The study of maintenance frequency during the warranty period of operation

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Abstract. Due to the high cost of car warranty repairs, it is expedient to optimize car maintenance (CM) during the warranty of their operation. It is necessary to analyze the economic feasibility of technological operations in the performance of routine work during the warranty period. The appeal of car owners to the service station is associated with the emergence of various kinds and nature of car malfunctions in the operation. In order to save personal time, car owners, especially during the warranty period, combine troubleshooting with maintenance. In this regard, it is advisable to take into account the actual indicators of their reliability when determining the optimal frequency of maintenance of vehicles.

1. Introduction
Due to the high cost of car warranty repairs, it is expedient to optimize car maintenance (CM) during the warranty of their operation. It is necessary to analyze the economic feasibility of technological operations in the performance of routine work during the warranty period [1-5].

2. Method of forecasting
Considering that during the warranty period, cars undergo several (CM) services, the probability of failure-free operation during the warranty period \( P_l \) is proposed to be expressed by the product of probabilities:

\[
P_l = P_{A_1}P_{A_2}...P_{A_m} = \prod_{j=1}^{m} P_{A_j}. 
\]

(1)

The probability of failure-free operation of cars between successive maintenance is determined by the formula:

\[
P_{A_j} = \frac{I}{N_0} \sum_{i=1}^{i=N_j} \left( I - \frac{K_{A_j}}{n} \right)^i,
\]

(2)

where \( N_0 \) – the number of cars in the considered group; \( n \) - the total number of nodes (units) in cars; \( K_{A_j} \) - the number of nodes (units) that failed in the period \( A_j \).
3. Experimental research
Since occasional failures do not occur rarely, during the warranty period it is necessary to assign additional control to the nodes (units) in which failures occur most often, in order to prevent them.

The appeal of car owners to the service station is associated with the emergence of various kinds and nature of car malfunctions in the operation. In order to save personal time, car owners, especially during the warranty period, combine troubleshooting with maintenance. In this regard, it is advisable to take into account the actual indicators of their reliability when determining the optimal frequency of maintenance of vehicles [6-9].

Experimental data on actual car arrivals to the service area for maintenance were obtained at the service station of the official dealer of Lada-Service JSC in Orenburg. The “Lada Kalina” cars were investigated, in the period from 2014 to 2018. The processing of the obtained information and the histograms plotting were carried out using the program Microsoft Excel 2010.

Figure 1 shows the histogram of the distribution of arrivals to the service station of Lada Kalina cars for passing the M-1.

As can be seen from figure 1, the main intensity of arrivals of cars to the service stations accounts for the mileage from 10 thousand to 15 thousand km. This is due to an increase in the flow of failures and malfunctions in this range.

To prevent failures, it is advisable to reduce the frequency of M-1 for the considered group of vehicles up to 10 thousand km. A significant decrease in the number of applies after a run of 15 thousand km is associated with the planned maintenance according to the regulations, as well as the elimination of many faults.

Figure 2 shows the variation of the developments of cars before they are placed in M-2, from which it is clear that the occurrence of faults is most often on the run from 25 thousand to 30 thousand km and makes up about 74% of all applies in the considered range. In this regard, it is proposed to conduct M-2 on the run of 25 thousand km, as the timely diagnosis of many components, assemblies and systems with the replacement of faulty elements will significantly reduce the flow of failures. The sharp decline in the
flow of applications (more than 2.4 times) in the range from 30 thousand to 35 thousand km is primarily due to the control-diagnostic and adjustment operations for M-2. On runs from 5 thousand to 25 thousand km and from 35 thousand to 45 thousand km there is a relatively low failure rate.

Figure 2. Distribution of arrivals of the “Lada Kalina” cars to the service station for passing M-2

Similar results of research on “Lada Kalina” cars were obtained on runs from 30 thousand km to 150 thousand km. However, the processing of statistical data on the actual arrivals of the Lada Priora, Lada Largus and Lada Vesta cars showed slightly different results.

4. Conclusion
The performed studies allow us to make a conclusion that the factory recommendations on the maintenance frequency are not acceptable for the real Russian operating conditions and require serious adjustments (M-1 - 10 thousand km; M-2 - 25 thousand km). The proposed recommendations for changing the frequency of cars servicing are used in the Lada-Service JSC dealership (figure 3) [10].
Figure 3. Maintenance service [10]

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