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Methodology of Development of Technical and Economic Model of Agricultural Machinery Dealer Point

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ABSTRACT: This article examines the issue of methodology and the creation of a technical and commercial model of a dealer of agricultural technology, as well as innovations developed in the field of agriculture.

KEYWORD: agriculture, car maintenance, model, FTS customers, dealer points (DP), indicators

Introduction

In many countries around the world, research and innovation aimed at improving the efficiency of car maintenance (TS). In this regard, the choice of a rational form of TS executors (service companies, technical centers, dealerships), the implementation of targeted research to justify the parameters of their functioning is a topical issue. In this regard, there is an urgent need to create service centers that meet the needs of farmers, speed and quality of services, low prices.

In carrying out these tasks, including "Wide use of high-performance agricultural machinery", the number of machines available in each region of the country and their distribution by districts, the maximum service speed, minimum maintenance costs are equally important for foreign and domestic complex machines. formation of universal service centers, equipping them with the necessary material and technical means is relevant [1].

To do this, first of all it is necessary to choose a criterion for the optimal placement of the enterprise, so that it maximizes the efficiency of the process under study and determines the compromise between the maximum income that the enterprise can receive and labor costs. This condition should be understood as reducing the time customers spend waiting for service and the cost of transporting a defective or service-intensive machine to workshops [2].

The model must meet the following condition: the system of repair and maintenance of facilities must be organized in such a way that the requirements for these services in the designated area are fully met and the optimum of the selected criteria is provided.

Before creating a model, we accept the following permissions:

1) a certain r area is divided into R number of districts where service facilities are located($r = 1, R$);

2) there are P projects for the establishmentπ of service enterprises and plans for their placement in points ($p = 1, \pi$);

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3) the value of the relative income from the maintenance of a car of a particular model is known in the project of each enterprise;

4) Each P point may be required to provide any j service ($i=\overline{1,m}$) to any i model car ($j=\overline{1,n}$) from any r region.

It should be noted here that if a dealership enterprise provides branded technical service (FTS) to several brands of agricultural machinery, there may be a machine model $i=1,2,3$, i.e., several. If a dealer with a narrow specialization is operating in the area, the car model is suitable for his specialization. For example, if a dealer shows an FTS to CLAAS's AXOS 340, ARION 640, and AXION 810 wheeled tractors, it will be a car model $i=\overline{1,m}$. If the dealer only serves the Dominator-130 grain harvester, then it is appropriate. Taking into account these permissions, the studied model can be formally written as follows [3]:

$$\sum_{i,j,p}^{m,n,\pi} x_{ijpr} \geq \sum_{i,j}^{m,n} B_{ijr};$$

$$\sum_{i,j,r}^{m,n,R} x_{ijpr} \leq \sum_{i,j}^{m,n} M_{ijp};$$

$$x_{ijpr} \geq 0;\ i=\overline{1,m};\ \ j=\overline{1,n};\ \ p=\overline{1,\pi};\ \ r=\overline{1,R};$$

$$\sum_{i,p}^{m,\pi}\left(\sum_{j,r}^{n,R} m_{ijpr}\times x_{ijpr} - \sum_{j,r}^{n,R} t_{ijpr}\times x_{ijpr} - \sum_{j,r}^{n,R} t^{0}{}_{ijpr}\times x_{ijpr}\right) \to \max. \quad (1.1)$$

The following definitions have been adopted in this expression:

x_{ijpr} - The number of cars of model i, which came to the enterprise number R from the region r and require the service of number j;

B_{ijr} - the need for digital maintenance of the model i car located in r area;

M_{ijp} - the capacity of the enterprise number R, which provides digital service to the car model i;

m_{ijpr} - Income of the enterprise number R, located in the region r, from the provision of digital service to the car of model i;

t_{ijpr} - transportation costs of the car owner or dealership when transporting a model i car in r region to digital enterprise R for the purpose of digital service;

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t^{0}_{ijpr} - Expenses incurred by the owner (farmer) of a model i car located in r area to wait for j digital service by R enterprise (model i is expressed as income lost as a result of one hour stoppage of a faulty machine).

As can be seen, the first inequality of model (1.1) represents the forecast needs of all FTS customers in the region for the provision of complex services to all machines on their balances and the degree of satisfaction by the dealership. In practice, a certain part of the machines on the customer balance is in good condition during operation, i.e. does not require maintenance, so the left side of the inequality is always larger than the right side. Simply put, the total number of cars is always greater than the number of faulty cars.

The second inequality is the limitation on the capacity of the R-digit enterprise in the j-numerical service of the i-model machine. Meaning of inequality: The capacity of the enterprise is sufficient to show FTS to all faulty machines.

The third inequality represents the condition that all the variables sought in the model always have a positive value. If the i model is not a machine, the j digital service will not be needed and will result $x_{ijpr} = 0$. $x_{ijpr} > 0$ An inequality occurs as soon as an R-numbered enterprise in region r provides a single j-numbered service to a single i-model car.

The fourth inequality, i.e. the criterion of optimality, ensures that the interests of all subjects involved in the FTS process are consistent:

- the dealership seeks to maximize revenue by providing FTS to customers' faulty machines ($m_{ijpr} \to \max$);
- Customers strive to minimize the cost of transporting their defective vehicles and showing them FTS

($t_{ijpr} \to \min$; $t_{ijpr} \to \min$).

When all the conditions of model (1.1) are met, in addition to the provision of quality FTS to the machines, a smooth distribution of the network of dealer points across the region is ensured [4].

This problem belongs to the class of standard (linear programmable) problems and can be solved using the simplex method. The final location plan of the network of service enterprises can be determined using an alternative approach. To do this, first, a specific set of layouts of enterprises with different capacities is studied, and then the value of the optimal load and optimality criterion of these enterprises is calculated. The number of dealer points located in the region can also be changed during the implementation of the model.

At the final stage of the model implementation, the value of the optimality criterion and the location of the enterprises are selected using an expert or decision-maker (CSA) using the values of the uniformity of the enterprises across the region.

It is known that new service enterprises are often established on the basis of existing repair and service bases. In this case, the mathematical model (1.1) will need to be improved as follows. In the case of variant calculations, the available capacity of these bases is taken as an integral part of the total capacity of the projected DPs.

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When the question of liquidation of dealerships that do not operate at full capacity is raised, in the system of constraints (in the fourth inequality of 1.1) it is necessary to take into account the cost of their liquidation.

It should be noted that in the process of solving the problem in the system of constraints, ie in the first and second inequalities of expression may arise inconsistencies: for example, the design capacity of the enterprise may not meet the high requirements for post-warranty service. There are two ways to get out of this situation:

1) search for new opportunities to increase the capacity of the enterprise (for example, through additional funding);

2) predetermining a certain level of satisfaction of service requirements. To do this, make appropriate changes to the right side of the constraint system (inequalities) $\left(\sum_{i,j}^{m,n} B_{ijr};\ \sum_{i,j}^{m,n} M_{ijp} \right)$ and the problem is solved again.

Thus, the optimal solution of the problem can be found on the basis of step-by-step iteration. From a methodological point of view, it is expedient to implement this issue in the dialogue mode of the CIS-PC. In this case, it is necessary to include in the dialog mode various utilities that provide solutions (for example, on the basis of contrast analysis) and facilitate the search for the optimal solution for CCS (Figure).

The principles of organizing such dialogue systems are discussed in detail in the work of N. Egorova on the compatibility of planned solutions using simulation systems.

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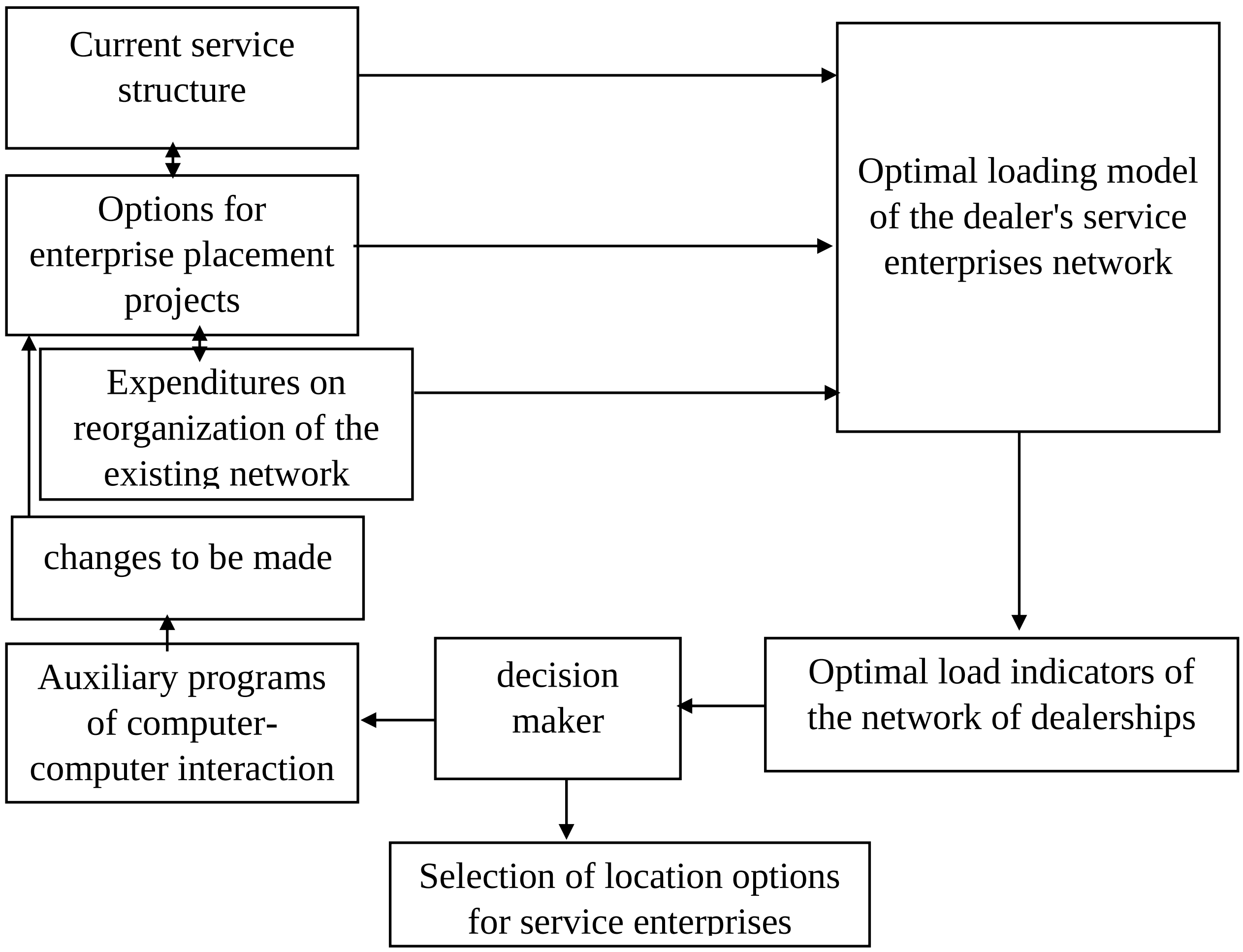

Scheme of the model of selection of placement options of the network of dealerships providing FTS

There are other options of optimal models used in the placement of dealer points (DP). The most common of these is the description of objects using a set of possible location options using zero variables. If the point under study enters the optimal plan, the value of the variable will be 1, if not, it will be 0. However, such models are more complex and require special training and additional research.

The advantage of the model is the simplicity of its numerical implementation and the possibility of testing many options for the optimal placement of DPs due to the direct involvement of the CC in this process. Using a geographic map of a particular area, the CAA can take into account social and environmental factors that are difficult to formalize in the selection and analysis of options, and sometimes even make the necessary changes to the initial project package.

The solution to the problem is the numerical values of the parameters that represent the effect of DP's activity on rendering FTS to machines. Such parameters include:

$\tilde{x}_{ijpr}$ - optimal solution of the problem (optimal number of machines);

m_{ijp} - Specific income from the provision of services to the car at point P;

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$t_{й}$ - time spent by the customer to load the defective vehicle into the vehicle and bring it back to the DP after repair (time spent on reaching and returning the defective machine to the DP) or time spent by the DP mobile workshop to return to the defective vehicle from the DP;

T_x - the average time spent waiting for the next car to be serviced;

t_y - average value of time spent on servicing one defective machine (demand);

$\tilde{t}_{ijpr}$ - the cost of transportation (delivery) of a defective car by the customer.

t_y -the value of the parameter is limited by the minimum condition of downtime of the serviced machine. Average service time for faulty machines in the DP zone [1]:

$$\bar{t}_y = \frac{\sum_{K=1}^{m} t_{yK}}{m}, \quad (1.2)$$

where m is the number of faulty machines serviced $K = \overline{1,m}$; t_{yK} - K is the average value of time spent servicing a numbered faulty machine.

1-for example. DP's mobile workshop showed FTS to m = 5 Dominator-130 grain harvesters per day, and it took $t_{y1} = 2$ hours, $t_{y2} = 3$ hours, $t_{y3} = 1$ hours, $t_{y4} = 3$ hours, and $t_{y5} = 1$ hours, respectively. So, the average time spent servicing 5 faulty combines:

$$\bar{t}_y = \frac{\sum_{K=1}^{5} t_{yK}}{5} = \frac{t_{y1} + t_{y2} + t_{y3} + t_{y4} + t_{y5}}{5} = \frac{2+3+1+3+1}{5} = \frac{10}{5} = 2 \ hours.$$

The average service time ($\bar{t}_y$) within DP performance indicators has a direct impact on service quality and the volume of demand for FTS. In particular, the efficiency of car maintenance and troubleshooting depends on the value of the average customer service time, ie the time the machine is under service.

The level of dealer work quality can be assessed by the I_v index, which depends on the rational placement of dealer points among customers (customers) and represents a reduction in time lost by the customer:

$$I_в = 1 - \frac{\bar{t}_{yp}}{\bar{t}_{ya}}, \quad (1.3)$$

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Where $\bar{t}_{yp}$ - the average service time of defective machines by dealerships rationally placed among customers;

$\bar{t}_{ya}$ - average service time for defective machines by existing dealerships.

Example 2. Achieved due to the rational placement of dealer points in the existing dealer points. According to (1.3), the reduction index of time lost by the customer is: I_v = 1 - 2/4 = 1 - 0.5 = 0.5 or 50%. when I_v = 1 - 3/4 = 1 - 0.75 = 0.25 or 25%.

It should be noted that the current demand for FTS rendering of machines located in the r region and differentiated by types B_{ijr} of services j and types is one of the important elements of the studied model (1.1). This requirement is predicted by many factors, such as the type and duration of agricultural and livestock work in a particular area, the number of machines used in this work, technical condition and distribution in the region, the financial capacity of agricultural producers to purchase new machines.

The location factor of the DP must always be taken into account in the calculations performed. The point should be located in such a way that the requirements for the provision of FTS to the cars sold in the warranty period are met with a minimum of time and money. In turn, in solving the problem of determining the location of the DP, it is necessary to take into account which of them customers prefer when choosing such enterprises. Because in practice, a customer in one area can be satisfied in another way - DP located in the neighboring area.

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