

Khavruk V.O.
National Transport University, Kyiv, Ukraine

METHODOLOGICAL APPROACH TO DEVELOPING A WORKING HYPOTHESIS FOR IMPROVING THE CALCULATION OF THE PRODUCTION PROGRAM FOR MAINTENANCE AND CURRENT REPAIR OF AUTOMOBILE ROLLING STOCK IN THE CONDITIONS OF A MOTOR TRANSPORT ENTERPRISE

The article considers a methodological approach to improving the calculation of the production program for technical maintenance and current repair of automobile rolling stock in the conditions of a motor transport enterprise. Given the diversity of modern cars in motor transport enterprises, it is proposed to use a cyclical method of calculating the production program to determine the volume of service work, which involves determining the optimal calculation cycle for performing routine service work for specific brands of cars.

A motor transport enterprise is represented by a complex structure, which includes such subsystems as: diagnostics and control; main production; auxiliary production; service production. Among them, the central place in the system of technical maintenance and current repair of vehicles is occupied by the main production, as a subsystem that performs service routine work and maintains vehicles in technically sound condition.

It has been established that the purpose of the maintenance and repair system is to ensure the required level of performance at minimal cost, which can be achieved by creating optimal capacities of subsystems for joint work and increasing their efficiency through organizational and other measures.

It was found that to ensure the required level of vehicle performance, it is necessary to calculate the throughput capacity of the main production subsystem of a motor transport enterprise using mathematical methods of the theory of mass service.

To assess the system throughput, together with the incoming flow of requirements, it is proposed to determine the duration of technical actions in the main production.

The article presents a mathematical model of the system of technical maintenance and current repair of automobiles based on the economic criterion of ensuring minimum costs or maximum specific profit.

The methodological approach to developing a working hypothesis is presented in the form of an objective function of minimizing the total costs of maintenance and current repairs of automotive rolling stock, which are performed through optimal calculated mileages – adjusted, recommended by automakers, inter-service mileages.

The purpose of the article is to clarify the indicators by which it is possible to further improve the calculation of the production program for technical maintenance and current repairs of automobile rolling stock in the conditions of a motor transport enterprise.

Keywords: automobile rolling stock, production and technical base, current repairs, billing cycle, Queueing system, maintenance, labor intensity.

INTRODUCTION

Motor transport enterprises that use foreign-made trucks face a number of problems in organizing their production and technical base, namely, calculating the production program for maintenance and current repairs of automobile rolling stock. The production and technical base cannot be subjected to radical changes at once due to a number of objective reasons: insufficient funds at enterprises, uneven structure of automobile rolling stock in terms of wear and tear and its operational properties. Therefore, the adaptation of the production and technical base to modern conditions should be phased, such that it optimally takes into account the need for the necessary capacities to perform maintenance and current repairs. Technological design plays a decisive role here, one of the main stages of which is the calculation of the production program for maintenance and current repairs of automobile rolling stock.

LITERATURE REVIEW AND PROBLEM STATEMENT

The issues of calculating the production program for technical maintenance and current repairs of automobile rolling stock were considered in their works, in particular, by such researchers as: V. V. Bilichenko, V. I. Belov, V. P. Volkov, M. Ya. Govorushchenko, V. M. Dembitsky, I. P. Kurnikov, O. A. Ludchenko, O. V. Zakharchuk, S. I. Kryvoshapov, I. A. Marmut, V. I. Pavlyuk, V. M. Prydyuk, V. Ya. Chabannyi.

Most authors are guided by recommendations [1] and outdated methods of calculating the production program for maintenance and current repair of automobile rolling stock, which are based on regulatory indicators for a limited range of car brands. At the same time, the authors only generally indicate the main directions of improving the production and technical base of the motor transport enterprise, for example, V. Ya. Chabannyi, I. O. Osypov indicate the inconsistency of the production and technical base with the new rolling stock [2], but do not provide specific calculation formulas, and other authors do the same.

Therefore, the issue of improving the calculation of the production program for maintenance and current repairs of automobile rolling stock in the conditions of a motor transport enterprise requires research, taking into account the different intervals between maintenance services and the volume of scheduled maintenance work for modern imported car brands, as well as the inexpediency of using a methodology based on regulatory indicators of outdated and currently non-existent car brands.

PURPOSE AND OBJECTIVES OF THE STUDY

To consider the issue of improving the calculation of the production program for technical maintenance and current repairs of automobile rolling stock in the conditions of a motor transport enterprise based on the theory of mass service, to form an objective function for minimizing total costs for the optimal calculation cycle.

RESEARCH RESULTS

As a working hypothesis for improving the methodology for calculating the production program for maintenance and current repairs and its adaptation for a motor transport enterprise using foreign-made automobile rolling stock, the following statement is proposed: the cyclical method for calculating the production program for maintenance and current repairs of automobile rolling stock remains unchanged, but at different stages of reconstruction of the production and technical base, the value of the calculation cycle should optimally take into account the structure of the automobile fleet of the motor transport enterprise. If the motor transport enterprise has automobile rolling stock with different mileage values since the beginning of operation for the calculation cycle, of course, the mileage of effective operation of cars (mileage, exceeding which leads to a significant increase in the labor intensity of the current one) becomes important. But at the stage of commissioning new foreign-made automobiles with high resource mileage for the calculation cycle, take the mileage of cars for the full cycle of scheduled maintenance. As the average mileage of the automobile rolling stock in the motor transport enterprise increases, the value of the calculation cycle value should increase, but at the same time maintain the multiplicity of the scheduled maintenance complex, until the mileage of effective operation of the vehicle is reached. This will allow the motor transport enterprise to increase the required capacity of the production and technical base in stages without significant one-time capital investments.

It is obvious that when changing and improving the processes of technical maintenance and current repairs, it is necessary to adhere to the following basic provisions:

firstly, it is necessary to establish the compliance of the existing production and technical base and its specific elements with the standards and rules, as well as the requirements of the scientific and technological process;

secondly, it is necessary to be guided by the principle of a systemic integrated approach, the essence of which is not to establish the compliance of one or another parameter with the current standards and requirements, but to find a solution that allows not only to formally eliminate the noted deficiency, but also to find a way to improve this indicator, increase the efficiency of using each element of the existing technological potential, and achieve the best result in the development process. That is why it is necessary not only to analyze the existing conditions of the research object, but also to consider the prospects for its development. A comprehensive systemic approach does not allow the separation of these processes, that is, simultaneously with the consideration of the existing conditions, the search for ways and means of improving individual elements of the production and technical base must take place;

thirdly, the development of promising directions for the development of a motor transport enterprise requires the use of a creative approach and a certain courage in decision-making.

A motor transport enterprise can be considered as a single system for ensuring the need for transportation, consisting of two interconnected subsystems: a subsystem for organizing transportation and a subsystem for ensuring the operability of automobile rolling stock. The choice of the size of a motor transport enterprise should be made taking into account the maximum efficiency of the interaction of subsystems. Thus, if an increase in the capacity of a motor transport enterprise contributes to a decrease in the specific costs of maintaining the operability of a unit of automobile rolling stock, then in the transportation subsystem this is associated with an increase in the costs of non-productive runs of automobile rolling stock.

The maintenance and repair subsystem can also be presented as a single system that ensures a sufficient level of performance of the automotive rolling stock for the transportation process. It consists of separate subsystems (subdivisions), which, in turn, consist of lower-order subsystems or elements that cannot be further divided.

The maintenance and repair subsystem can also be presented as a single system that ensures a sufficient level of performance of the rolling stock for the transportation process. It consists of separate subsystems (subdivisions), which, in turn, consist of lower-order subsystems or elements that cannot be further divided.

In the system of technical maintenance and current repair of cars, it is possible to distinguish four subsystems that differ from each other in nature, location, organization of work, etc., having different partial and one common goal. The following subsystems are accepted as such subsystems:

- subsystem of diagnostics and control;
- subsystem of main production;
- subsystem of auxiliary production;
- subsystem of service production.

The structural diagram of the functioning of the vehicle maintenance and repair system in a motor transport enterprise is presented in Fig. 1.

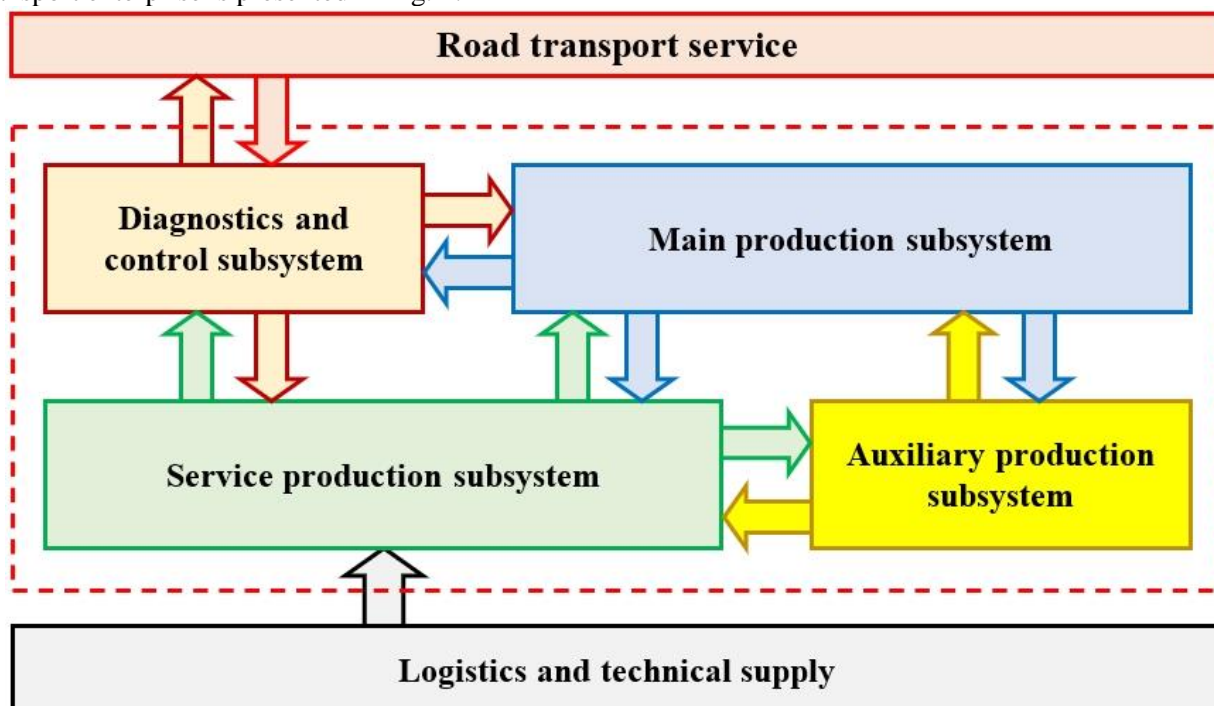


Fig. 1. Scheme of the functioning of the system of technical maintenance and current repair of vehicles in a motor transport enterprise [3–6]

The central place in the vehicle maintenance and repair system is occupied by the main production, as a subsystem that performs work directly on the vehicles and prepares them for entry into the production line in a technically sound condition.

Each of the specified subsystems of the main, auxiliary production and diagnostics can be put into optimal operating conditions, i.e. to ensure their maximum efficiency, according to certain technical and economic criteria. But when studying the entire system as a whole, these subsystems cannot be considered in isolation from each other, since achieving a single goal - ensuring the required level of performance of the automotive rolling stock at minimal costs - is possible only with their joint effective work. This is the principle of a systems approach in the study of complex technical systems, which includes the system of technical maintenance and current repair of vehicles in a motor transport enterprise.

The essence of the systems approach in studying maintenance and repair systems in a motor transport enterprise is to focus on the entire system as a whole, and not on its individual parts. When considering individual elements of the system, it is necessary to establish the impact of their work on the functioning of other elements and the entire system as a whole.

The study of complex systems consisting of various subsystems and elements, without violating their integrity, can be carried out through their analysis and synthesis. When analyzing individual subsystems, those properties that make them parts of a whole are identified, and when synthesizing, the whole is understood as consisting of parts that are somehow interconnected.

The goal of the maintenance and repair system - ensuring the required level of performance at minimal cost – can be achieved by creating optimal capacities of subsystems for joint work and increasing their efficiency through organizational and other measures.

Ensuring the required level of performance depends significantly on the incoming flow of requirements and the performance of the maintenance and repair system when performing a particular type of action. By requirement (application) we mean the need to perform a particular type of technical action. In this regard, to analyze the efficiency of the system, it is necessary to establish dependencies between the incoming flow of requirements and the performance of the system. These tasks are successfully solved using mathematical methods of the theory of queuing.

The main elements of a Queuing system are the incoming flow of requests (ΣN_i), service stations, a queue of requests awaiting service, and an outgoing flow of requests ($\Sigma \mu_i, X_i$). Service refers to the satisfaction of a request (application) for a technical action.

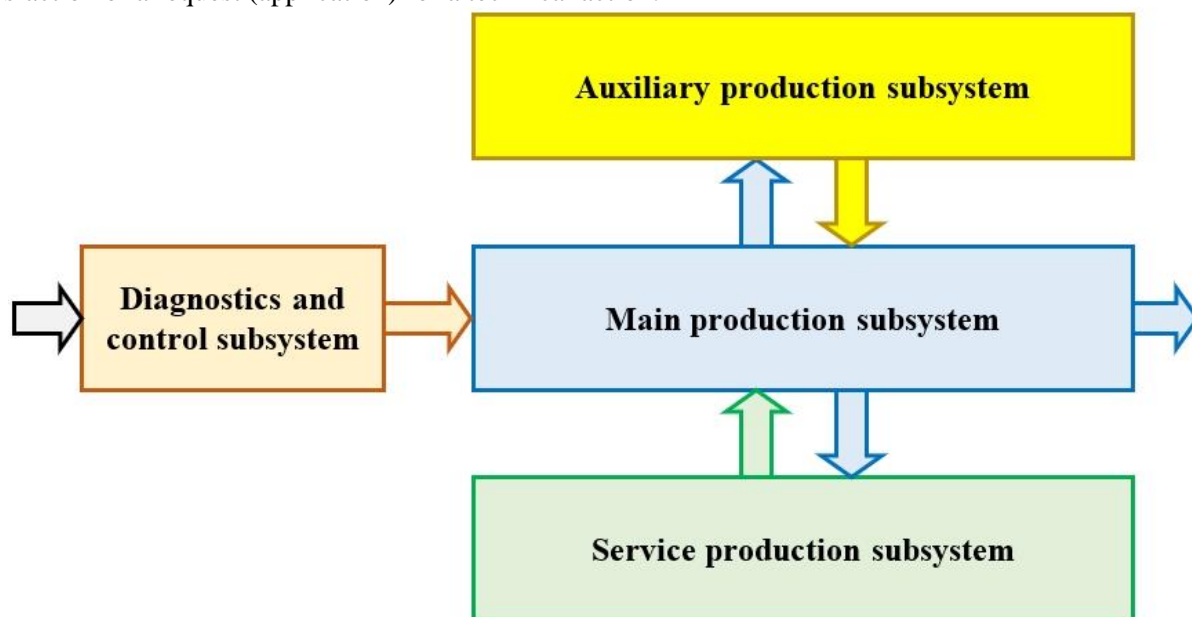


Fig. 2. Block diagram of a queuing system

Since the purpose of the service system as a whole is to satisfy the requirements for performing certain works, the most important concept of the Mass Service System is the system performance and the incoming flow of requirements entering the system of technical maintenance and current repair of automobiles.

In the event that the number of incoming requirements exceeds the throughput capacity in the mass service system, a queue of requirements for performing technical actions appears. The queue can be formed in front of each subsystem separately, therefore, each of the subsystems can block the operation of the entire system. To avoid this, it is necessary to select one of the most appropriate subsystems as a blocking one, ensure its sufficient throughput capacity and coordinate the throughput capacities of other subsystems in relation to the blocking one (Fig. 2).

Incoming flow of requirements – requirements entering the system. As studies of the operational reliability of cars show, random flows of requirements enter the system and its subsystems, which are formed through random runs at random points in time and require work of random complexity to perform technical actions.

Outgoing flow of requirements – requirements leaving the system. When requirements sequentially pass through different subsystems (phases), the flow of requirements leaving one subsystem can be input for another. The system of technical maintenance and repair of cars in a motor transport enterprise is considered as a lossless system (a requirement does not leave the system unserved) with a limited number of service devices when a relatively unlimited number of requirements arrive.

A random flow of requests for technical actions entering the system of technical maintenance and current repair of automobiles is defined in Queuing theory as simple. A characteristic of a simple flow of requests is the probability of occurrence of K requests during time $t(P_K(t))$, which is described by Poisson's law [7–16]:

$$P_K(L) = \frac{(\lambda t)^K}{K!} e^{-\lambda t}, \quad (1)$$

where: λ – demand flow density (average number of demands entering the system per unit of time).

The duration of technical actions affects the amount of system throughput along with the incoming flow of requests. The duration of maintenance of this car is a random variable, depending on numerous factors, such as the maintainability of the car, operating conditions, mileage since the beginning of the car's operation, the availability of spare parts, the qualifications of drivers and repair workers, the degree of mechanization of production processes, labor organization, etc.

When studying the system, it is necessary to take into account the influence of individual subsystems on the operation of the entire system. For example, the duration of a car's stay in the system, in addition to the duration of technical actions in the main production t_i , also significantly depends on the waiting time for the start of actions T_{EX} , the time for cleaning and washing works T_{DM} , the time for diagnosing T_D and the amount of unproductive time losses T_l (simple due to untimely provision of workplaces with spare parts, tools, equipment, etc.). Then the total duration T of a car's stay in the system of technical maintenance and current repairs when performing technical actions can be written in the following form:

$$T = T_E + T_{DM} + T_D + T_l \quad (2)$$

Thus, the time a car stays in the maintenance and repair system, which characterizes its throughput, depends on the operation of individual subsystems: diagnostics, main, auxiliary and service production. The system can successfully cope with the tasks assigned to it only if the system throughput ΣW_i exceeds the total input flow of requirements ΣN_{ci} for all types of actions [7–16]:

$$\sum_{i=1}^n N_{ci} \leq \sum_{i=1}^n W_i = \sum_{i=1}^n \mu_i X_i, \quad (3)$$

where: X_i – conditional capacity (number of posts) at the i -th action;

μ_i – average productivity of the post at the i -th action.

A slight excess of the system's post capacity over the incoming demand flow may not have the desired effect, and an excessive increase in posts is associated with high costs for creating additional production capacities. Therefore, it is necessary to establish the most profitable (optimal) reserve value η of production capacities:

$$\sum_{i=1}^n \mu_i X_i - \sum_{i=1}^n N_{ci} = \eta \rightarrow \text{opt} \quad (4)$$

The optimal value of the system's production capacity reserve can be found by the economic criterion (ensuring minimum costs C or maximum specific profit P_{sc}):

$$\sum_{i=1}^n C_i \rightarrow \min; \sum_{i=1}^n P_{sc} \rightarrow \max \quad (5)$$

The mathematical model of the vehicle maintenance and repair system must ensure that the following conditions are met:

$$\begin{aligned} \sum_{i=1}^n N_{ci} \leq \sum_{i=1}^n W_i = \sum_{i=1}^n \mu_i X_i; \sum_{i=1}^n \mu_i X_i - \sum_{i=1}^n N_{ci} = \eta \rightarrow \text{opt}; \\ \sum_{i=1}^n C_i \rightarrow \min; \sum_{i=1}^n P_{sci} \rightarrow \max \left(\sum_{i=1}^n P_{sci} \geq P_{sci}^0 \right) \end{aligned} \quad (6)$$

The application of this model is reduced to determining the total costs of vehicle maintenance and repair and their minimization (C_i) taking into account the specific cost of vehicles (C_A). The minimum costs correspond to the optimal mileage of effective vehicle operation (L_{opt}). In this case, the costs of vehicle maintenance are equal to:

$$C_{CM} = SC_{CM} \cdot LI_{CM}, \quad (7)$$

where: SC_{CM} – питомі витрати на виконання операцій ТО;

LI_{CM} – labor intensity of maintenance work at the corresponding mileage of the car.

The costs of current repairs are equal to:

$$C_{CAR} = SC_{CAR} \cdot LI_{CAR}, \quad (8)$$

where: SC_{CAR} – specific costs for current repairs;

LI_{CAR} – labor intensity of current car repairs based on the mileage. The total costs are determined as follows:

$$C = C_{CM} + C_{CAR} \tag{9}$$

With increasing mileage, the costs of maintenance and current repairs increase (reduction in the resource of parts or units and increase in repair costs), and the specific cost of cars decreases. The expression $C = C_{CM-CAR} + C_A$ is an objective function, the extreme values of which correspond to the optimal solution. In this case, the optimal solution (L_{opt}) corresponds to the permissible cost value (Fig. 3). The determination of the value of the objective function of the optimal value is determined graphically or analytically if the dependencies $C_{CM} = f(l)$ and $C_{CAR} = \psi(l)$ are known.

Analysis of the operation of the maintenance and repair system using an analytical mathematical model is carried out on the basis of certain statistical information about random phenomena occurring in it and processes that can also be obtained by the method of statistical modeling.

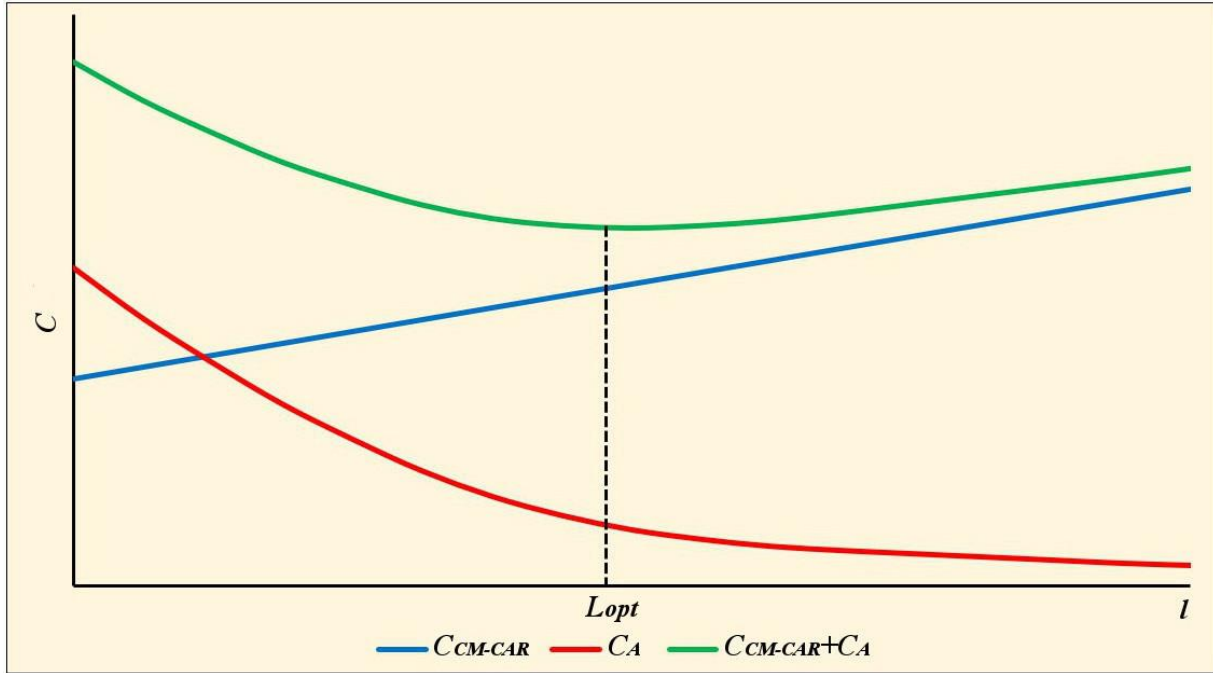


Fig. 3. Determining the value of the vehicle's effective operating mileage

The general structure of the production and technical base of a motor transport enterprise must be considered as a set of interconnected complexes (Fig. 4).

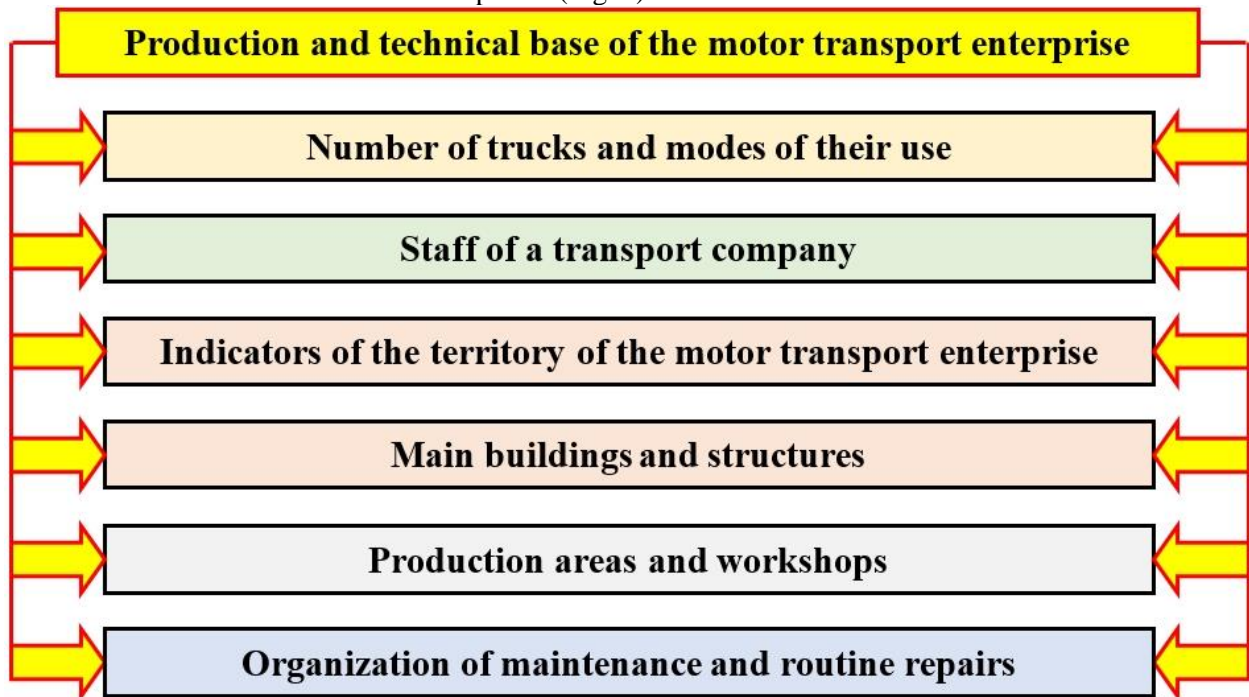


Fig. 4. General structure of the production and technical base of a motor transport enterprise

Since the study is carried out at a specific motor transport enterprise, then the influence of individual complexes can be neglected, in particular, such as: indicators of the territory, main buildings and structures, production areas, and enterprise staff. To develop a methodology for calculating the production program for maintenance and current repair of automobile rolling stock, it is necessary to first consider the following set of interrelated factors: maintenance and repair system; fleet size; operating modes of rolling stock; age of rolling stock; performance indicators of maintenance and repair services; regulatory framework used; operating conditions of automobile rolling stock.

The solution to the problem of improving the methodology for calculating the production program for technical maintenance and current repairs and its adaptation to the real conditions prevailing in motor transport enterprises that use foreign-made automotive rolling stock will be solved:

- by changing the value of the calculation cycle at the stage of commissioning of automotive rolling stock with high resource mileage (a complex of technical maintenance works), having reached the planned capacity of the motor transport enterprise – the mileage of effective operation of vehicles;
- determining the natural impact of changes on the values of the performance indicators of the production and technical base (the coefficient of technical readiness of vehicles, annual volumes of work in terms of the number and complexity of technical maintenance and current repair actions);
- determining the value of the mileage of effective operation for the studied automotive rolling stock;
- using the results of determining the production program for technical maintenance and current repairs to determine the number of daily maintenance, technical maintenance and current repair posts.

Therefore, as an object of research in developing a methodology for determining a production program for technical maintenance and current repairs for automotive enterprises that use foreign-made automotive rolling stock, the following objective function was defined:

$$C, L_{opt}(t) \rightarrow \text{opt} \quad (10)$$

The calculation cycle is understood as a certain mileage of a car, during which a strictly certain number of technical actions are performed with a clear work schedule, which is periodically repeated throughout the entire service life. Currently, according to the «Regulations on technical maintenance and repair of rolling stock of road transport» [1], the calculation cycle is taken as the mileage of a car before major repairs or before write-off.

To determine the production program for maintenance and repair of vehicles with high resource mileage, the calculation cycle at the stage of commissioning new rolling stock is taken as the mileage for a regularly recurring complex of «service» maintenance (L_C).

For example, for the IVECO Stralis 2013 model (EURO VI standard), the following types of maintenance are provided, which are performed after $L_C = 150,000$ km of mileage [17]:

M (Maintenance) – standard operations carried out at regular intervals, multiples of each other, expressed in kilometers of vehicle mileage;

EP (Extra Plan) – unscheduled operations (additional to standard maintenance), carried out at intervals that do not coincide with standard maintenance intervals;

T (Time) – one-time special operations associated exclusively with time intervals, and, as a rule, carried out at certain times of the year.

In Mercedes Actros vehicles, the Telligent® maintenance control system allows, depending on the intensity of use of the truck, to form service intervals of up to 120,000 km and oil change intervals of up to 150,000 km. The system monitors the actual load on the Actros, thanks to which the potential of all operating materials can be fully utilized [18].

Maintenance intervals for the Volvo FM vary depending on operating conditions and specific vehicle components. As a rule, the standard interval for most operations is 90,000 km or one year, but in difficult operating conditions it can be reduced to 45,000 km or 400 hours. The corresponding frequency recommendations are given in the operating manual [40].

DISCUSSION OF RESEARCH RESULTS

Improving the calculation of the production program for maintenance and current repair of automobile rolling stock in the conditions of a motor transport enterprise includes the objective function of minimizing the total costs for the calculation cycles for specific car brands. For Mercedes Actros trucks, the calculation cycle of routine maintenance is fully controlled by the Telligent® system, other car manufacturers indicate the periodicity of routine maintenance in the manuals for a specific car brand. To optimize the production and technical base of a motor transport enterprise, it is advisable to apply the theory of mass service of formulas (3, 4) using the economic criterion (formulas 5, 6).

CONCLUSIONS

The successful activity of a motor transport enterprise consists in minimizing the costs of organizing transportation and ensuring the operability of the automobile rolling stock (the system of technical maintenance and current repair of automobiles). Minimization of the costs of technical maintenance and current repair of automobiles is achieved when performing all routine work through calculation cycles, which depend on the periodicity of execution recommended by automobile manufacturers, their optimal values are determined on the basis of statistical data on the operation of automobiles in real conditions. The production program for technical maintenance and current repair of automobile rolling stock in the conditions of a motor transport enterprise will include the volume of all routine work, as will be performed through calculation cycles of automobile mileage.

LITERATURE

1. On approval of the Regulations on technical maintenance and repair of road vehicles of road transport. March 30, 1998 No. 102. Database «Legislation of Ukraine». Source of electronic access: <https://zakon.rada.gov.ua/laws/show/z0268-98#Text>
2. Chabannyi, V. YA; Osypov, I. M. Trends in the development of the production and technical base of road transport. Collection of scientific papers of Kirovograd National Technical University. Techniques in agricultural production, industrial mechanical engineering, automation. 2011. Issue 24(2). P. 82–90.
3. Ludchenko, O.A. Technical operation and maintenance of vehicles: Organization, planning and management. Kyiv. Logos. 2014. 464 p.
4. Dembitskyi, V.M.; Pavliuk, V.I.; Prydiuk V.M. Technical maintenance of cars. Lutsk. 2018. 473 p.
5. Fornalchyk, YE. YU; Olishevych M. S.; Mastykash, O. L.; Pelo, R. A. Technical operation and reliability of cars. Lviv. Afisha. 2004. 492 p.
6. Zakharchuk, O. V. Maintenance and repair of motor vehicles. Lutsk. 2015. 140 p.
7. Dubinenko, S. B.; Mitiushkin, YU. I. Operations research. Part 1. Queuing systems. Vinnytsia. 2008. 55 p.
8. Holoskokov, O. YE; Holoskokova, A. O.; Moshko YE. O. Fundamentals of the theory of exponential queuing systems. Kharkiv. 2017. 312 p.
9. Zhernovyi, YU. V. Simulation modeling of Queuing systems. Lviv. 2007. 307 p.
10. Tolubko, V. B. Simulation modeling of Queuing systems. Kyiv. 2018. 175 p.
11. Lytvynov, A.L. Theory of queuing systems. Kharkiv. 2018. 141 p.
12. Lozhkovskiy, A. G. Theory of queuing systems in telecommunications. Odesa. 2010. 112 p.
13. Pavlenko, P.M. Fundamentals of mathematical modeling of systems and processes. Kyiv. 2013. 201 p.
14. Savchuk, O.V.; Morhal, O.M. Process and systems modeling. Kyiv. 2012. 2012 p.
15. Samoilenko, M.I; Skokov B. G. Operations Research (Mathematical Programming. Queuing Theory). Kharkiv. 2005. 176 p.
16. Tomashevskiy, V.M. Systems modeling. Kyiv. 2005. 362 p.
17. Maintenance schedule for Iveco vehicles. Source of electronic access: <https://zakon.rada.gov.ua/laws/show/z0268-98#Text>
18. Mercedes-Benz. Actros. Axor. Brochureю. 2008. 42 p.
19. Technical information Volvo FM400. Source of electronic access: <https://www.autoklad.ua/ua/techinfo/10841/>

Хаврук В. О. Методологічний підхід до розробки робочої гіпотези удосконалення розрахунку виробничої програми з технічного обслуговування та поточного ремонту автомобільного рухомого складу в умовах автотранспортного підприємства

У статті розглядається методологічний підхід вдосконалення розрахунку виробничої програми з технічного обслуговування та поточного ремонту автомобільного рухомого складу в умовах автотранспортного підприємства. Зважаючи на різномарочність сучасних автомобілів в автотранспортних підприємствах, пропонується для визначення обсягів сервісних робіт використовувати цикловий метод розрахунку виробничої програми, який передбачає визначення оптимального розрахункового циклу виконання регламентних сервісних робіт для конкретних марок автомобілів.

Автотранспортне підприємство представлене складною структурою, яка включає такі підсистеми, як: діагностування і контролю; основного виробництва; допоміжного виробництва; обслуговуючого виробництва. Серед яких центральне місце в системі технічного обслуговування і

поточного ремонту автомобілів займає основне виробництво, як підсистема, що виконує сервісні регламентні роботи і підтримує автомобілі в технічно справному стані.

Встановлено, що метою системи технічного обслуговування і поточного ремонту є забезпечення необхідного рівня працездатності при мінімальних витратах, яка може бути досягнута створенням оптимальних потужностей підсистем для спільної роботи і підвищенням їх ефективності організаційними і іншими заходами.

З'ясовано, що для забезпечення необхідного рівня працездатності автомобілів необхідно виконати розрахунки пропускнує спроможності підсистеми основного виробництва автотранспортного підприємства за допомогою математичних методів теорії масового обслуговування.

Для оцінки величини пропускнує спроможності системи разом з вхідним потоком вимог запропоновано визначати тривалість технічних дій в основному виробництві.

В статті наведена математична модель системи технічного обслуговування і поточного ремонту автомобілів на основі економічного критерію – забезпечення мінімуму витрат або максимуму питомого прибутку.

Методологічний підхід до розробки робочої гіпотези представлений у вигляді цільової функції мінімізації сумарних витрат на технічні обслуговування і поточні ремонти автомобільного рухомого складу, які виконуються через оптимальні розрахункові пробіги – відкоректовані, рекомендовані автовиробниками, міжсервісні пробіги.

Метою статті є з'ясування показників, за якими в подальшому можливо удосконалити розрахунок виробничої програми з технічного обслуговування та поточного ремонту автомобільного рухомого складу в умовах автотранспортного підприємства.

Ключові слова: автомобільний рухомий склад, виробничо-технічна база, поточний ремонт, розрахунковий цикл, система масового обслуговування, технічне обслуговування, трудомісткість.

ХАВРУК Володимир Олександрович, асистент кафедри технічної експлуатації автомобілів та автосервісу, Національний транспортний університет, e-mail: khavruk@gmail.com. <http://orcid.org/0000-0002-4686-4109>.

Volodymyr KHAVRUK, Assistant of Motor Vehicle Maintenance and Service Department, Kyiv National Transport University, e-mail: khavruk@gmail.com. <http://orcid.org/0000-0002-4686-4109>.

Дата надходження статті до видання: 01.04.2026

Дата прийняття статті до друку після рецензування: 01.05.2026

<https://doi.org/10.36910/r1zg7d50>