Efficiency improvement of the productivity of the motor transport enterprise due to the expense of rational age structure

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ABSTRACT

The market formation of the transport services in the Republic of Kazakhstan is impossible without internal reforming of the transport itself as a branch of the economy infrastructure. For these were improved new management systems and introduced the regulatory and legal framework for transport activities. Nevertheless, today it is possible to note the general adaptation of transport to market conditions, however, the state of the transport system cannot be considered as an optimal. Existing requirements for the structure of the vehicle fleet (MTE), aimed at meeting the needs of the industry, often do not take into account the potential of the fleet due to the lack of a valid system of indicators for assessing the efficiency of rolling stock operation. Research aimed at justifying and developing requirements for a rational structure of the MTE fleet in order to increase the efficiency of car operation is relevant.

Key words: Motor transport enterprise, motor transport, MTE efficiency, rolling stock, fleet of vehicles, efficiency of the motor transport enterprise, vehicle efficiency, efficiency of the MTE maintenance service, truck service life, vehicle reliability.

INTRODUCTION

The transport complex interacts with all branches of the national economy, solves numerous problems of uninterrupted operation of enterprises of various industries. In these conditions, it is necessary to determine the prospects for a balanced development of the transport complex as a self-organizing system, conduct economic analysis of efficiency and problems of the organization of the transport process, since miscalculations can entail colossal material losses.

The widespread use of motor transport, its technological and organizational advantages require the identification of existing reserves to increase the efficiency of vehicle operation, technical and technological levels of vehicles and equipment; development of modern mechanisms for renewal of rolling stock; improvement of the structure of rolling stock of the fleet of motor transport enterprises (MTE) and taking into account modern principles of management and organization of activities in a market economy (Ahmedov, 1990; Velmozhin, 2007).

Increasing the efficiency of the maintenance of motor transport by determining the rational structure of rolling stock of MTE using a complex indicator is possible with the solution of the following tasks (Velmozhin, 2007; Myachkova, 2010):

1) Theoretical justification and experimental determination of the ranges of the coefficients of technical readiness and output for the line, ensuring the effective maintenance of the rolling stock;
2) Development of an integral indicator of maintenance efficiency of rolling stock, taking into account the values of the technical availability and release factors for the line of vehicles;
3) Development of a methodology for determining the
rational structure of the rolling stock fleet of MTE based on the integrated indicator of the maintenance efficiency of rolling stock;
4) Effectiveness estimation of the determination of the rational structure methodology of rolling stock of MTE using the indicator system of valuation maintenance efficiency.

EFFICIENCY OF A MOTOR TRANSPORT ENTERPRISE

The effectiveness of the MTE activity is a very broad concept, therefore, in the scientific and methodological literature they offer and in practice different approaches to its evaluation are used. Each of them allows reveals in the greatest degree any side of efficiency. It is difficult to estimate the overall efficiency using any one particular indicator, since MTE is a complex system and in each of its elements are pursued specific purposes and formed personal results.

According to Bogatin (1991) and Lopatnikov (2003), dictionaries give the following definitions of efficiency as:

Efficiency is the ability to bring an effect (useful result), to exert an effect. Efficiency of cost is the achievement of a purpose with minimal costs. Efficiency, economic – the effectiveness of economic activities, economic programs and activities characterized by the ratio of the resulting economic effect, the result to the cost of factors, resources, resulting in obtaining this result, achieving the greatest amount of production with the use of resources of a certain value.

From the aforementioned definitions, it is possible to formulate particular cases of efficiency used in this study.

Efficiency of a motor transport enterprise

The effectiveness of an economic system, expressed in the difference of useful final results of its functioning, the aggregate sequence of functional - technological, technical, labor and economic operations for the direct provision of transport services, and spent resources is formed as an integral indicator of efficiency at different levels of the functioning of the system.

The efficiency of MTE maintenance operation

This characterizes the transport process effectiveness of the organization, including the effective use of technically serviceable vehicles, in comparison with the expended resources and public needs. The efficiency of a vehicle is a measure of the use of useful properties of rolling stock in the process of its maintenance. The effectiveness of the MTE technical service characterizes the effectiveness of the maintenance of vehicles in a technically serviceable condition, ensuring the development of the production and technical base and the management realization of the material and technical supply of the enterprise, in comparison with the expended resources.

Currently, the development of the economy of the Republic of Kazakhstan requires a radical change in forms and methods of management and changes in the relationship between the enterprise and the national economy. In these conditions, even the most perfect indicator is not enough. Therefore, the long-term realization of the economic reform has used three main indicators: total revenue from transportation (including incomes from loading and unloading operations and execution of transport operations), total profit and profitability.

Specific knowledge of the nature and characteristics of the flow of hardware store processes, the identification of problems and ways to solve them within the framework of a system analysis of the enterprise's activity create the basis for the preparation of appropriate management decisions (Kozhin, 1994; Maydanchik, 1991). Nowadays, enterprises are planning their activities and the types of services provided and that is why buying a car without evaluating its effectiveness is inappropriate.

RESEARCH PART

Theoretical aspects of the considered issues are reflected in the works of Kuznetsov (1991) and Prudovsky (1990): formation of the size and age structure of rolling stock, requirements for spare parts and materials, production and technical base, technological equipment, that is, resources required for engineering and technical service.

In the motor transport enterprise, as a rule, cars have a certain age structure (AS) (Figure 1). The age structure of a car fleet is understood as the quantitative or percentage distribution of a car fleet by age group; this is given by the formula.

\[ \alpha_{ij} = \frac{A_{ij}}{A_i} \text{, since } \sum_j=1 a_{ij} = 1 \]  

(1)

Where: 
\( A_i \) - the number of cars of the j-th age group at time i; 
\( A_i \) - the size of the park at the time i, which is the calendar time of existence of the park of cars of this model.

The task of calculating, forecasting and controlling AS of the fleet are solved using the theory of recovery, dynamic programming and a number of other methods. In general, the following main factors influence the formation of the size and age structure of the park: the original size of \( A_1 \).
and the age structure, that is, the distribution of the park by age group $j$ at the initial time $i = 1$ ($a11, a12, ..., a1j$), the size of supply of new vehicles $A_n$ at the time $i = 1; 2; 3 ...$; the amount of write-off of cars $A_{WO}$; $i$; resource (write-off) of the car before decommissioning $t_{wo} = t_v$.

The ratio of the size of the supply to the size of the park in the $i$-th year is called the coefficient of replenishment given as:

$$r_i = \frac{A_{ni}}{A_i}$$  \hspace{1cm} (2)

The ratio of the write-off to the park in the $i$-th year is called the write-off or disposal ratio given as:

$$d_i = \frac{A_{WOi}}{A_i}$$  \hspace{1cm} (3)

The formation of parks has a number of general patterns (Figure 2). For the fleet of products of one model, there are three periods of existence in time $i$: 1) - from the beginning of the production (or delivery) to until the end of the average life of the car before decommissioning $t_{wo}$ - intensive growth in the size and aging seasoning of the park; 2) the period of relative stabilization during which the park is constant (line 2, $r_i = d_i$) and insignificantly grows (line 1, $r_i > d_i$) or shortens (line 3, $r_i < d_i$). During this period, as a rule, the supply of products is constant or insignificantly changes and the average age of the park is also quite stable; 3) after the termination of the release of products of this model or their supply to the park ($t_n$), there is an intensive reduction in the size of the park of these cars and all these products are eliminated from service on average by the time.

During the change the service life of cars changes the maintenance cost and investments. With the reduction of fixed service lives, the costs for maintenance operation and repair, the need for personnel and the production and technical basis for maintenance operation and repair and the need and cost for spare parts are reduced. But at the same time, the supply of new cars should increase, that increases the depreciation charges for MTE and
investments in industry grow to expand production of new cars (Table 1) (Kuznetsov, 1991; Prudovsky, 1990). Methods of AS of the fleet calculating depend on the accepted method of write-off of the products.

**Discrete write-off**

When the specified service life is reached, it is characterized by a variation of the actual operating time before the write-off period \( f(j) \); mixed write-off is a combination of the listed methods characterized by the specific weight of the discrete write-off. Calculation of the indicators of AS of the fleet with discrete write-off is based on the following: 1) If the calendar time is changed by one unit \((i + 1)\), the cars available at time \( i \) age \( j \), "aging" by one unit of time and "pass" to the next age group of the park (diagonal shift).

In general, in the case of writing off cars at \( j < tC \) (crashes, transfer to other enterprises) or replenishment of the fleet by cars that were in service, the size of the age group \((j + 1)\) at time \((i + 1)\) is given as:

\[
A_{(i+1)(j+1)} = A_{i+1} - 1
\]  

(4)

Where \( A_{n(j+1)} \) is the number of cars \((j + 1)\)-th age group newly arrived at the moment \((i + 1)\);

\( A_{WO(j+1)} \) is the number of vehicles \((j + 1)\) cars written-off (transferred) at the time \((i + 1)\). At \( j = tWO \), the remaining cars are written-off Kuznetsov, 1991; Prudovsky, 1990).

**Operating time to write-off**

In practice, it is necessary to take into account the quality of the service provided, which in turn depends on the reliability of the rolling stock. Reliability is a complex property depending on the purpose of the product and the conditions of its operation can include reliability, durability, repairability, serviceability and storage, or a specific combination of these properties.

Table 2 shows the formalized definition of an integrated indicator of vehicle reliability - the coefficient of availability, technical utilization and planned use. For a well-defined and unambiguous interpretation of the estimation coefficients for the technical maintenance of a car, it is necessary to consider the possible states in which a car may be in the process of its maintenance:

- Serviceable, works (in maintenance);
- Serviceable, idle in anticipation of work (non-working days, without driving);
- Defective (repair, maintenance operation, waiting for repair or maintenance operation).

**CONCLUSION**

During choosing a rolling stock for the purpose of forming an MTE fleet, it is first necessary to determine the principal provisions of an objective assessment of vehicles, to establish efficiency meters and develop a method of calculation determination which is most affordable for practical use. Thus, the executed analysis made it possible
Table 1: Influence of the service life of heavy-duty trucks on the necessary size of the park and resource provision, (%).

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Write-off-period (year)</th>
<th>3</th>
<th>5</th>
<th>7</th>
<th>9</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Necessary fleet size</td>
<td></td>
<td>93</td>
<td>100</td>
<td>109</td>
<td>117</td>
<td>124</td>
</tr>
<tr>
<td>Annual supply of new cars to the park</td>
<td></td>
<td>33,3</td>
<td>20</td>
<td>14,2</td>
<td>11,1</td>
<td>9,0</td>
</tr>
<tr>
<td>Average annual performance of the written-off car</td>
<td></td>
<td>113</td>
<td>100</td>
<td>74</td>
<td>71</td>
<td>65</td>
</tr>
<tr>
<td>Annual demand for MR of the set of the basic units to the supply of new cars</td>
<td></td>
<td>29</td>
<td>100</td>
<td>137</td>
<td>175</td>
<td>202</td>
</tr>
<tr>
<td>The annual need of major repair of the set of the main components</td>
<td></td>
<td>44</td>
<td>100</td>
<td>108</td>
<td>115</td>
<td>117</td>
</tr>
<tr>
<td>The need in the workforce for MO and MR at the MTE</td>
<td></td>
<td>91</td>
<td>100</td>
<td>111</td>
<td>117</td>
<td>131</td>
</tr>
<tr>
<td>The need in spare parts</td>
<td></td>
<td>44</td>
<td>100</td>
<td>119</td>
<td>145</td>
<td>142</td>
</tr>
<tr>
<td>Expenses of the replacement parts to the cost of delivery of new cars</td>
<td></td>
<td>16</td>
<td>27</td>
<td>37</td>
<td>54</td>
<td>60</td>
</tr>
<tr>
<td>Total expenditure on transportation</td>
<td></td>
<td>110</td>
<td>100</td>
<td>105</td>
<td>109</td>
<td>120</td>
</tr>
</tbody>
</table>

Table 2: Formulas for determining the integrated indicators of vehicle reliability.

\[
\begin{align*}
&k_W^A = \frac{t_W}{t_W - t_WST} \quad k_W^T = \frac{t_W}{t_W} \quad k_W^P = \frac{t_W}{t_W}\n
&k_W^A = \frac{t_W}{t_W - t_WST} \quad k_W^T = \frac{t_W}{t_W} \quad k_W^P = \frac{t_W}{t_W}\\
&k_W^A = \frac{t_W}{t_W - t_WST} \quad k_W^T = \frac{t_W}{t_W} \quad k_W^P = \frac{t_W}{t_W}\\
&k_W^A = \frac{t_W}{t_W - t_WST} \quad k_W^T = \frac{t_W}{t_W} \quad k_W^P = \frac{t_W}{t_W}
\end{align*}
\]

REFERENCES


to establish the influence of the technological operational properties of trucks on the main performance indicators (truck production, transportation costs, and technical availability coefficients). The identified TOP is structured in the following groups:

- Type of vehicle;
- Reliability of the car;
- Operational manufacturability;
- Dynamism;
- Stability;
- Maneuverability;
- Flotation ability;
- Fuel economy;
- Resource intensity;
- Ease of management;
- Comfort.

The reliability of the car determines its performance; that is, the possibility of realization of the transportations, which affects productivity. Operational manufacturability specifics determine the time for performing maintenance operation and repair works, and the time of withdrawal of the car from the line, which affects its productivity. Dynamism, stability, mobility, ease of control and comfortableness of the car determine the amount of time for loading and unloading and the average technical speed on which the performance of the car depends.