, we divide the value in each constraint P_1 column by the values in the RHS column:

- $\frac{8}{2} = 4\left(P_1 - qator\right)$
- $\frac{10}{4} = 2.5(P_2 - qator)$
- $\frac{12}{3} = 4\left(P_3 - qator\right)$

The smallest value is 2.5, so **the pivot row is** P_5 will be.

Step 3: Select the pivot element

To select the pivot element, we select the value in the row P_1 in the column P_5 . This value is 4, which is **the pivot element** .

Step 4: Update the table

Now we need to set the pivot element to 1 and update all other values.

To set the pivot element to 1, P_5 We split the array into a pivot element:

$$\frac{P_5 qatoridagi\_har\_bir\_element}{4}$$

Now let's update the table:

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Basis	P_1	P_2	P_3	P_4	P_5	P_6	Right side
P_4	**0**	**2.5**	**0**	**1**	**-0.5**	**0**	**3**
P_1	**1**	**0.25**	**0.5**	**0**	**0.25**	**0**	**2.5**
P_6	**0**	**3.25**	**0.5**	**0**	**-0.75**	**1**	**4.5**
Z	**0**	**-2.75**	**-0.5**	**0**	**1.25**	**0**	**12.5**

Pivot again

Now Z We find the most negative value in the column. This time the most negative value is P_2 in the column -2.75. So, P_2 We enter .

The following:

- $\frac{3}{2.5} = 1.2(P_4 - qator)$
- $\frac{2.5}{0.25} = 10(P_1 - qator)$
- $\frac{4.5}{3.25} \approx 1.38(P_6 - qator)$

Pivot: 2.5 (1st row, P_2 column)

Step 3. (Update according to pivot)

Iteration Table 3

Basis	P_1	P_2	P_3	P_4	P_5	P_6	Right side
P_2	**0**	**1**	**0**	**0.4**	**-0.2**	**0**	**1.2**
P_1	**1**	**0**	**0.5**	**-0.1**	**0.3**	**0**	**2.2**
P_6	**0**	**0**	**0.5**	**-1.3**	**-0.1**	**1**	**0.6**
Z	**0**	**0**	**-0.5**	**1.1**	**0.7**	**0**	**15.8**

Pivot selection

The only negative value: - 0.5(P_3 (includes)

The following:

$$\frac{2.2}{0.5} = 4.4(P_1 - qator)$$

$$\frac{0.6}{0.5} = 1.2(P_6 - qator)$$

Pivot: 0.5 (3rd row, P_3 column)

Step 4. (Final)

Iteration Table 4

Basis	P_1	P_2	P_3	P_4	P_5	P_6	Right

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							side
P_2	0	1	0	0.4	-0.2	0	1.2
P_1	1	0	0	0.2	0.4	0	1.4
P_3	0	0	1	-2.6	-0.2	2	1.2
Z	0	0	0	-0.2	0.6	1	17.4

Step 5: Check
Z row, which means that the optimal solution has been found:
P_1 **= 7/5=1.4**
P_2 **= 6/5 = 1.2**
P_3 **= 6/5 = 1.2**
Profit: Z=5* (7/5)+4*(6/5)+3* (6/5)=7+ 4.8 +3.6= 17.4 **(17.4 thousand soums)**
Result:
The maximum profit is **17.4 thousand** soums, where:
P_1 **= 1.4 (Energy drink)**
P_2 **= 1.2 (Fruit juice)**
P_3 **= 1.2 (Mineral water)**

General Summary

In this study, the Simplex method was used to obtain maximum profit through the efficient allocation of resources in a confectionery factory. As a result of the analysis, the main constraints and the objective function affecting the production process were identified, and a mathematical model was formed. Using the Simplex algorithm, this model was optimized and the most optimal resource utilization plan was developed.

The results showed that by optimally determining the volume of products produced within the specified constraints, it is possible to increase the economic efficiency of the factory. This allows to reduce production costs, fully utilize available raw materials, and maximize profits.

In conclusion, the Simplex method is an effective tool for creating a production plan for a confectionery factory, and its implementation in practice allows for optimization of the production process and increased competitiveness.

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