

### Automated Methods for Solving the Transport Problem of an Open Type

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#### Article Information

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#### ABSTRACT

*This article discusses methods for solving an open-type transport problem using the Optimal 2 program.*

#### INTRODUCTION

Consider the following problem, called the transportation problem. There are  $m$  suppliers  $A_1, A_2, \dots, A_m$ , who have stocks of the same cargo in the amount of  $a_1, a_2, \dots, a_m$  units, respectively. This cargo needs to be delivered to  $n$  consumers  $B_1, B_2, \dots, B_n$ , who ordered  $b_1, b_2, \dots, b_n$  units of this cargo, respectively.

All tariffs for cargo transportation  $c_{ij}$  (the cost of transporting a unit of cargo) from supplier  $A_i$  to consumer  $B_j$  are also known. It is required to draw up such a transportation plan in which the total cost of all transportation would be minimal.

The condition of the transport problem is conveniently written in the form of the following transport table 1 (Таблица 1).

Let's designate the total stock of cargo from all suppliers by the symbol  $a$ , and the total need for cargo from all consumers - by the symbol  $b$ . Then

$$a = \sum_{i=1}^m a_i,$$

$$b = \sum_{j=1}^n b_j.$$

A transportation problem is called *closed* if  $a = b$ . If  $a \neq b$ , then the transport problem is called *open*.

Table 1

Orders \ Stocks		$B_1$	$B_2$	...	$B_n$
		$b_1$	$b_2$	...	$b_n$
$A_1$	$a_1$	$c_{11}$	$c_{12}$	...	$c_{1n}$
$A_2$	$a_2$	$c_{21}$	$c_{22}$	...	$c_{2n}$
...	...	...	...	...	...
$A_m$	$a_m$	$c_{m1}$	$c_{m2}$	...	$c_{mn}$

Note that in the case of a *closed task*, all cargo stocks will be removed from suppliers, and all requests will be satisfied.

In the case of an open problem with  $a < b$ , the entire cargo will be exported, but there will be under deliveries of the cargo to economically unprofitable consumers.

When  $a > b$ , on the contrary, all consumers will be satisfied, but part of the cargo will remain in the warehouses of economically unprofitable suppliers.

The solution of the transport problem begins with clarifying the question of whether the problem is open or closed.

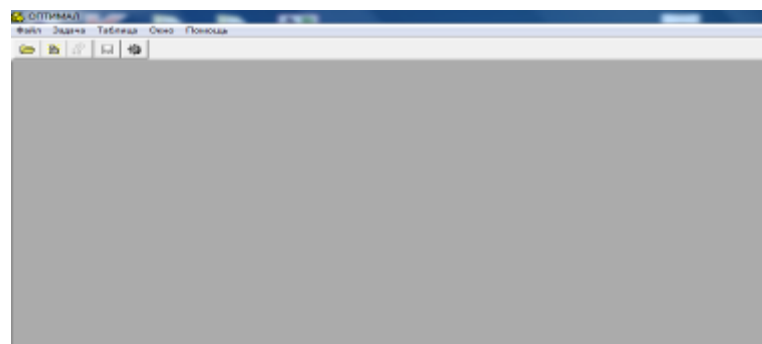
If the task is open, then it is necessary to carry out the procedure for closing the task. For this purpose, for  $a < b$ , we add a *fictitious supplier*  $A'_{m+1}$  with a cargo stock  $a'_{m+1} = b - a$ . If  $a > b$ , then we add a *fictitious consumer*  $B'_{n+1}$  with a cargo order  $b'_{n+1} = a - b$ .

In both cases, the transportation tariffs  $c'_{ij}$  corresponding to fictitious objects are assumed to be equal to zero. As a result, the total cost of transportation  $Z$  does not change.

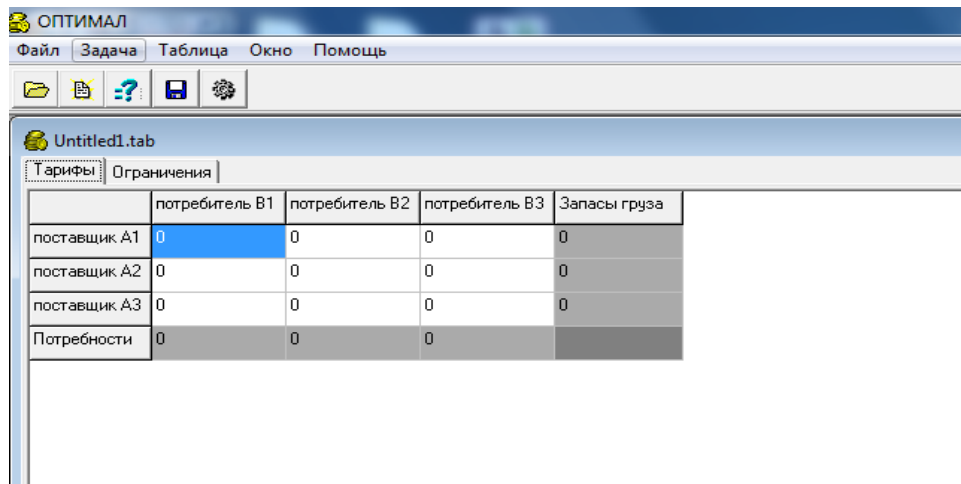
There are several analytical methods for solving the transport problem. The northwest corner method can be used to find the original plan, but this solution is not always optimal. The same can be said about the solution found by the minimum cost method. The potential method has the ability to find the optimal solution and check the optimality of each found solution, but it takes a lot of time.

Below is the automated method for solving the transport problem allows you to save time. One of these methods is the Optimal 2 program.

After starting the Optimal 2 program, the following window appears:



After selecting the “Создать” section the “Файл” menu, the following window appears:



In this window, the rows stand for suppliers A1, A2, A3, and the columns for consumers B1, B2, and B3. They form a 3x3 matrix. The last row and the last column show respectively the demand for the cargo and the stocks of the cargo.

The size of the matrix can be changed depending on the state of the task. To do this, select one of the “Добавить строку”, “Добавить колонку”, “Удалить строку”, “Удалить колонку” sections in the “Таблица” menu. They are used to add row and column respectively and also to remove row and column.

Consider an example for an open type of transport problem.

Let an open-type transport problem is given in the form of the following table (case  $a < b$ ):

Source table

Supplier	Consumer			Cargo stocks
	B1	B2	B3	
A1	7 0 M	3 0 M	6 0 M	20
A2	4 0 M	8 0 M	2 0 M	45
A3	1 0 M	5 0 M	9 0 M	30
Need	74	40	36	

The transport task is open, since the stock of cargo is less than the requirements by 55 units.

Let's take some notation:

$i$  – row index

$j$  – column index

$m$  – number of suppliers

$n$  – number of consumers

$x_{ij}$  – transportation between supplier  $A_i$  and consumer  $B_j$

$M$  – some number close to infinity

The red color shows the bandwidth limitations of communications between suppliers and consumers. Transportation costs (tariffs) are displayed in gray.

This transport task of an open type looks like this:

There are 3 suppliers A1, A2, A3, which have stocks of cargo in the amount of 20, 45, 30 units, respectively. This cargo needs to be delivered to four consumers B1, B2, B3, who ordered 74, 40, 36 units of this cargo, respectively. The cost of transportation is determined by the following matrix

$$C = \begin{pmatrix} 7 & 3 & 6 \\ 4 & 8 & 2 \\ 1 & 5 & 9 \end{pmatrix}$$

It is required to draw up such a transportation plan in which the total cost of all transportation would be minimal.

By the condition of the problem, the number of suppliers is  $m = 3$ , and the number of consumers is  $n = 3$ . Let's enter data:

Untitled1.tab				
Тарифы		Ограничения		
	потребитель В1	потребитель В2	потребитель В3	Запасы груза
поставщик А1	7	3	6	20
поставщик А2	4	8	2	45
поставщик А3	1	5	9	30
Потребности	74	40	36	

Then we select the “Решить задачу” section in the “Задача” menu and at the 4<sup>th</sup> stage we will get the following solution.

Поставщик	Потребитель			Запасы груза
	В1	В2	В3	
A1	7 M	3 20 M	6 M	20
A2	4 9 M	8 M	2 36 M	45
A3	1 30 M	5 M	9 M	30
A4	0 35 M	0 20 M	0 M	55
Потребность	74	40	36	

**Целевая функция F= 198**

35 единиц груза потребителю В1 не поставлено.  
20 единиц груза потребителю В2 не поставлено.

Thus, for  $X_{min} = \begin{pmatrix} 0 & 20 & 0 \\ 9 & 0 & 36 \\ 30 & 0 & 0 \\ 35 & 20 & 0 \end{pmatrix}$  the objective function F takes its minimum value, i.e. F=198.

The solution has a matrix form, we can write it in the following form:

$$x_{12} = 20, x_{21} = 9, x_{23} = 36, x_{31} = 30, x_{41} = 35, x_{42} = 20$$

In this open problem, for  $a < b$ , the entire cargo was taken out, but there were underdeliveries of the cargo to economically unprofitable consumers:

35 units of cargo were not delivered to consumer B1;

20 units of cargo were not delivered to consumer B2.

## REFERENCES

1. J. T. Beksultanov. Solution of the transport task using the “Optimal” program. <https://www.elibrary.ru>
2. V. Stepanov. Software implementation of a simplex method in Java. Higher mathematics. <http://www.mathelp.spb.ru>
3. С. Хайдарова. РЕШЕНИЕ ТРАНСПОРТНОЙ ЗАДАЧИ ОТКРЫТОГО ТИПА С ПОМОЩЬЮ ПРОГРАММЫ ОПТИМАЛ 2. Interpretation and researches, 1(1), 2023
4. S. Khaidarova. Automated methods for solving linear programming problems. International Journal of Culture and Modernity 4,45-48, 2021
5. S. Khaidarova. Automated methods for solving linear programming problems. Texas Journal of Engineering and Technology, Volume 15, Issue 11, Pages: 112-116, 2022/12/20