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SIMULATION OF THE PROCESS OF SELECTION OF THE OPTIMUM TYPE OF ROLLING STOCK FOR TRANSPORTATION OF MEDICINES TO THE CONSUMER

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Abstract:

The work was carried out modeling the process of choosing the optimal type of rolling stock for the transportation of medicines to the consumer. The optimal pair for transportation of the entire daily volume was chosen as a euro pallet with dimensions of 800x1200x145mm and a KamAZ-4308 vehicle with a static load capacity utilization factor of 1.023.

Keywords: rolling stock, pallet, container and packaging, medication, choice of container, Euro pallet, Finnish pallet. Transport package

The pharmaceutical industry of Uzbekistan began to take shape in 1993. In the same year, the Uzfarmsanoat (Uzbekistan pharmaceutical industry) concern was established, which launched the Uzkimiofarm (Uzbekistan chemical industrystate) plant and the Research and Production Association of Vaccines.

As a result, a long-term strategy has been established to increase domestic pharmaceutical production, in which the government develops essential drugs, infusion solutions, vaccines, blood products, disposable blood transfusion systems and blood substitutes, and pursues a policy to meet domestic demand in production. International standards for the production of medicines are also being introduced.

The pharmaceutical market of Uzbekistan is the third largest in the CIS after Russia and Ukraine. This is one of the fastest growing markets in the CIS region in terms of growth dynamics (8-10% per year).

In 2016-2021, the Republic of Uzbekistan has achieved significant results in the pharmaceutical industry. In particular, drug manufacturers are exempt from all taxes for 5 years. During 2017-2021 44 documents of the government of Uzbekistan were adopted aimed at reforming the pharmaceutical industry [1,2].

As a result of consistent policies in the pharmaceutical sector, there is a clear separation between the roles of the government and the private sector. While the government has the primary responsibility for regulating the sector, the production and distribution of pharmaceutical products rests with the private sector.

In order to improve the efficiency of drug delivery in pharmacies, the following tasks have been resolved:

- Analysis of the state of the pharmaceutical industry in Uzbekistan;
- Studying the characteristics of cargo (medicines);
- Choice of containers;
- The choice of rolling stock.

Currently, Uzbekistan has a long-term strategy to increase local production of medicines and a policy of self-sufficiency in basic types of medicines. Particular attention is paid to the introduction of international production standards.

In 2017, attention to the development of the industry increased, and it was determined that drug manufacturers would be exempt from all taxes for five years. Enterprises engaged in the creation of new production facilities and the reconstruction of existing ones were exempted from paying all customs duties on imports of technological equipment. In the same year, the President of Uzbekistan adopted a resolution on the creation of seven free economic zones specializing in the cultivation of medicinal plants and their processing in special natural conditions. As a result, investment in the country's pharmaceutical industry is gradually increasing [3].

The number of pharmaceutical companies increased from 2 in 1994 to 68 in 2002 to 130 in 2012. Currently, there are 191 pharmaceutical companies operating in the country, producing more than 2,500 pharmaceutical products. The production of the pharmaceutical industry in 2018 was [4]

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- medicines - 179 million dollars, of which 6.4 million dollars were exported. Considering the fact that enterprises use 40-60% of their capacities, there is a high potential for increasing the export of medicines;
- medical products (medical cotton wool, gauze, etc.) - 17.2 million dollars and exported in the amount of 6.6 million dollars, of which 5.4 million dollars accounted for the EAEU countries. Industry enterprises are loaded at 77-80% of their capacities;
- raw materials for the production of pharmaceutical products, which are mainly imported from third countries (India and China).

Exported products of the industry in the amount of 20.3 million dollars [7-9].

CHARACTERISTICS OF THE CARGO.

Medicines belong to the class of goods that require special conditions for transportation and storage, as well as loading and unloading operations. In this regard, when planning delivery, it is necessary to study in detail the features and characteristics of the cargo being transported in order to ensure maximum safety not only of the outer packaging, but also of the properties of the product itself.

The delivery of medicines is carried out according to the following standards given in the official instructions of the chemical-pharmaceutical industry [5]:

- For transportation, it is necessary to use specialized transport that can maintain the desired temperature.
- The supplied rolling stock must be kept clean.
- It is not allowed to use passing or attracted rolling stock for transportation.
- Upon delivery, medicines must be protected from direct sunlight, precipitation, dust and dirt.
- Medicines must be delivered from suppliers to the consumer in containers and packaging provided for by the current regulatory and technical documentation and ensuring its safety throughout the shelf life.
- Delivery of medicines on any vehicles is required to be carried out in compliance with their configuration by groups. The presence of markings is a prerequisite.

Here are some examples of the most popular medicines.

Citramon is a non-narcotic analgesic that has antipyretic, analgesic and moderately anti-inflammatory properties. It is transported only in bulk in corrugated boxes 600x400x400 in size. Each box contains 200 packs of 20 tablets (Fig. 1).

Figure 1. Container and packaging for Citramon

Pentalgin is a combined analgesic, antipyretic and anti-inflammatory drug. The composition of the drug includes 5 active components, the pharmacological properties of which determine the medicinal properties of the drug. It is transported only in bulk in corrugated boxes 600x400x400 in size. Each box contains 200 packs of 20 tablets [6,7] (see Fig. 2).

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Figure 2. Containers and packaging for Pentalgin

Ibuklin has analgesic, anti-inflammatory and antipyretic effects. Weakens arthralgia at rest and during movement, reduces morning stiffness and swelling of the joints, increases range of motion. It is transported only in bulk in corrugated boxes 600x400x400 in size. Each box contains 200 packs of 20 tablets (Fig. 3).

Figure 3. Container and packaging for Ibuklin

Thus, medicines are mostly transported in boxes. Average gross weight - 30.0 kg

CHOICE OF CONTAINER.

We will select containers for transporting boxes with medicines from the following types of pallets: euro and Finnish

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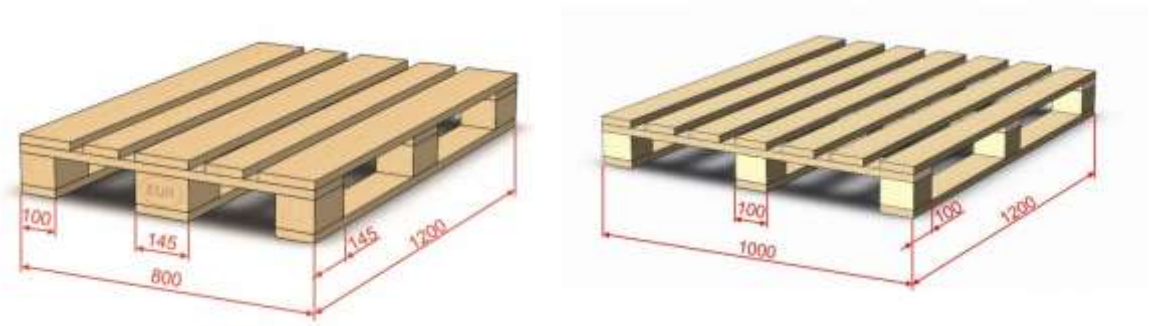

а) б)

Figure 4. Pallets: a) Euro pallet b) Finnish pallet

The euro pallet has overall dimensions of 800x1200x145mm, and the load capacity is 1500 kg [8]. (see tab.1).

Table 1
Technical characteristics of euro pallet

Length, mm	1200
Width, mm	800
Height, mm	145
Weight, kg	15
Load capacity, kg	1500
Maximum additional load, kg	4000 when stacking
Manufactured in accordance with EPAL technical regulations	EPAL

Placement of cargo on a Euro pallet is shown in Figure 5.

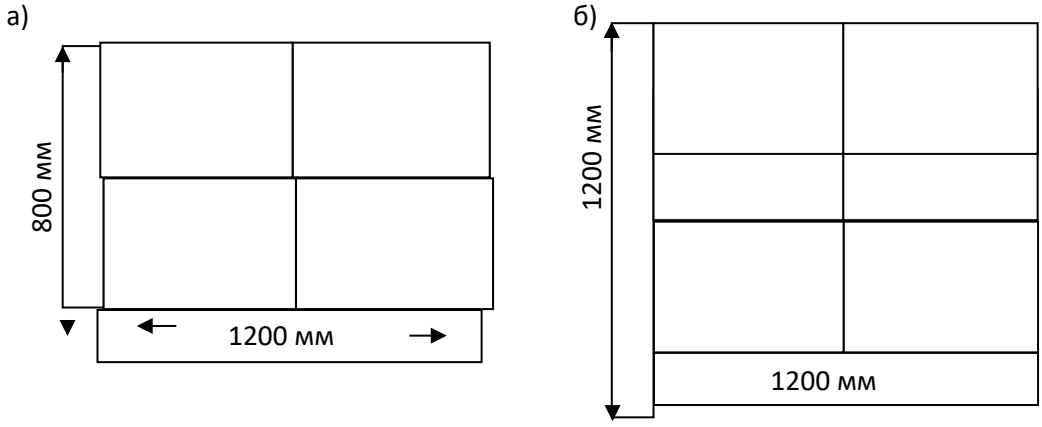

Figure 5 - Placement of cargo on a euro pallet: a) top view, b) side view.

Euro pallet capacity utilization factor: γ_s=G_f/q_a = 360/1500 = 0.24
The Finnish pallet has overall dimensions of 1000x1200x145mm, and the load capacity is 1500kg (see tab. 2).

Table 2
Technical characteristics of the Finnish pallet

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Length, mm	1200
Width, mm	1000
Height, mm	145мм
Weight, kg	15
Load capacity, kg	1500
Maximum additional load, kg	4000 when stacking
Manufactured in accordance with FIN technical regulations	FIN

Placement of cargo on a Finnish pallet is shown in Figure 5.

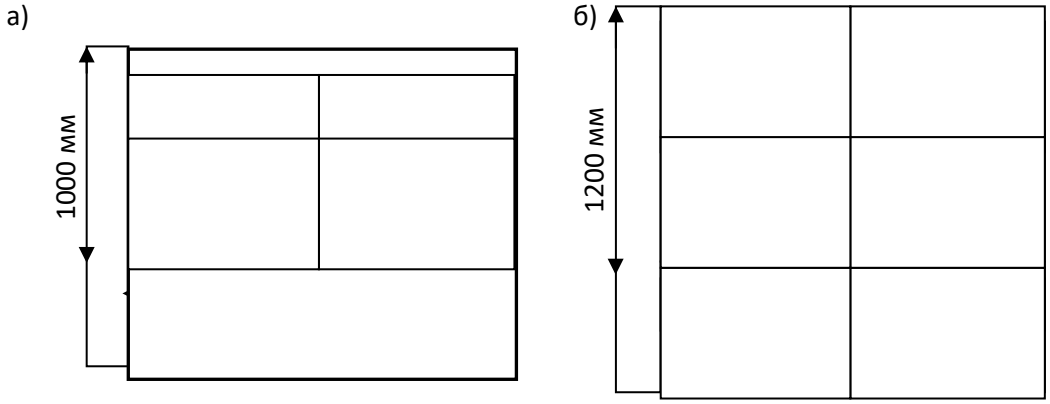

Figure 6. Placement of cargo on a Finnish pallet: a) top view, b) side view

Load capacity utilization factor Finnish pallet

$\gamma_c = \frac{G_ф}{q_a}$= 360/1500=0,24

Thus, the optimal type of container for the transport of medicines in boxes is a euro pallet in terms of the use of its area.

The euro pallet holds 12 boxes of medicines of 30 kg each, which is 360 kg, while the weight of the package is 375 kg (taking into account the weight of the pallet - 15 kg) [9-10].

1. Euro pallet capacity utilization factor

$\gamma_c = \frac{G_ф}{q_a}$= 360/1500=0,24

2. Load capacity utilization factor Finnish pallet

$\gamma_c = \frac{G_ф}{q_a}$= 360/1500=0,24

The choice of rolling stock. We will select the rolling stock from the vehicles presented in Table 3.

Table 3

Characteristics of the rolling stock

Rolling stock brand	Body dimensions, L×W×H, m	Carrying capacity, t
Refrigerator van ISUZU ELF 5.2	4,3×2×1,85	3
GAZ-3309 with isothermal van	3,72×2,4×2,32	4
KAMAZ-4308 with isothermal van	6,27×2,54×2,1	5,5
Refrigerator Hyundai HD 78	4,9×2,2×2,2	5
MAZ 5340 with isothermal van	5,2×2,5×2,4	9,7

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Comparative characteristics of the rolling stock during the transportation of various types of containers are presented in Table 2.

The coefficient of statistical use of load capacity for the car ISUZU ELF 5.2 [11]:

$$\gamma_c = \frac{G_ф}{q_a} = 0{,}375*6/3=0{,}75$$

The coefficient of statistical use of load capacity for the GAZ-3309 car:

$$\gamma_c = \frac{G_ф}{q_a} = 0{,}375*9/4=0{,}844$$

The coefficient of statistical use of load capacity for the KAMAZ-4308 vehicle:
Statistical capacity utilization factor for HYUNDAI HD 78:

$$\gamma_c = \frac{G_ф}{q_a} = 0{,}375*15/5{,}5=1{,}023$$

The coefficient of statistical use of load capacity for the car MAZ 5340:

$$\gamma_c = \frac{G_ф}{q_a} = 0{,}375*8/5=0{,}6$$

Table 2
Comparative characteristics of rolling stock

Indicator	Car brand				
	ISUZU ELF 5.2	GAZ - 3309	KAMAZ-4308	HYUNDAI HD 78	MAZ 5340
Carrying capacity, t	3	4	5,5	5	9,7
Pallet space, pcs	6	9	15	8	24
Static capacity utilization factor	0,75	0,844	1,023	0,6	0,928

It has been established that the optimal type of rolling stock in terms of the use of carrying capacity is the KAMAZ-4308 vehicle.

The location of pallets in the KAMAZ-4308 vehicle is shown in Figure 7.

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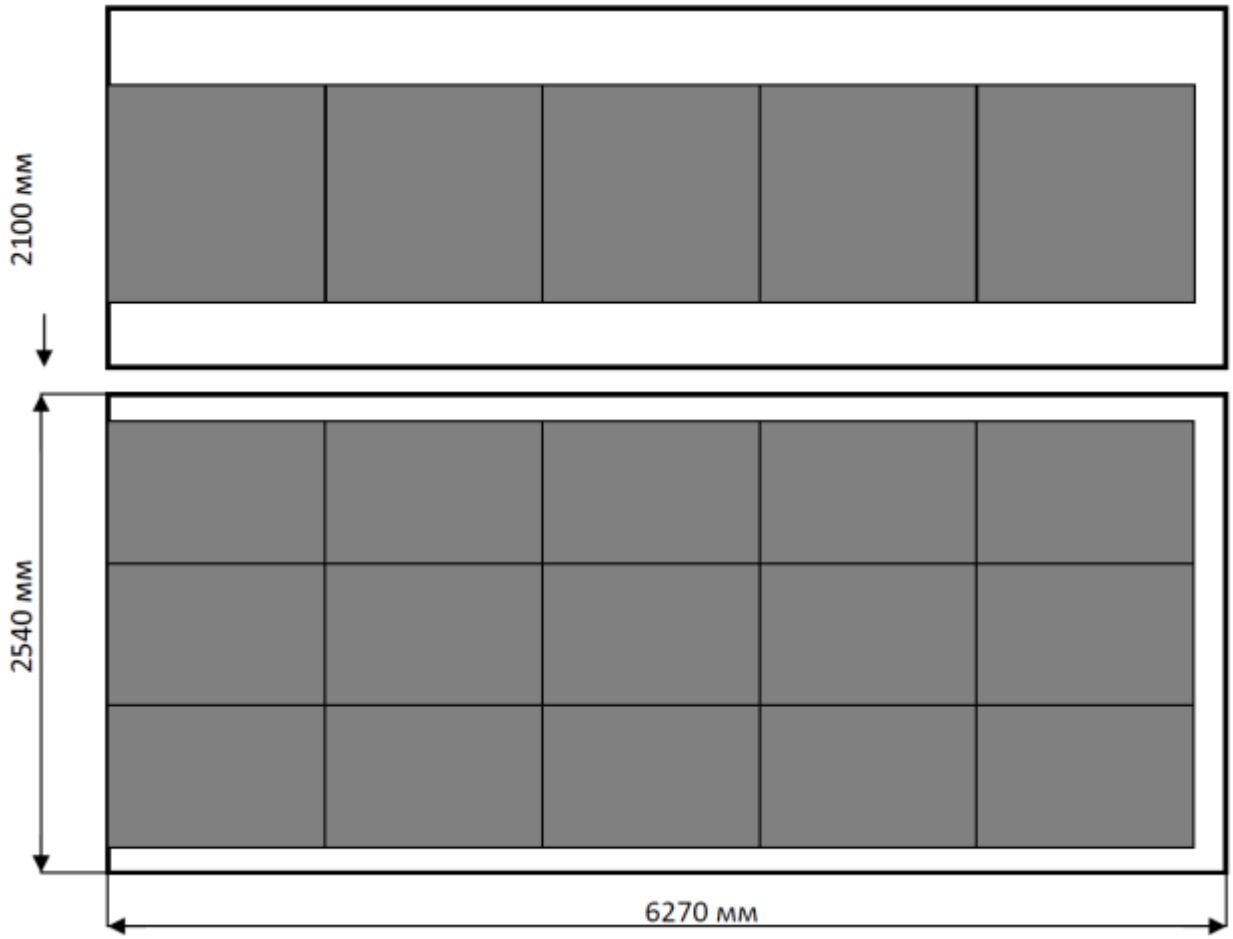

Figure 7 - Location of pallets in a KAMAZ-4308 vehicle:
a) top view, b) side view.

Figure 8. KamAZ-4308 car with an isothermal van

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CONCLUSIONS.

The work was carried out modeling the process of choosing the optimal type of rolling stock for the transportation of medicines to the consumer.

The optimal pair for transporting the entire daily volume is a euro pallet with dimensions of 800x1200x145mm and a KamAZ-4308 car, while:

- the carrying capacity of the rolling stock is effectively used (γ=0,928);
- transported simultaneously in the back of a car 24 units. containers;
- the entire daily volume is transported for the minimum number of trips- 2 units;
- the minimum total transport time was obtained for the transportation of the daily volume - 3.53 hours;

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