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OPTIMIZATION OF CARGO FLOWS IN THE SYSTEM OF HIGHWAY CONSTRUCTION

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Abstract:
In this article, the issue of making the movement of material flows, i.e. finished products, raw materials, fuel resources, building materials, agricultural products, waste of production activities, etc., in space through the shortest distance, at the lowest cost was considered. Optimization of raw materials or semi-finished product flows that need to be transported allows you to determine the plan that provides the minimum of the transport work being carried out.

Keywords: material flows, transport, Warehouse, raw material flows, warehouse, optimization.ro

Introduction

The activities of the production (provision of services) of all sectors of the iqdisadiyot of the Republic of Uzbekistan are carried out due to the movement of flow processes: material, financial, information and service flows.

Therefore, it will be necessary to carry out the movement of material flows, i.e. finished products, raw materials, fuel resources, building materials, agricultural products, waste of production activities, etc.in space through the shortest distance, at the lowest cost.

Since sokhas producing material goods are also broadband, the nomenclature of manufactured and cultivated products is correspondingly numerous, therefore, the issue of optimizing the movement of cargo flows between enterprises and organizations is considered extremely relevant from a scientific and practical nature.

In general, the process of transporting raw materials of construction materials for the construction of highways to factories that process them consists of two stages:

* transportation of raw materials of construction materials from quarries to processing plants(tsex) or warehouses;

* transportation of semi-finished raw materials from processing plants, or warehouses, to factories producing finished products or to customers.

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Main Body

Optimization of raw materials or semi-finished product flows that need to be transported allows you to determine the plan that provides the minimum of the transport work being carried out. The issue of load flow optimization is expressed in terms of the transport model of linear programming from the formal hexadecimal and is formed as follows.

Set of carriage numbers sending raw materials $I = \{1,2,\ldots,\mathrm{I},\ldots,\mathrm{m}\}$ and the set of numbers of receiving plants for processing raw materials $J = \{1,2,\ldots,\mathrm{j},\ldots\mathrm{n},\}$ given. All ***I*** digital quarries or warehouses and ***j*** distances between factories producing digital finished products L_{ij} Matrix $||L_{ij}||$ ||L*ij*||*ij* known. In addition, the volume of shipment of raw materials of each sender number I quarry or warehouse ai and j the need of a factory producing digital finished building material to process raw materials is given bj values. We form a mathematical model of the problem of optimization of raw materials flows.

Each i and j s flow of raw materials of construction between X_{ij} it is necessary to determine such positive values of, that is

$$X_{ij} \geq 0, \qquad i\epsilon I, \qquad j\epsilon J \qquad (1.1)$$

In this every i all from the quarry or warehouse $j\epsilon J$ flow of raw materials transported to factories $\sum jXij$ its shipping options a_i **cannot exceed, i.e.**

$$\sum_{j\in J} X_{ij} \geq a_i\,, \qquad i \in I \qquad (1.2)$$

Each finished product is transported to the factory (TMICHZ) - the flow of recumbent raw materials $\sum_j X_{ij}$ its ability to process raw materials a_i**- not exceeding, i.e.**

$$\sum_i X_{ij} \leq b_i, \quad j \in J \qquad \mathbf{(1.3)}$$

The volume of transport work in the performance of raw material transport flows between the sender and the recipient destination $\sum_i \sum_j X_{ij} L_{ij}$ **the minimum should be.**

$$\sum_{i\epsilon I} \sum_{j\epsilon J} X_{ij} L_{ij} \rightarrow min \qquad \mathbf{(1.4)}$$

In the above-mentioned model of the Transport issue, the limiting conditions are either unequal or egalitarian, $\sum_i a_i = \sum b_j$ тенглик мавжуд булса,
бундай моделлар ёпиқ моделлар дейилади equitable ,
such models are called closed models..

To determine the quantitative solutions of the same problems as above, it will be necessary to transform them into a model of an open view, that is, the conditions of the constraint consisting only of equations (1.1). Let's look at the extended model of the Transport problem and its form, which is presented in the Matrix. Let's say the

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raw material is a set of numbers of sender quarries or warehouses $I = \{1,2,\ldots \text{I},\ldots,\text{m}\}$

TMICHZ numbers are $J = \{1,2,\ldots \text{j},\ldots,\text{n}\}$ let. Хомашё юборувчи ҳар бир i карьернинг жўнатиш ҳажми a_i бўлиб, барча $i\epsilon I$ Raw material sender-each all b_1 , b_2 , ... , b_j ..., b_n given in Fig. Each i sender and j let us mathematically express the conditions under which the volume of raw materials consumed by the recipient TMICHZS does not exceed the capacity of its raw materials shipped and received, while the volume of raw materials transported for addresses.

Let`s say, $j = 1$ - for the recipient, it is necessary to draw up extreme options for the formation of flows of raw materials of construction materials: $j = 1$- to the recipient $i = 2$ - shipment from sender X_{11} tons of flow,$i = 2$ - from sender X_{21} and etc. i = m *from the sender* X_{ml} make up tons of values. This is the sum of the flows $X_{11} + \text{X}_{21} + \cdots + \text{X}_{\text{ml}}$ while, that is, all $\text{i} = \text{l}, 2, \ldots, \text{m} -$ from senders $\text{j} -$ 1 – or 2- or n- the sum of the flows of raw materials being sent to the recipient must be the awning for the burden consumption of the same recipient, i.e.

$$\left.\begin{array}{l} X_{11} + X_{21} + \ldots + X_{m1} = b_1 ; \\ X_{12} + X_{22} + \ldots + X_{m2} = b_2 ; \\ \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \\ X_{1m} + X_{2m} + \ldots + X_{mn} = b_n ; \end{array}\right] \qquad (1.5)$$

Now let's form the requirements for the sum of the volume of raw material flows that each sender leaves from the destination. In general, all from a known I - Number sender *J= 1,2,...j,...,n* sum of shipping flows to digital consumers X_{11}+ X_{12} + ...+ X_{1n} the same must be equal to the possibility of sending a cargo from the sender, i.e.

Where the above X_{ij} transportation work taking shape in the implementation of the flow rate X_{ij}, L_{ij} and the sum must have a minimum value, i.e.

$$+L_{11} + X_{21} + L_{21} + \cdots + X_{m1} + L_{m1} + X_{12} + L_{12} + X_{22} + L_{22} + \cdots + X_{m2} + L_{m2} + \qquad (1.7)$$

Another condition for the extended model of the Transport problem is that its variability cannot be negative. Because the load current with negative value does not exist and does not make sense from the physical Jack. All of this condition *I={1,2,...,I,...,m}* and *J={l,2,...,j,...,n}* for is represented by the condition that the value of the variables is not negative, i.e.

$$\text{X}_{\text{ij}} \geq 0, \quad \text{i}\epsilon\text{I}, \quad \text{j}\epsilon\text{J} \qquad (1.8)$$

Thus the open-view model of the transport problem is expressed as follows. It is necessary to determine the value of such an Xtj of the cargo flows sent from the sender to the consumer, in which the total transport work measured in tons of kilometers P_{ij} or cost of carrying out a unit of transport work S_{ij} the total costs spent on its execution when considering N_{ij} the value of the least

$P_{ум} = \sum_{i=1}^{m}\sum_{j=1}^{n} X_{ij} \cdot l_{ij} \rightarrow min$ (1.9) ёки $C_{ум} = \sum_{i=1}^{m}\sum_{j=1}^{n} X_{ij} \cdot S_{ij} \rightarrow min$ (1.10)

Let and let the following conditions be met:

$$\sum_{i=1}^{m} X_{ij} = b_j,\ j \in \{1,2,\dots,m\}; \quad (1.11)$$

$$\sum_{j=1}^{n} X_{ij} = a_j,\ i \in \{1,2,\dots,n\}; \quad (1.12)$$

$$X_{ij} \geq 0,\ \ i \in \{\overline{1-n}\},\ j \in \{\overline{1-m}\}, \quad (1.13)$$

To determine the numerical solution to the transport issue (CHDTM) of linear programming $\sum_i a_i = \sum_j \hat{a}_j$ must be. For the initial data of the issue, this condition is not met, i.e. 1) $\sum_i a_i > \sum_j a_j$ or vice versa 2) $\sum_i a_i < \sum_j b_j$ may be. In such cases, the initial data of the issue is artificially $\sum_i a_i = \sum_j b_j$ is made visible. The above condition satisfies, for example 1-state $\sum_i a_i = \sum_j {b^1}_j$, 2 - for example $\sum_i {a^1}_i = \sum_j {b_j}_j$ values are taken and the matter $\sum_i a_i$ ва $\sum_j {b^1}_j$ or $\sum_i {a^1}_i$ ва $\sum_j {b_j}_j$ are solved for values.

The chdtm property is that the embedding and model of a problem can also be expressed in terms of a matrix for a given initial information system (Table 1)(2).

In each row X_{ij} sum a_i, $\sum_i x_{ij} = a_i$ and on each column X_{ij} the sum of the lar is b_j is equivalent to, i.e. $\sum_j X_{ij} = b_j$ is. For shippers a_i sum $\sum_i a_i$ for cargo recipients a_j sum $\sum_i b_j$ is equivalent to:

$$\sum_i a_i = \sum_i b_j \quad (1.14)$$

At the next stage, it is possible to formulate the transport issue, which will be necessary to optimize the flows of raw materials (Appendix 2.Table 1).

One of the most commonly used methods of solving the Transport issue is the integration (improvement) of the transport plan. The essence of the method is as follows: we look for the cell of the transport schedule where the minimum transport tariff is located.

The fulfillment of the condition (1.5) or (1.11) in the above transport issue model indicates that it is necessary to fulfill the requirement of all cargo recipients to consume TMICHZ raw materials (1.6) or (1.12) according to the condition to fulfill the volume of transportation that must be sent from all cargo senders. The algorithm for solving the Transport problem can be in general as follows:

- drawing up a schedule of transport work;
- checking the issue in closeness;
- drawing up a base plan;
- checking to change the base plan;
- calculation of potential for transportation plan;
- checking the base plan for optimality;
- redistribution of transportation plan;
-if an optimal solution is found, go to Item 9, return to Item 5 if not found;
- drawing up a graph of waste transportation by calculating the total volume of cargo transportation.

Бир бирлик маҳсулотни жўнатиш манзилидан қабул қилиш манзилига етка-зишнинг нархи матрицаси қуйидагича (1- жадвал). Масалани ечишнинг зарур ва етарлилик шартини текширамиз.

The price matrix of etka-zish per unit product from the address of shipment to the address of receipt is as follows (Table 1). We check the necessary and sufficient condition for solving the issue.

$$\sum a = 1000 + 300 + 100 + 400 + 40 = 1840$$

$$\sum b = 600 + 250 + 450 + 240 + 300 = 1840$$

1-table

Representation of CHDTM in matrix representation.

j i	1	2	...	j	...	n	a_i
1	$l_{11}(S_{11})$ $X_{11}=?$	$l_{12}(S_{12})$ $X_{12}=?$		$l_{1j}(S_{1j})$ $X_{1j}=?$		$l_{1n}(S_{1n})$ $X_{1n}=?$	a_1
	$l_{21}(S_{21})$ $X_{21}=?$	$l_{22}(S_{22})$ $X_{22}=?$		$L_{2j1}(S_{2j})$ $X_{2j}=?$		$L_{2n}(S_{2n})$ $X_{2n}=?$	a_2
...							...
i	$l_{i1}(S_{i1})$ $X_{i1}=?$	$l_{i2}(S_{i2})$ $X_{i2}=?$		$l_{ij}(S_{ij})$ $X_{ij}=?$		$l_{in}(S_{in})$ $X_{in}=?$	a_i
...							...
m	$l_{m1}(S_{m1})$ $X_{m1}=?$	$l_{m2}(S_{m2})$ $X_{m1}=?$		$l_{mj}(S_{mj})$ $X_{mj}=?$		$l_{mn}(S_{mn})$ $X_{mn}=?$	a_m
b_j	b_1	b_2	...	b_j	...	b_n	$\sum a_i = \sum b_j$

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The condition of balance is satisfied. Reserves are equal to demand. So the model of the transport issue is closed.

We enter the necessary information into the distribution table (Table 2).

2- table

	1	2	3	4	5	Reserves
1	875 [60]	450[250]	350[450]	380[240]	720	1000
2	646[300]	620	586	570	630	300
3	752,5	545	420	743	450[100]	100
4	714[200]	625	620	543	560[200]	400
5	980[40]	712	560	670	770	40
Талаб	600	250	450	240	300	

Stage 1. Search for the first base plan.

1. Using the minimum price style, we determine the first base plan of the transport issue.

2. We determine the number of occupied cells of the table, they are 9, however, they are $m + n - 1 = 9$ must be.

The amount of target function for this base plan is equal to $F(x) = 8 * 560 + 8 * 240 + 8 * 200 + 5 * 300 + 7 * 100 + 6 * 250 + 9 * 50 + 12 * 100 + 5 * 40 = 13550$

Stage 2. Improving the base plan.

We check the optimality of the base plan.$u_1 = 0$ depending on the condition, based on the occupied cells of the table, the primary potential is

$$u_i, \quad v_j$$

define, where $u_i + v_j = c_{ij}$.

$$u_1 + v_1 = 875; 0 + v_1 = 875;\ v_1 = 875$$

$$u_2 + v_1 = 646;\ 875 + u_2 = 646;\ u_2 = -229$$

$$u_4 + v_1 = 714;\ 875 + u_4 = 714;\ u_4 = -161$$

$$u_4 + v_5 = 560;\ -161 + v_5 = 560;\ v_5 = 721$$

$$u_3 + v_5 = 450;\ 721 + u_3 = 450;\ u_3 = -271$$

$$u_5 + v_1 = 980;\ u_5 + 875 = 980;\ u_5 = 105$$

$$u_1 + v_2 = 450;\ 0 + v_2 = 450;\ v_2 = 450$$

$$u_1 + v_3 = 350;\ 0 + v_3 = 350;\ v_3 = 350$$

$$u_1 + v_4 = 380;\ 0 + v_4 = 380;\ v_4 = 380$$

The base plan is not optimal, since there is an estimate of the Bush cells , for them $u_i + v_j > c_{ij}$

$$(1; 5): 0 + 721 > 720;\ Д15 = 0 + 721 - 720 = 1$$

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$$(5;5): 105 + 721 > 770;\ Д55 = 105 + 721 - 770 = 56$$

$$max(1,56) = 56$$

We select the maximum possible estimate of the empty cell (5,5): 770. To do this, we put the symbol " +" on the cell (5,5), alternating to other edges of the Polygon"-", "+", "-" we put the signs. The cycle is given in the following table(5,5> 5,1> 4,1> 4,5). Standing in minus cagesx_{ij} from the loads, we choose the minimum, namely $\gamma = \min(5,1) = 40$

We add the number 40 to the amount of loads in the plus cells, subtract the number 40 from the amount of loads standing in the minus cells. As a result, we will have a new base plan.(Tables 3,4,5).

Table 3.

	1	2	3	4	5	reserves
1	875 [60]	450[250]	350[450]	380[240]	720	1000
2	646 [300]	620	586	570	630	300
3	752,5	545	420	743	450[100]	100
4	714[200][+]	625	620	543	560[100] [-]	400
5	980[40][-]	712	560	670	770[+]	40
Талаб	600	250	450	240	300	”

Table 4

	1	2	3	4	5	■ ------------- reserves
1	875[60]	450[250]	350[450]	380[240]	720	1000
2	646[300]	620	586	570	630	300
3	752,5	545	420	743 ^	450[100]	100
4	714[240]	625	620	543	560[160]	400
5	980	712	560	670	770[40]	40
demand	600	250	450	240	300	

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Table 5

	v 1 =8	**v2=5**	**v3=8**	**v4=8**	**v5=8**
и 1=0	875 [60]	450[250]	350[450]	380[240]	720
и2=-3	646[300]	620	586	570	630
u3=-l	752,5	545	420	743	450[100]
u4=l	714[240]	625	620	543	560[160]
u5=—3	980	712	560	670	770[40]

We check the optimality of the base plan. Primary based on the occupied cells of the table u_i, v_j we find the potentials, $u_1 = 0$ to the condition
according to, they have
$u_i + v_j = c_{ij}$.

$$u_1 + v_1 = 875; 0 + v_1 = 875;\ v_1 = 875$$
$$u_2 + v_1 = 646;\ 875 + u_2 = 646;\ \mathrm{u}_2 = -229$$
$$u_4 + v_1 = 714;\ 875 + u_4 = 714;\ u_4 = -161$$
$$u_4 + v_5 = 560;\ -161 + v_5 = 560;\ v_5 = 721$$
$$u_3 + v_5 = 450;\ 721 + u_3 = 450;\ u_3 = -271$$
$$u_5 + v_1 = 980;\ u_5 + 875 = 980;\ u_5 = 105$$
$$u_1 + v_2 = 450;\ 0 + v_2 = 450;\ v_2 = 450$$
$$u_1 + v_3 = 350;\ 0 + v_3 = 350;\ v_3 = 350$$
$$u_1 + v_4 = 380;\ 0 + v_4 = 380;\ v_4 = 380$$

The base plan is not optimal because there is an estimate of empty cells
are for

$$u_i + v_j > c_{ij}.$$
$$(1;5): 0 + 721 > 720;\ Д15 = 0 + 721 - 720 = 1$$

Let's choose the maximum possible estimate of the empty cell (1,5): 720. To do this, we put the symbol "+" on the prospective cell (1,5), alternating to other edges of the Polygon "-", "+", "-" we put the signs.

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Load cycle: 944260 (Table 6) Table 6

	1	2	3	4	5	reserves
1	875[60][-]	450(250]	350[450]	380[240]	720[+]	1000
2	646(300]	620	586	570	630	300
3	752,5	545	420	743	450(100]	100
4	714[240][+]	625	 620	543	560(160][-]	400
5	980	712	560	670	770[40]	40
demand	600	250	450	240	300	

The cycle is given in the following table(1,5 —" 1,1 —* 4,1 —> 4,5). From the loads standing in the minus cells, we select the smallest, that is, u = min (1, 1) = 60. We add the number 60 to the load charge in the plus cells, we separate the number 60 from the load charge in the minus cells. As a result, we will have a new base plan. (Note 2. Table 8) we check the optimality of the base plan. Based on the busy cells of the table u_i, v_j. we find the primary potentials, $u_1 = 0$ according to the condition, they have $u_i + v_j = c_{ij}$.

$$u_1 + v_2 = 450;\ 0 + v_2 = 450;\ v_2 = 450$$
$$u_1 + v_3 = 350;\ 0 + v_3 = 350;\ v_3 = 350$$
$$u_1 + v_4 = 380;\ 0 + v_4 = 380;\ v_4 = 380$$
$$u_1 + v_5 = 720;\ 0 + v_5 = 720;\ v_5 = 720$$
$$u_3 + v_5 = 450;\ 720 + u_3 = 450;\ \ u_3 = -270$$
$$u_4 + v_5 = 560;\ 720 + u_4 = 560;\ v_4 = -160$$
$$u_4 + v_1 = 714;\ -160 + v_1 = 714;\ v_1 = 874$$
$$u_2 + v_1 = 646;\ 874 + u_2\ =\ 646;\ \mathrm{u}_2\ =\ -228$$
$$u_5 + v_5 = 770;\ 720 + u_5 = 770;\ u_5 = 50$$

The base plan is optimal because all estimates of empty cells $u_i + v_j \leq c_{ij}$ satisfies the condition.

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Table 2 Base plan (optimal plan)

	v1=8	**v2=5**	**v3=8**	**v4=8**	**v5=8**
u1=0	875	450[250]	350[450]	380[240]	720[60]
u2=-3	646[300]	620	586	570	630
u3=-1	752,5	545	420	743	450[100]
u4=1	714[300]	625	620	543	560[100]
u5=-3	980	712	560	670	770[40]

$100 + 714 * 300 + 560 * 100 + 770 * 40 = 944200$ т.км

We carry out an analysis of the Optimal plan. In the Optimal plan, the load turnover is compared to the first option - 2300 tkm. Ga less.

We will draw up a graph that will be able to trace the leprosy and the result of the problem and is provided for in the algorithm: (figure 2.6).

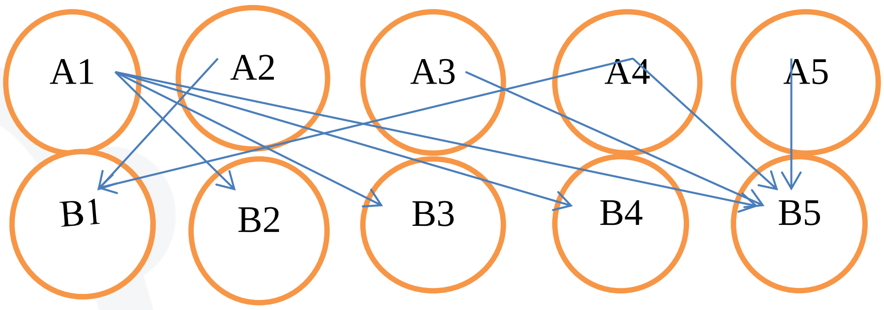

Figure 2.6. Graph of cargo transportation.

Shipments from warehouse 1 must be shipped to customer 2 (250), customer 3 (450), customer 4 (240) and customer 5.

All goods from warehouse 2 must be shipped to customer 1 all goods from warehouse 3 must be shipped to customer 5.

It is necessary to send from warehouse 4 to customer 1 (300) and customer 5 (100).

All shipments from Warehouse 5 must be shipped to customer

Conclusion

The issue of load flow optimization is expressed in the form of a transport model of linear programming from a formal typewriter and allows you to determine the plan that provides the minimum of traffic performance.

The essence of solving the burnt issue is that in this we determine some kind of base plan and check it for optimality. If, the plan is optimal, then the solution will be found. The plan will continue to improve using the potentials style until you find an optimal plan if not optimal. Cargo circulation 944200 tons km. The average load current is 80 tons. The average shipping distance is 513.15 km.

The RNR programming language was chosen in its development in order to make it possible to host the program on the internet and make its use public.

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