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ARTICLE

ANALYSIS OF THE LEVEL OF DEVELOPMENT OF PRODUCTION AT THE SERVICE ENTERPRISES

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ABSTRACT

Car performance is affected by several factors including loads in structural elements, climatic and road conditions of operation, modes of vehicle operation. Because of these factors change in technical condition of a car and appearance of failures are random events. The questions of forecasting of development of a network of the auto service enterprises of various sizes at the regional level on the basis of population dynamics of a car park, opportunities of production capacity growth is difficult. In this paper we present an analysis of efficient operation of the car service companies.

KEY WORDS
development, the auto service enterprise, capacity, working post, efficiency, maintenance, repair.

INTRODUCTION

The organization of vehicles servicing and repairing is significantly influenced by such factors as: large annual runs, lack of strict periodicity and completeness of servicing, unevenness in the flow of vehicles to the company, random nature of distribution of quantities over time and species [7]. The process of predicting the development of service networks is a complex task that can be divided into several stages.

The placement of the fleet by region (districts) is characterized by large variations. The regional distribution of production capacity is also uneven. As a result there is a significant imbalance between the available fleet of vehicles and the need for its maintenance and repair by regions.

Calculation of needs in capacity growth of service businesses is based on the forecast of the number of fleet taking into account the differentiation by areas and using the predicted values of the system of economic standards adopted for service companies (throughput work of fasting, the coefficient of repeatability of addresses to the enterprise, the equipment utilization rate) [6].

Organization of work of the car service companies includes: selection and substantiation of optimum structure of production and technical base, the selection and justification of the technological scheme of work and organizational structure of the enterprise, the optimal distribution of material resources. However, whatever optimal organization options are at the design stage, they are unable to ensure the effective operation of the system in time. This is because external factors at any given point in time are random events. So you need constant regulation and control of the production process, which should ensure the most efficient operation of the enterprise [2].

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MATERIALS AND METHODS

In the calculations must be considered [4]:

- Possible increase of production capacities, which are determined by the number of work stations;
- Trends in the structure of the vehicle fleet;
- Social, environmental and urban planning limits for the saturation of service centers in the regions;
- Possible standards of service vehicles.

The calculation of the required number of work stations (X) for each region r can be carried out according to the following formula:

$$X_r = \frac{K_r N_r d_{Nr} K_{ob}}{t_n \cdot n},$$

where

k_r is the adjustment factor of the regional structure, taking into account the region saturation in production capacity;

N_r – the number of cars in the rth region;
I_{Nr} – projected index of the increase in the number of vehicles for the period;
k_{ob} is the coefficient of repeatability of addresses to the enterprise;
k_u – coefficient of capacity utilization;
P – performance of the post: the number of cars per one working post.

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Calculation of the necessary number of work stations is advisable to fulfill taking into account the range of possible variations of the individual characteristics of the enterprise. Various options with the change of regional structure of the fleet (I_{Nr}) can be considered, change in the performance of the post (P) due to the increase in the quality of services and reduction of works execution waiting time.

The increase of the required number of work stations is determined as the difference between the required and existing capacity:

$$\Delta X_r = X_r - X_f,$$

where X_f is the actual implementation of the r th district with working posts.
Investment needs for increasing service capacity in the region r can be calculated using the average capital coefficient spent on creation one working post (k_f) and data about the required increase in the number of posts (D_{Xr}):

$$I_r = k_f D_{Xr}.$$

Total required investment amount in several regions will be the following:

$$Iå = åIr.$$

The obtained value for the total size of the investment is compared with the available financial resources (F), then the minimum amount of investment necessary for the development of the service industry is determined:

$$Iopt = \min(Iå, F),$$

where F is the amount of available funds.

Then there is the alignment of goals and financial capabilities for the development of service enterprises, final clarification and correction, followed by a choice of increasing production capacity.

Allocated to the development of the service network investments can be divided into two groups [10]: for reconstruction, modernization and expansion of existing businesses and creation of new enterprises:

$$Ir = Ip + Ic,$$

where Ip and Ic are values of investment resources for reconstruction, modernization, expansion of existing enterprises and creation of new businesses, respectively, in region r.

After determining the values of investment for reconstruction and creation of new businesses, allocation of funds by regions is made in proportion to identified needs in capacity growth.

To determine the best patterns of production facilities the following information is required: the amounts of investments allocated to the development of the service network in general and by regions, the specific intensity and effectiveness of the work of the post with the differentiation of these indicators by types of enterprises (small, medium, large).

Solving the problem by using the criterion of efficiency (maximizing profits) under a constraint on the allocation of financial means, it is possible to obtain a structure of production capacity in three groups of enterprises.

Formally, this problem can be written as follows [1]:

$$\begin{cases} \sum_{r=1}^{R} (p_м X_{rм} + p_c X_{rc} + p_к X_{rк}) \to \max . \\ k_{фм} X_{rм} + k_{фc} X_{rc} + k_{фк} X_{rк} \le И_r, \quad r = \overline{1...R}, \\ X_{rм}, X_{rc}, X_{rк} \ge 0. \end{cases}$$

where

Xrm, Xrc, Xrk – the required number of working post created in the rth region in small, medium and large enterprises respectively;

kfm, kfc, kfk – specific capital ratio for creation of one working post on small, medium and large enterprise

pm, pc, pm – profitability of the operation of one working post on small, medium and large enterprise.

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RESULTS AND DISCUSSION

The resulting structure of production capacity is distributed between the small, medium and large enterprises in accordance with the specified power range, characterizing the size of workshop.
The economic effect of the program of development of car networking (E) is the sum of the effect of expansion, reconstruction and upgrading of existing service businesses (Ep) and the effect of creation of new enterprises (Ec):

$$E = Ep + Ec.$$

To estimate the total economic effect from the development of service network is also possible on the basis of the methodology, which takes into account the contribution of the service enterprises in the development of the urban economy.

The approximate evaluation of the effect can be done on the basis of data on unit profitability of a single post and a number of newly commissioned work stations (including separate indices for groups of companies) [9]:

Where

Дm, Дc, Дk – profitability from one working post on small, medium and large service enterprises respectively;

Xrm, Xrc, Xrk – number of work stations created for small, medium and large enterprises respectively in the r th region.

An important indicator of effectiveness is the total amount of all contributions to the city budget:

$$Ob = Oн + Oa,$$

Where

Oн is tax deductions from profits of enterprises;

Oa is the amount of rent per occupied square.

Rent is paid only by those of car service enterprises, which are located on the autonomous territory and have a lease with the city government.

Dividing the total volume of investments allocated for the development of the service station network, on the obtained value of annually arriving in the city budget means from the point of view of municipal economy, approximate payback period of investment put into the service can be determined:

$$CO = \frac{IT}{\Delta} .$$

The system of indicators of comprehensive evaluation of companies must be market-oriented and reflect the following [3, 5]:

- current conditions in which enterprises operate on the market (the initial data for development of strategy and tactics of development of the enterprises);
- production and economic condition of companies (the characteristics of the existing level of technical and economic development of production facilities and their interaction with each other);
- performance of companies during the period under review (changes of enterprises state and their market position).

The formal statement of the search problem of effective control action is the following: let X be a set of external factors that affect the air supply (daily mileage of cars, traffic, climatic conditions). Then the state vector X has the form:

$$X = \{X1, X2, ..., Xm\}.$$

Internal state of the system is characterized by the properties and processes that determine the change of the dynamic characteristics of the system (absence from work of maintenance workers, availability of spare parts and damaged equipment). Denote them by vector Y:

$$Y = \{Y1, Y2, ..., Yn\}.$$

The change of vectors X and Y in the operation of companies will be restricted. Suppose that all the available information about the state of the control object in time is described by the functions argument of which is the time t:

$$Xi(t); Yj(t); \quad i = 1, 2, ..., m; j = 1, 2, ..., n$$

The task is that at any given point in time t to choose a control action on the system, which would bring the value of the selected criterion of efficiency for extreme value.

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The criterion of effectiveness must reflect the specific conditions of the production functioning and provide an objective solution of the problem under consideration. Therefore, we can say that this criterion is a measure of comparison for quantitative evaluation of different solutions. Selection and justification of performance criteria is one of the most important conditions for successful solution of various tasks and performing research.

To assess the effectiveness of the vehicle maintenance system the total adjusted cost for one service can be applied. In general, the aggregate adjusted cost is a function of the input (number of maintenance requirements) and controllable parameters (number of work positions, maintenance workers, the mode of the system). In general, the discounted total costs are a function of several variables [8]:

W = f (M, N, X, P),

where

M is the capacity of the company;

N – the number of requirements;
X – the number of posts;
R – the number of workers on duty.

The analytical criterion of selecting the best variant of the organization of the maintenance system is expressed by the formula:

WTO = CД TO – Cз TO,

where

CД TO – the total revenues of the system;
Cз TO – the total cost of the operation of the system.

Possible revenues from the vehicles service are determined according to the formula:

CД TO = ☐Ci TO ti TO,

where

Ci TO – the cost of one hour of service for the ith vehicle;
ti TO – the complexity of maintenance of the ith vehicle.

The total cost of maintaining the service system is determined according to the formula:

Ce TO = CbPf + Esal + 3m + Ec,

Where

Cb is the specific carrying value of buildings and equipment;
Pf – the amount of payment for production assets;
Esal – the cost of salary for workers;
Em – the cost of materials and spare parts;
Ec – energy costs.

To assess the efficiency of the vehicles, repair system the total costs of maintaining the positions of the system and the costs of idle vehicles awaiting repair are used. In General, this criterion is expressed by the following formula:

Wp = to pCo p + tп pCп p,

where to

p – time a car spends in the queue;
Co p – downtime costs of the car in the queue;
tп p – time of downtime of maintenance workers or posts;
Cп p – costs of the idle worker or post.

Minimization of this objective function allows to determine the production capacity of the repair system based on the incoming flow requirements, repair time and cost. However, to solve the problem of selection of different kinds of repair strategies, the criterion is not sensitive enough.

Therefore, when choosing a management strategy for maintenance to evaluate the efficiency of the system the best criterion is that which is characterizing the possible value loss of profits, and also taking into account the level of security of the company's revolving fund [8]:

$Wp = \sum_{i=1}^{N} C_i T_i - \sum_{j=1}^{X} C_{jn} T_{jn} - \sum_{k=1}^{P} C_{kp} T_{kp} - \sum_{s=1}^{N_{azp}} C_{s\ xp} T_{s\ xp}$,

where N is the number of repaired cars over a certain period of time, Ci – profit that the ith vehicle brings to the company, Ti is the spent time of the ith vehicle in the service system, X is the number of posts or

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jobs, Cjп – the cost of downtime of the jth post repair within the hour, Tjп – total idle time jth post, P – the number of maintenance workers in the system, Ckp – wages per hour of kth worker, Tkp – total time of the kth worker, Narp – number of working units, Cs xp – the cost of storing the sth unit, Ts xp – the total storage time of sth unit.

CONCLUSIONS

Thus, the first stage to predict the development of service networks at the regional level is a reasonable assessment of the prospects of development of the transport network associated with the problems of economic development of the region as a whole.

The next step is to identify the largest cities of the region and analyze their development prospects. These cities should be considered as the main link in a future service network throughout the region.

In the third stage of development of the program of perspective development of service enterprises of the region the required number of production facilities of vehicle service along major highways, depending on the tension of the movement, is calculated.

Basic requirements which should correspond to the criterion of effectiveness:

1) be the one that allows you to choose the simplest solution to the problem, especially with use of the computer;
2) be expressed in the quantitative measure to allow an objective assessment of the exact methods;
3) a quantitative measure of the efficiency criterion should objectively reflect the results of system operation;
4) a quantitative characterization of the criterion should be sensitive even to minor changes imposed on the system constraints;
5) have a precise mathematical expression to be calculated.

The most common criterion is the minimum reduced cost, which reflects costs of production. Given the unit costs consist of costs for maintenance and repair of motor vehicles.

CONFLICT OF INTEREST
There is no conflict of interest.

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