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CALCULATING WAREHOUSE SPACE AND IMPROVING SPARE PARTS DELIVERY IN AUTOMOTIVE TRANSPORT ENTERPRISES

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Abstract
This article addresses existing challenges and prospects for improving warehouse space calculation and spare parts supply in motor transport enterprises. The organization of warehouse space for storing inventory and providing auto service enterprises with spare parts and materials is primarily based on developing scientifically grounded proposals. These proposals aim to systematize the role of the transport system in the national economy, address current issues, and outline development prospects.

Keywords: Automobile, auto service, warehouse space, dealerships, spare parts, storage warehouses, parts, units and assemblies, automotive industry, maintenance and repair.

General part

Large companies have established direct connections between selling cars and supplying them with spare parts. The increase in the quantity and variety of spare parts, their product characteristics, strict legal requirements in different countries, and challenges in finding dealers have compelled manufacturers to modify their approaches to handling spare parts. It became evident that to ensure high-quality and timely repair of vehicles, it was necessary to revise the systems for supplying spare parts to car buyers. Consequently, the largest automotive companies have developed distribution networks with warehouse systems, effectively organized inventory management in individual warehouses, and established scientific foundations for analyzing and forecasting the demand for spare parts. The systematic organization of sales and complete computerization have not only reduced the costs of storing spare parts but also significantly accelerated customer service.

The foundation of successful automobile sales lies in establishing distribution networks to promote vehicles, spare parts, and maintenance and repair services to customers. These networks, in compliance with the "Consumer Protection Act," provide comprehensive services during both warranty and post-warranty periods of vehicle operation. Consequently, distribution networks offer an organization for spare parts delivery that guarantees the supply of necessary components to mechanics or consumers anywhere in the market within 24 hours of request.

Each automobile manufacturing plant, besides its own production, had numerous partner enterprises (for instance, nearly 250 for AZLK) that produced and delivered their components to the assembly line according to a predetermined plan. As a result, these partner enterprises lacked the flexibility to swiftly alter the production of specific components. This, in turn, led to increased shortages of certain products and an accumulation of unsold inventory for others. Such an inefficient planning system resulted in the inability to rapidly retool production and reconfigure the assembly line for manufacturing new car models.

Main part

Currently, great importance is placed abroad on producing spare parts in the required volumes and assortment, as their shortage leads to a sharp decrease in the competitiveness of cars. Overproduction results in inefficient use of labor, equipment, and materials, as well as excessive costs for transportation, processing, and storage. The production of spare parts continues throughout the entire production cycle of a particular car model and for an average of 5 years after production ceases. If the model is very widespread, then the production of spare parts and components continues for about 8-10 years. Subsequently, the production of spare parts for discontinued car models can be carried out in developing countries where the technology for manufacturing certain parts is sold.

Calculation of warehouse area for stored reserves

The warehouse area (F_o) is determined based on the surface area occupied by stored reserves (f_j) and the placement density coefficient (K_z) as follows:

$$F_0 = f_j \cdot K_z \text{ , m}^2$$

Here, K_z = 2,5 is the coefficient of equipment placement density.

The quantity of stored reserves (fuel, lubricants, tires, spare parts and assemblies, materials) is determined based on the standard daily consumption (G_m) and the number of storage days (D_{ik}):

- fuel reserve:

$$G_{yoz} = G_{yom} \cdot D_{yok} \text{ , l}$$

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The standard daily fuel consumption at motor transport enterprises is generally determined as follows:

$$G_{yk} = 0{,}01 \cdot (H \cdot l_k + H_{sn} \cdot L_{sn} + H_w \cdot W) \cdot (1 + 0{,}01 \cdot D) \cdot K + H_z + H_{IST} \cdot T_{IST} + H_{mq} \cdot T_{mq} + Q_{\rho b}, \text{ l}$$

Here, H - represents the linear base norm of fuel consumption per distance traveled by road transport vehicles, measured in liters per 1000 km;

l_k - denotes the daily distance traveled by the vehicle, measured in km.

H_{sn} - fuel consumption rate for performing special tasks during operation, l/100 km;

L_{sn} - distance traveled by rolling stock performing special tasks, km;

H_w - fuel consumption rate per 100 ton-kilometers of transport work, l/100 km or m^3/l00 km;

W - volume of transport operations, t*km;

D - specific normative coefficient, in percentage;

K - adjustment coefficient;

H_z - fuel consumption rate for each trip with load, l;

Z - number of loaded trips;

H_{IST} - fuel consumption rate for the operation of heater (s), l/hour;

T_{IST} - time the vehicle operates on the road with a heater, hours;

H_{mq} - fuel consumption rate for the operation of a special device in l/hour;

T_{mq} - operating time of the device in hours;

Q_{pb} - fuel consumption rate for engine operation while the vehicle is stationary.

The values of the daily fuel consumption components are provided in the "Regulatory document on fuel and lubricant consumption norms for automotive transport rolling stock and road construction machinery."

- lubricant supplies: $G_{mz} = \frac{G}{100} \cdot q_m \cdot D_k$, l

where q_m represents the consumption of lubricants per 100 l of fuel.

The reserve of lubricants (motor oils, transmission oils, lubricating greases) is calculated separately.

After determining the reserve of lubricants, containers for storage are selected and their occupied area (f_j) is determined.

-Tire reserve: $N_{sh} = \frac{A_s \cdot \alpha_t \cdot L_y \cdot X_z}{L_m} \cdot D_{shk}$,

where X_{wn} - number of wheels, excluding spare wheels;

L_m - warranty mileage of tires, km;

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D_{Shk} - tire storage days, (D_{Shk} =20...30 days).
Number of shelving units for tire storage:

$$N_{st} = \frac{N_{sh}}{P}, \text{ m}$$

where P is the number of tires on a two-tiered shelf with a length of one meter: P = 6...10.
The shelf width (b_s) is determined by the tire size. The area occupied by the shelf:

$$f_{st} = L_{st} \cdot b_{st}, \text{ m}^2$$

Where L_{st} - shelf length, m.
Weight of the spare parts and materials inventory:

$$G_{eq} = \frac{A_s \cdot \alpha_t \cdot L_{yk}}{1000} \cdot \frac{\delta \cdot G_a}{100} \cdot D_{eq}, \text{ kg}$$

The inventory of spare parts and materials (metals, paints, and others) is calculated as a certain percentage (δ) of the vehicle's weight (G_a) per 10,000 km of travel distance. Storage period D_{eq} = 30 days
Weight of aggregates in reserve:

$$G_{ag} = \frac{A_s}{100} \cdot K_{ag} \cdot q_{ag}$$

Here, K_{ag} is the number of units per 100 vehicles according to the Regulation;
q_{ag} - weight of units in kg.

The area occupied by shelves for storing units, spare parts, metals, and materials:

$$f_j = \sum \frac{G_i}{q_i}, \text{ m}^2$$

Here: G_i - weight of the stored object, kg;
q_i - load corresponding to 1 m^2 of shelf space; q_{eq} = 600 kg/ m^2; q_{ag} = 500 kg/ m^2; q_{met} = 600-700 kg/ m^2.
According to the new standards (TLUM 01-91), the area of warehouses is determined based on the specific area allocated for 10 vehicles and the space occupied by stored reserves.

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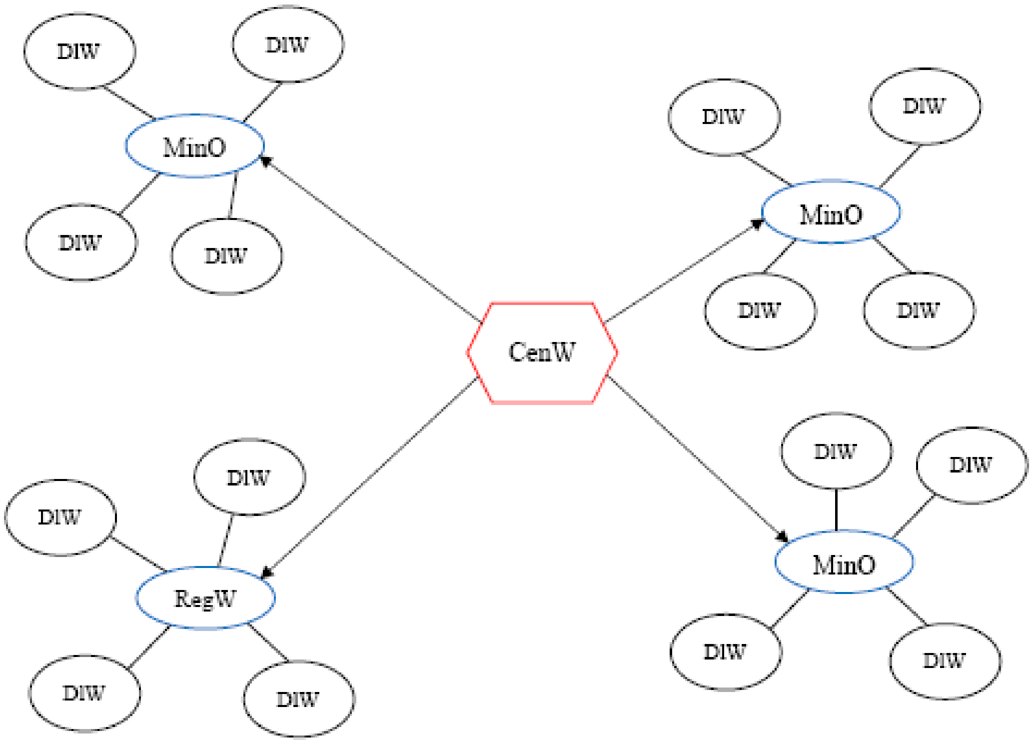

Structure of spare parts distribution networks:

CenW - central warehouse; RegW - regional warehouse; DlW - dealership warehouse.

When determining the production volumes of spare parts, we proceed from the following basic principles:

- The automobile manufacturer determines the expected consumption volumes with a certain margin of error and identifies the assortment of spare parts required for a specific regional fleet. This is influenced by a number of time-varying factors (climate, operating conditions, driver skill level, etc.);
- The delivery from both the manufacturer and all subordinate spare parts warehouses should be highly flexible and dynamic;
- The only effective basis for creating spare parts inventories is constant, continuous, and accurate information about their consumption, which provides a reliable foundation for calculating consumption forecasts.

For this reason, companies in all countries invest substantial funds in creating electronic computing systems to process large volumes of information and enhance the effectiveness of decision-making. In such cases, computers are utilized to identify optimal warehouse network structures, automate information processing, and manage inventory in warehouses.

In these distribution networks, all organizational and managerial decisions are based on maximizing adaptation to consumer interests. Warehouses serve as the primary functional units in enterprises participating in distribution systems. The distribution network comprises central warehouses, zonal or regional warehouses, and dealer (trade) warehouses.

The central warehouse houses a computer center connected to regional warehouses, with functions including:

- determining warehouse inventory;
- processing orders;
- cost accounting;
- monitoring inventory replenishment;
- controlling spare parts consumption.

As a result of analyzing the current state of warehouse management in car service enterprises in our republic and the situation with the supply of spare parts and materials, we can identify the following problems:

- lack of management system for supplying spare parts to car service enterprises and absence of analysis and planning for the required quantity of spare parts; absence;
- the selected warehouse area does not meet current requirements;
- lack of warehouse space in private dealerships;
- absence of a centralized distribution system for car service enterprises, dealerships, and stores selling spare parts, resulting in the reliability and quality of spare parts not meeting the required standards;
- lack of information on what types and quantities of spare parts (groups A, B, C) are required;
- absence of a system for determining the volume of commonly used parts through the manufacturing plant;
- unavailability of spare parts for some car models and high time and financial costs for their delivery when ordered;

Conclusion

Based on the above, it is necessary to conduct a centralized analysis of the restoration of warehouse management and spare parts supply in car service enterprises of our republic, and to ensure the delivery of only necessary spare parts by connecting them to a single computerized system.

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