# 10. OPTIMIZATION OF AUTOSERVICE ENTERPRISES ACTIVITY BASED ON THE CURRENT STATE INDICATORS

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A functional model of monitoring the performance of autoservice enterprises for optimization their activity by standard IDEF0 was developed and a mathematical dependence for the calculation of current state enterprise indicators was obtained. Approbation of the proposed methodology was carried out on the basis of autoservice enterprises in Cherkassy. A discrepancy between the actual and normative current state enterprise indicators was detected by this model and the direction of their restructuring was identified. In the framework of the restructuring, the stages of the algorithm for selecting the optimal organization form of enterprise are proposed.

## INTRODUCTION

An enterprise of any branch of production, including an autoservice enterprise (ASE), is a complex multifunctional system, a comprehensive description of which is quite a serious task. The necessity for such a description arises in connection with the restructuring of enterprises, especially in the context of the establishment and implementation of quality management systems. Periodic restructuring of the ASE takes place in two main directions: the development of the offered services and a comprehensive restructuring of the ASE, which is based on a project of innovation. The development of the innovation project consists of five stages: the choice of innovation composition; development of the project of restructuring of the organizational structure; development of a project for the modernization of the infrastructure of the enterprise (buildings and structures, equipment, equipment, etc.); development of technology upgrade project; development of a retraining and reshuffling project [1].

The periodic implementation of the restructuring allows to update the production-technological characteristics of its activities, to increase the level of personnel qualification, which ensures the ability of the automotive industry to maintain its competitiveness in the market.

## ANALYSIS OF LAST RESEARCHES AND PUBLICATIONS

In international practice, recently widespread use acquires the terminology of international standards for the establishment of quality management systems in the

series ISO 9000 [2]. Such systems is recommended to build on the basis of the use of the Deming Cycle [3], that contains the following operators of process management in the organization: planning of the object of management (OM), operation of the OM (execution of the planned work), verification (control) of the results of the OM and adjustments (taking measures to eliminate the causes of deviations from the intended result). The authors [4] built diagrams and provided a detailed description of the business processes of planning the activity of the ASE and its functioning, as well as the operators of verification and adjustment only as a list of subprocesses of the macro process "Managing the activities of the enterprise".

In the work [1] considered the structure of the process control system at the industrial enterprise is considered. In particular, the components of the Deming Cycle. In [1] a functional model is constructed that illustrates three iterations of the enterprise life cycle: enterprise operation, continuous technical and financial audit of the state of the enterprise and periodic restructuring of the enterprise. This model is with a feedback. The results of restructuring come in the input of the first iteration, changing the characteristics of the enterprise and ensuring its ability to adapt to changes in the functioning environment. The system of analyzing the status of the OM responds to the second and third operators of the Deming Cycle. The Operator of Control contains the following business processes: "Control of the results of the OM activity", "Analysis of the results of the control of the OM activity", "Detection of inconsistencies" and "Decision-making about the realization of managerial influence".

In [5] are constructed models of data flows for planning processes of activity and operation of subsystems of ASE. Descriptions of the standards of structural modeling and functional models of enterprises of various industries are devoted to work [1, 4-8]. The authors [9] proposed a functional model for choosing the form of organization of ASE.

## PARTS OF GENERAL PROBLEM, WHICH WEREN'T SOLVED BEFORE

In modern conditions of market of autoservice services, the work of car service enterprises should be aimed at the most complete satisfaction of consumers by providing various quality services to ensure the functioning of vehicles. This task can be accomplished by establishing in the enterprise the development mechanisms that would ensure continuous improvement of the quality of the whole activity of the enterprise or its individual components in accordance with the ISO 9000 quality standard methodology. Achievement of this goal can be accomplished by developing and implementing methodologies for optimizing the activity of autoservice enterprises.

Recently, a lot of publications appeared that contained structural models developed by the authors reflecting various aspects of the functioning of the ASE, but despite this, the construction of the model for checking the functioning of the ASE, the development of the functional model [9] and the implementation of these models remains relevant.

The object of research is the business processes of the operation of the motor transport enterprise and the means of their optimization.

The purpose of the article: the study of ways to optimize the functioning of the ASE on the basis of a functional model of the business process of controlling its activities.

To achieve this goal, the following tasks were solved:

– An analysis of the business process structure that corresponds to the Deming Cycle audit and adjustment operators for the ASE,
– Development of the algorithm used in adjusting the work of the ASE.

## PRESENTATION OF THE MAIN RESEARCH MATERIALS

The overall ACE activity management is carried out in accordance with the requirements of the operating environment, investor expectations, consumers demands and parameters of the status indicators of ASE. Thus, before starting the restructuring, all stages of the analysis of the current state of the NGN, in particular, control over the results of its work (Fig. 1) and state indicators, should be carried out.

Within the functional model, the following terms are used: NTTD – normative and technical and technological documentation; RE – planned repair of technological equipment; TC – technological cards; MaR – maintenance and repair of vehicles; PS – production sites; MS – metrological support; SP – spare parts; OS - organizational structure; PP – production process.

The current state of the ASE is described using the following vector:

$$Rv = \{S, Q, P, D, M, W, T, Csel, Fenv\},$$

the elements of which are the outputs of the relevant business processes and serve as state parameters. Characteristics and weights of the state parameters are given in the table. 1. Weights are determined using the expert estimation method. As experts, employees of PJSC "Cherkasy-Avto", which is a structural unit of the leader of the automobile market of Ukraine - "UKRAVTO" corporation, were involved. PJSC "CHERKASSY-AUTO" provides a complete cycle of car service. The values of all parameters are within the interval [0, 1]. Parameters S, Q, P are expressed in normalized form and are calculated as the ratio of actual values to the normative, respectively. The method of calculating the normative values of S, Q, P and determination of other parameters of the state is given in [10].

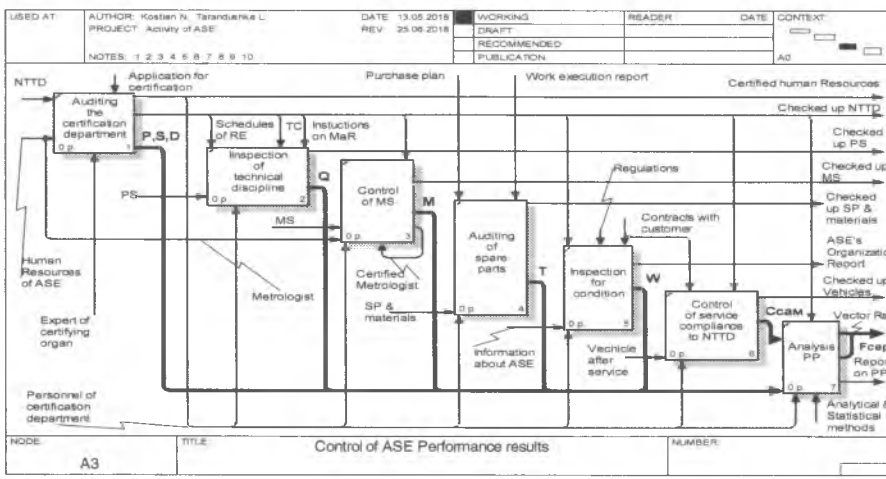



Fig. 1. Functional model of business process «Control of ASE perfomance results» by standard IDEF0

Table 1. Parameters of current state of ASE

| Marking | Weight *Vi* | Characteristic |
|---|---|---|
| *S* | 0,2 | provision of production with areas |
| *Q* | 0,1 | provision of production with equipment |
| *P* | 0,2 | provision of production with personnel |
| *D* | * | provision of production with necessary documentation |
| *M* | 0,03 | availability of necessary metrological support |
| *W* | 0,1 | Provision of production with material resources |
| *T* | 0,07 | completeness of services |
| Ссам | 0,1 | self-esteem |
| *F*сер | 0,2 | parameter of the production environment |

* - within the scope of this study was not taken into account due to the availability of a complete package of normative and technical and technological documentation.

Weight of balance state parameters indicate their importance in comparison with others.

Analysis of the results of control the operation of the ASE and the detection of inconsistencies is carrying out on base of the following expression:

$$E(R\text{в}) = \max_i E_i(R\text{в}) = \max_i \left[ \frac{V_i}{R\text{в}_i} \right]; i = 1,...,n \qquad (1)$$

where :

$E(R\text{в})$ – estimation of the vector of the current state of ASE;

$E_i(R\text{в})$ – *i-th* indicator of the current state of ASE;

$V_i$ – the weight of *i*-th parameter of state;

$R\text{в}_i$ – the value of the i-th parameter of state;

$n$ – number of parameters.

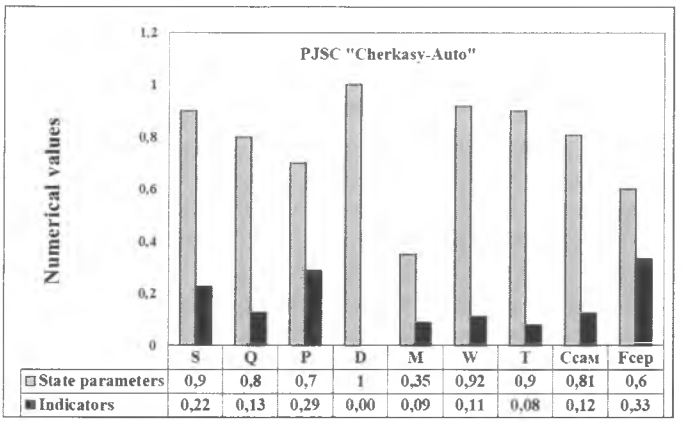
In the numerator (1), are replaced the weights of the parameters of the state of the ASE, which are maximized, and in the denominator, are their values that minimized. The priority will be to improve the activity of the ASE in the direction of the parameter that gives the maximum value of the indicator.

Two companies from Cherkassy were selected for approbation of the proposed methodology: PJSC "Cherkasy-Auto" and SS "Anto-Auto-Service" specializing in servicing cars of the Lexus and Toyota brands. In fig. 2, 3 show the results of approbation.

For SS "Ant-Auto-Service" priority is the development of a program of training for staff, and for PJSC "Cherkassy-AUTO" – restructuring by changing the form of organization of the enterprise.

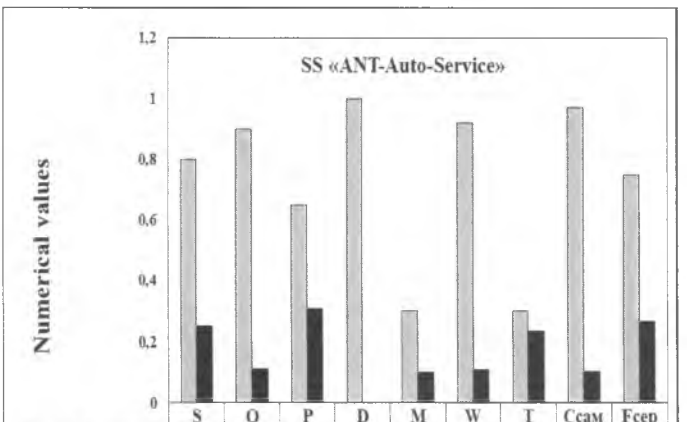
The business processes required to select the optimal form of organization described by the authors in [9]. The notation is introduced: $H=\{h_j\}$ – the set of executable services, on the ASE; $B=\{b_k\}$ – the set of forms of organizing maintenance and repairs, $k=1...4$; $U=\{u_i\}$ - the set of possible regions (places of location), where the auto-service enterprise can be located: $u_1$ – the capital; $u_2$– district center,$u_3$ – regional center;$u_4$ – outside the city.

The Commission of experts from PJSC "CHERKASSY-AUTO" has selected four types of services that are most often performed at the enterprise: $h_1$ –- diagnostics of vehicles state; $h_2$ – technical maintenance of vehicles; $h_3$ – current repair of vehicles; $h_4$ – re-equipment of vehicles. Four forms of enterprise organization were analyzed. $b_1$ is typical; $b_2$ – complex; – operational-post; $b_4$ – aggregate-zonal. With, the forms of organization$b_1$, $b_2$– are used for technical diagnosis of the state of cars $h_1$ and car maintenance $h_2$, and, $b_3$ $b_4$– for the current repair of cars $h_3$ and the re-equipment of cars $h_4$.




| | S | Q | P | D | M | W | T | Ссам | Fсер |
|---|---|---|---|---|---|---|---|---|---|
| State parameters | 0,9 | 0,8 | 0,7 | 1 | 0,35 | 0,92 | 0,9 | 0,81 | 0,6 |
| Indicators | 0,22 | 0,13 | 0,29 | 0,00 | 0,09 | 0,11 | 0,08 | 0,12 | 0,33 |

Fig. 2. Results of evaluation of the current state of PJSC "Cherkasy-Auto"




| | S | Q | P | D | M | W | T | Ссам | Fсер |
|---|---|---|---|---|---|---|---|---|---|
| State parameters | 0,8 | 0,9 | 0,65 | 1 | 0,3 | 0,92 | 0,3 | 0,97 | 0,75 |
| Indicators | 0,25 | 0,11 | 0,31 | 0,00 | 0,10 | 0,11 | 0,23 | 0,10 | 0,27 |

Fig. 3. Results of evaluation of the current state of SS "Ant-Auto-Service"

The choice of the optimal form for organizing the work of an auto-service enterprise is based on the following three vector estimates using Analytic Hierarchy Process (AHP) [11] and scale of relative importance (Table 2):

- evaluation of the proposed ASE services, taking into account production criteria,

- assessment of the needs of consumers in services, taking into account the location of the ASE,
- assessment of the quality of service delivery taking into account the existing forms of organization of ASE.

Table 2. Scale of relative importance

| Level of relative importance | Quantitative value |
|---|---|
| Equal importance | 1 |
| Moderate advantage | 3 |
| Significant or strong advantage | 5 |
| Significant big advantage | 7 |
| Very great advantage | 9 |

Levels of relative importance are given in numerical values. The algorithm for calculating the weighting coefficients of the evaluation criteria and the elements of the vector for each assessment is given by the authors in [12]. The algorithm foresees the challenge of a subprogram of verifying the validity of primary expert data in accordance with the method described in [13]. On the basis of each assessment, integral estimates of the attractiveness of the offered services ($P_j$), their consumer quality index ($S_{ij}$) and the quality of the performed work at the enterprises with the corresponding form of organization ($Q_k$), respectively, are formed, respectively.

At the next stage, a 3-partite graph G=($V_1$, $V_2$, $V_3$, E is constructed. The vertices of the first set correspond to the possible locations of the ASE U={$u_i$}, the second – to some element of the set of most frequently performed services H={$h_j$}; third – to form of production organization B={$b_k$}. The set of all edges connecting the vertices of the first and second set $w1_{ij}$=($v_i$ $v_j$)=$S_{ij}$, i=1,4, j=5,8, is defined as the set of all admissible pairs "zone location service ". Edge that are simultaneously incident to the vertices of the second and third lobes – $w2_{ij}$=($v_j$ $v_k$)=$R_{jk}$, j=1,4, k=9,12, correspond to the pairs "service-form of enterprise organization. You need to find a chain in the graph for which

$$S_{ij} * R_{jk} \rightarrow max$$

We create a new graph

$$G' = (V', E')$$

(Fig. 4), in which

$$V' = \{V_1, V_2, V_3, v_{start}, v_{finish}\}$$

$$E' = \{E, (v_{start}, v_i), (v_k, v_{finish}): i = \overline{1,4}, k = \overline{9,12}\}$$

Applying instead of weighting coefficients of the edges of the graph $w1$ and $w2$, the values -log$\omega 1_{ij}$ and -log$\omega_{jk}$ received problem of the minimization, which made it possible to apply the algorithm for finding the shortest path in the graph.

The implementation of the corresponding functional model and the proposed algorithm is carried out in the visual development environment of Delphi 7.0 software applications, which supports the concept of object - oriented programming.

The developed program complex defined the shortest path L in the graph G', consisting of the following edges:

$$L: (v_{start}, v_1), (v_1, v_5), (v_5, v_9), (v_9, v_{finish})$$

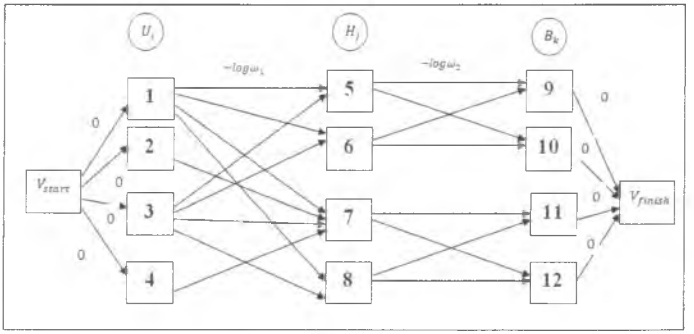



Fig. 4. Convert the initial problem of maximizing the minimization problem

Structural units, which meet the following characteristics for the corporation "UKRAVTO" will be most effective: place of location is $v_1$ – the capital; priority service is $v_5$– diagnostics of vehicles state; form of enterprise organization is $v_9$ – typical.

For its Cherkasy structural unit it was given a place of location – the regional center (vertex of the graph $v_2$ ). The shortest path that passes through $v_2$ is obtained. It is L:

$$(v_{start}, v_2), (v_2, v_7), (v_7, v_{11}), (v_{11}, v_{finish})$$

Priority service is $v_7$ – current repair of vehicles, optimal form of enterprise organization is $v_{11}$ – operational–post.

The developed program complex determined the optimal form of PJSC "CHERKASSY–AUTO" organization – operational–post.

## CONCLUSIONS

The results of the study showed that the developed model is capable of optimizing the work of the autoservice enterprise. This model has nine indicators of the required indicators, which reflect the current state of the enterprise, which in turn, allows us to determine the direction of further restructuring of service enterprises.

Two enterprises of the city of Cherkassy were selected for approbation of the proposed methodology: specializing in servicing cars. The results of the study showed that the optimal form of organization for PJSC "Cherkassy–Auto" is operational post, as the most frequently performed service at the PJC is expected to carry out repairs, and the priority for the reorganization of the SS "An–Auto–Service" is to develop and implement the project in relation to retraining and reshuffling. In the process of approbation it was confirmed that the model is effective in terms of computer realization.

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## OPTYMALIZACJA DZIAŁAŃ PRZEDSIĘBIORSTW Z SEKTORA USŁUG SAMOCHODOWYCH W OPARCIU O BIEŻĄCE WSKAŹNIKI STANU

Streszczenie

Opracowano funkcjonalny model monitorowania wydajności przedsiębiorstw z sektora usług samochodowych w celu optymalizacji ich działalności według standardu IDEF0 i uzyskano matematyczną zależność do obliczenia bieżących wskaźników stanu przedsiębiorstw. Aprobacja proponowanej metodologii została przeprowadzona na bazie przedsiębiorstw zajmujących się usługami auto-service w Czerkasach. W tym modelu wykryto rozbieżność między rzeczywistymi a normatywnymi wskaźnikami przedsiębiorstw w obecnym stanie i zidentyfikowano kierunek ich restrukturyzacji. W ramach restrukturyzacji zaproponowano etapy algorytmu wyboru optymalnej formy organizacji przedsiębiorstwa.