TYPES OF TRANSPORTATION PROBLEMS. DETERMINATION OF THE INITIAL PLAN

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Annotation: *In this article, the formulation of the transportation problem, its mathematical models, and the development of the most efficient and cost-effective transportation routes are discussed. The transportation problem involves ensuring the movement of goods between production enterprises, warehouses, and consumers with minimal costs based on their geographical locations. The article explores methods to reduce overall transportation time, optimize shipping costs, and eliminate inconveniences arising during the delivery process. It also provides recommendations, through real-life examples, on how companies can reduce their transportation costs, improve their logistics systems, and increase overall economic efficiency. Effective solutions to the transportation problem lead not only to a reduction in internal company costs but also significantly improve product turnover and service quality within the overall economic system.*

Keywords: *Transportation problem, mathematical models, efficient transportation routes, minimal cost, geographical location, movement of goods, optimization of transportation costs, delivery process, logistics system, reducing transportation expenses, economic efficiency, product turnover, service quality, company expenses.*

Аннотация: *В данной статье рассматриваются постановка транспортной задачи, её математические модели, а также разработка наиболее эффективных и экономичных маршрутов перевозки товаров. Транспортная задача включает обеспечение перемещения товаров между производственными предприятиями, складами и потребителями с минимальными затратами, с учётом их географического расположения. В статье рассматриваются методы сокращения общего времени транспортировки, оптимизации расходов на перевозку и устранения неудобств, возникающих в процессе доставки. Также на реальных примерах даны рекомендации, как предприятия могут снизить свои транспортные расходы, усовершенствовать логистические системы и повысить* *общую экономическую эффективность. Эффективное решение транспортной задачи приводит не только к снижению внутренних расходов предприятия, но и значительно улучшает товарооборот и качество услуг в экономической системе в целом.*

Ключевые слова: *Транспортная задача, математические модел, эффективные маршруты перевозки, минимальные затраты, географическое расположение, перемещение товаров, оптимизация транспортных расходов, процесс доставки, логистическая система, снижение транспортных расходов, экономическая эффективность, товарооборот, качество услуг.*

Annotatsiya: *Quyidagi maqolada transport masalasining qo'yilishi, uning matematik modellari, hamda tovar tashishning eng samarali, ya'ni tejamkor yo'llarini ishlab chiqish masalalari yoritilgan. Transport masalasi ishlab chiqarish korxonalari, omborlar va iste'molchilarning geografik joylashuvi o'rtasida tovarlarning minimal xarajat evaziga harakatini ta'minlashni o'z ichiga oladi. Maqolada tovarlarning umumiy harakat vaqtini kamaytirish, tashish xarajatlarini optimallashtirish va yetkazib berish jarayonida yuzaga keladigan noqulayliklarni bartaraf etish usullari ko'rib chiqiladi. Maqolada, shuningdek, real hayotdagi amaliy misollar orqali korxonalar o'z tashish xarajatlarini qanday kamaytirishi, logistika tizimini qanday takomillashtirishi va umumiy iqtisodiy samaradorlikni oshirishi mumkinligi haqida tavsiyalar berilgan. Transport masalasini samarali yechish natijasida nafaqat korxona ichki xarajatlari qisqaradi, balki umumiy iqtisodiy tizimda mahsulot aylanmasi va xizmatlar sifati ham sezilarli darajada oshadi.*

Kalit so'zlar: *Transport masalasi, matematik modellari, samarali tashish yo'llari, minimal xarajat, geografik joylashuv, tovar harakati, tashish xarajatlarini optimallashtirish, yetkazib berish jarayoni, logistika tizimi, tashish xarajatlarini kamaytirish, iqtisodiy samaradorlik, mahsulot aylanmasi, xizmatlar sifati, korxona xarajatlari.*

Introduction. The transportation problem is one of the most common optimization problems in the fields of economics and logistics. This problem involves distributing goods from certain sources (warehouses) to consumption points (customers) with minimal cost. The uniqueness of the transportation problem lies in the fact that it is considered a special case of linear programming. We will explore the topic in three main parts: types of transportation problems, determination of the initial plan, and the application of the potentials method.

The general laying of the Transport issue is as follows A1, A2....., Ai, ... Am are supply points trading with the same type of product, let the volume of product quantity in Ai - point be equal to ai unit. B1, B2....., Bj,...let Bn be required to distribute to consumption points. In this case, BJ-let the volume of the product that must be brought to the consumer point BJ be equal to the unit Ai-from the supplier BJ-let the cost of carrying the product per unit to the Consumer be equal to CIJ som. Be required to distribute products at the point of supply to consumers at the lowest cost. To solve a given issue, Ai with xij-the supplier Bj-the amount of the product intended to be transported to the consumer is determined and a mathematical model of the issue is drawn up, namely:

$$\sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}x_{ij} \to \min \quad x_{ij} \geq 0, i=1,2,...,m, \ j=1,2,...,n.$$

$$\sum_{j=1}^{n} x_{ij} = a_{i,} \quad i=1,2,...,m,$$

$$\sum_{i=1}^{m} x_{ij} = b_{j}, \ j=1,2,...,n,$$

$$x_{ij} \geq 0, i=1,2,...,m, \ j=1,2,...,n.$$

Types of Transport issues. Transportation issues are seen in different ways. The most common species are the following:

- The issue of full transport: in this case, the total reserve in the warehouse will be equal to the total demand of consumers.
- The issue of improper transportation: here there will be a discrepancy between the Reserve and demand. In such a situation, an additional artificial repository or consumer is included for missing or surplus resources.
- The issue of unbalanced transport: in this case, supply and demand are not equal, but are brought into equilibrium with artificial values (for example, zero costs) to maintain balance.
- Specialized transport issues: for example, complex models in which the time factor, warehouse capacity, delivery times or several criteria (price, time, safety) are taken into account.

Methods for drawing up an initial plan. To solve the Transport issue, an initial basic plan is first drawn up. The initial plan may not be optimal, but it provides a basic solution. Basic methods for determining the initial plan:

1. Northwest corner method: starts at the top left corner of the table and a sequential cost distribution is made along the row and column. This method B1-consumer demand A1-with the supplier's existing product begins with satisfaction. If the demand is fully satisfied (for this, a1 ≥ B2 must be present), then with the increased product of the supplier A1, the demand of the consumer B2 is shifted to satisfaction, etc. Location, if A1 supplier B1 cannot fully meet the consumer's demand, then A2 from the supplier's product it is switched to use, and with its help, B1 is met by the consumer's demand, either full, or partial. Since the issue of closed transportation is being considered, this

process is continued until the death of B, which is a complete dissolution of the supplier's all-purpose products to consumers. In every step of this process, or suitable supplier product is divided into full distribution, or suitable consumer requirement is fully satisfied.

2. The smallest cost method: starting with the lowest cost cells, resources are distributed. The essence of this method is that first a cell with the smallest number is selected (if the number of such cells is more than one, then an optional one is selected), through which as many products as possible are sent.

More precisely, in this cell is written the smallest of the corresponding supplier and consumer product quantities. In this case, of course, either the consumer demand will be fully satisfied, or the supplier's product will be fully consumed, or both will be fulfilled. After that, either the corresponding column, or the corresponding row, or the corresponding column, the elements of the row cell do not participate in subsequent computations. After that, it is selected that the least cost is from the remaining cell elements, and the corresponding distribution to the same cell is carried out as above. After that, the previous process is repeated, and this process is continued until the product quantities of all suppliers are fully distributed and the requirements are fully satisfied

3. Method of potentials: by this method, using a previously defined initial plan,by redistributing successively existing products, an optimal plan is found. This process is carried out using a cost table. In this case, most notably, if the plan is not bro ken, the value of the target function after each step is at least becomes smaller by one unit. This means that this method, after finite iteration, will certainly lead to an optimal plan. At the same time, with the help of a certain criterion, an optimal plan is found, or not found, at each step, followed.

When choosing a start-up plan, the goal is to allow the start — up solution to cost as little as possible.

Sample issue.

1.1.Find the initial basis solution of the following transport issue by the “northwest corner” method.

Suppliers	**Consumers**				**Backup size**
	B_1	B_2	B_3	B_4	
A_1	3	5	7	11	100
A_2	1	4	6	2	130
A_3	5	8	12	7	170

Demand volume	150	120	80	50	

Table 1.

Solution: the following calculation matrix of the conditions of the problem is visible we write.

b_j \ a_i	150	120	80	50
100	3	5	7	11
130	1	4	6	2
170	5	8	12	7

Here is the product Reserve in ai-suppliers, bj-consumers
indicates the demand for the product.
The cell in the northwest corner (1;1) has x11 = min(100;150)=100.
we insert and delete row 1 and select B1 to b1 ' =150 -100 = 50
we will replace. Then we place X21 = min(130,50) = 50 in the (2; 1) cell. This
in case Column 1 is deleted and the A2 in Row 2 to a2' = 130 - 50=80
we will replace. Then we go to the cell(2; 2) and write x22 = min (80,120) =80.
In such a way that (3;2) cells x32 = min(170,40) =40, (3;3) cells
we write min(130,80) =80 and (3;4) min(50,50) 5=0 in the cell. The resulting plans were
we obtain the Matrix:

b_j a_i	150	120	80	50
100	3100	5	7	11
130	150	480	6	2
170	5	840	1280	750

The initial basis solution found consists of:

$$X=\begin{pmatrix} 100 & 0 & 0 & 0 \\ 50 & 80 & 0 & 0 \\ 0 & 40 & 80 & 50 \end{pmatrix}$$

We calculate the cost corresponding to the drawn up plan:

F(X)=100·3+50·1+80·4+40·8+80·12+50·7=2300.

1.2. The initial basis solution of the transport issue given above is find by the" minimum costs " method.

Solution: the following calculation matrix of the conditions of the problem is visible we write.

b_j / a_i	150	120	80	50
100	3	5	7	11
130	1	4	6	2
170	5	8	12	7

Then find min cij=c21=1(2;1) to the cell x21 = min (130,150)= 130

we write. 2-we turn off the second row so that there is no product left in the supplier, and we substitute the value of b1 for b1 ' = 150-130 = 20. In the second step we find the smallest of the remaining costs.

min cij=c11 = 3

since(1; 1) we write X11= min (20,100) =20 in the cell. In this case, the first column is also deleted, and the value of A1 is exchanged for a1' =100 - 20=80. In such a way we write X12 = 80 in Cell 3 (1;2), X34 = 50 in Cell 4 (3;4), x32= 40 in cell 5 (3;2) and X33 = 80 in Cell 6 (3;3). As a result, we will have the following matrix of plans.

b_j / a_i	150	120	80	50
100	3 20	5 80	7	11
130	1 130	4	6	2
170	5	8 40	12 80	7 50

The basis solution in this case will be as follows.

$$X=\begin{pmatrix} 20\ 80\ 0\ 0 \\ 130\ 0\ 0\ 0 \\ 0\ 40\ 80\ 50 \end{pmatrix}$$

In this case, the number of busy cells was equal to n+m-1=3+4=6, i.e. the structured initial basis solution would be a non-trivial basis solution. When drawing up such a solution, the cost of the road is taken into account. For this reason, the cost of Transportation corresponding to the drawn up plan is often smaller than the cost in the “northwest corner” method and closer to the optimal solution. Indeed $F(X)=20\cdot3+80\cdot5+130\cdot1+40\cdot8+80\cdot12+50\cdot7=2200$

There are other ways to build a baseline solution.

For example, "the minimum cost method in a column", “the minimum in a row

costs " method, etc. With the help of such methods, an initial basis solution to the transport issue can be found. It is usually better to use methods that help you find a beginner base solution that is close to the optimal solution. An algorithm called the potentials method can be used to convert a structured initial basis solution into an optimal solution.

Conclusion. The issue of Transport plays an important role in solving many real-life logistical and distributional problems. An optimal distribution with a minimum cost can be achieved by choosing the right model based on the type of problem, meticulously constructing the initial plan, and effectively using the potentials method. These methods make it possible to increase economic efficiency and use resources wisely.

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