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THE INTEGRAL ESTIMATION METHODOLOGY OF MOTOR TRANSPORT ENTERPRISES' SUBSYSTEMS IN DETERMINING THE DEVELOPMENT STRATEGIES THROUGH TRANSFORMATION

BY

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Abstract: The paper considers the issue of the determination of evaluation factors for subsystem efficiency, choosing the reference values, and the calculation of the relative index in determining the strategies of the development of the automobile transport enterprises through transformation.

Keywords: estimated features; reference values; strategy.

1. Introduction

In the market economy practice, there is being often used a method for comparison of the activity of an enterprises with competitors, since each of them is committed to be better by all aspects and more attractive for the final products' consumers. This method should be used in determining the strategies of motor transport enterprises through a transformation, because comparing their own performance factors with the indexes of companies-competitors can detect deviations and develop a strategy for transformational change.

Some elements of the reference comparison method have been developed in the USSR concerning the issues of comparative analysis of

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product quality. This is reflected in the works of the leading experts on quality management E. Deming, F. Crosby, K. Ishikawa. Methodology for comparing acquired scientific features in the late 1980s, in the writings of R. Kemp, G. Watson, M. Zairi, H.J. Harrington, J. Shotmiller and others. Among modern scientists T.G. Golubeva, I.P. Danilov, D.V. Maslov, E. Mikhailova, N.G. Mikhailova, E. A. Bilokorovina should be mentioned [1].

However, nowadays, virtually no works are devoted to the definition of the reference indicators for modeling transformation processes in the motor transport sphere.

2. Problem Statement

In determining the most efficient development strategies for the motor transport enterprise from the positions of system approach, it is relevant to divide it into the following subsystems: structural, organizational, functional, managerial [2]. A search for strategies and the directions of enterprise functioning improving is suggested to conduct within each of the subsystems based on the comparison of the enterprise's subsystems performance factors, which are analyzed with standard parameters. This paper suggests to determine the reference values subsystems' estimated performance on the basis of analysis of really market functioning motor transport enterprises.

In determining these indicators it is suggested to use parametric methods of analysis and ranking score. These methods nowadays are becoming more common for comparing the performance of several enterprises.

Parametric analysis will be used to determine the set of parameters that characterize each of the subsystems.

Rating score shall be used to determine the numerical values of the reference indicators.

The objective of this paper is to develop integrated (complex) methods which evaluates the effectiveness of structural, functional, organizational and management subsystems and to determine the most effective strategy for motor transport enterprise's subsystems on its basis.

3. The Main Part

This method aims to prepare information for making the management decisions about the choice of the lagging subsystems and designing the developing strategies through the transformation of selected subsystems of ATE.

The basis of the suggested integral methodology is a solution of multi-objective problem, related to the procedure of formation of the generalized function $F_i\ (a_{i1}, a_{i2}...a_{in})$, which is monotonically dependent on the criteria $a_{i1}, a_{i2}...a_{in}$.

This procedure is called the folding criteria method (additive optimization method).

A mathematical model of the additive optimization method looks as follows:

$$F_i(a_{ij}) = \sum_{j=1}^{J} \lambda_j \cdot a_{ij} \qquad (1)$$

where: λ_j coefficients of importance, which quantitatively determine the importance of the *j*-th criterion in comparison with other criteria; a_{ij}- are the optimization criteria.

The economic meaning of this formula is that one of the a_{ij} criteria has weight factor that characterizes its importance. The system weight coefficients is compiled the way that $\sum_{j=1}^{J} \lambda_j = 1$.

To determine the a_{ij} criteria there shall be used the methods of complex multidimensional comparative estimates based on the method of distances which allows to takes into account the absolute values of subsystems' performance as well as their proximity or distance degree to standard subsystems' indicators (reference virtual enterprise).

The a_{ij} criteria are the relative magnitudes, *i.e.* the particles of subsystems' efficiency indicators appropriately attributed to the standard subsystems' efficiency indicators and are calculated by

$$a_{ij} = \frac{x_{ij}^{\text{в}}}{x_{ij}^{e}} \qquad (2)$$

where: $x_{ij}^{\text{в}}$ is the reported value of the *i*-th indicator in the *j*-th subsystem on the under research enterprise, x_{ij}^{e} is the reference value of the *i*-th indicator in the *j*-th subsystem, it may be maximal, minimal or normative.

The methodology of integral estimation of ATE subsystems provides for the consistent performance of the following stages:

The first stage is the formation of the estimated figures (performance indicators) set within all ATE subsystems and their calculation.

Основними вимогами до оціночних показників є:

The main requirements for the estimated figures (performance indicators) are:

a) unity, necessity and numerical limitations of indicators for particular subsystems;

b) the ability to aggregate, disaggregate and to be comparable;

c) definiteness, the ease of calculation and readily available information access about them;

d) overall system of indicators should provide for a complex characteristic of all the subsystems' aspects;

e) даний набір показників повинен бути найбільш вагомим як з точки зору автотранспортних підприємств так і з точки зору задоволення інтересів кінцевих споживачів транспортних послуг.

f) the given set of performance indicator has to be the most important from the point of view of motor transport enterprises, satisfying at the same time the final consumers' interests of transport services.

A set of performance indicators within all ATE subsystems is described in details in [3].

The second stage is the formation of matrix of output data for each Y_{ij} (i – number of indicator, j – number of subsystem) indicator of the j-th subsystem (structural, functional and organizational) which characterize them.

The matrix elements value depends on the rolling stock (k), company number (n), type parameter (s), subsystem number (j).

$$Y_{ij} = \begin{bmatrix} a_{11ij} & a_{12ij} & \dots & a_{1kij} \\ a_{21ij} & a_{22ij} & \dots & a_{2kij} \\ \dots & \dots & \dots & \dots \\ a_{n1ij} & a_{n2ij} & \dots & a_{nkij} \end{bmatrix}$$

These matrixes include different values of their original values, so the ATE subsystems must be normalized (reduced) to the standard interval in order to get their integral estimation.

In the third stage, each k-th column of the matrix (Y_{ij}) determines by the maximum (reference) item's value (max a_{nkij}). Then all the elements of the k-th columns are divided by the maximum value of the corresponding column. As a result we get the U_{ij} matrixes of the standardized coefficients

$$u_{nkij} = a_{nkij} / \max a_{nkij} \tag{3}$$

$$U_{ij} = \begin{bmatrix} u_{11ij} & u_{12ij} & \dots & u_{1kij} \\ u_{21ij} & u_{22ij} & \dots & u_{2kij} \\ \dots & \dots & \dots & \dots \\ u_{n1ij} & u_{n2ij} & \dots & u_{nkij} \end{bmatrix}$$

As a result of normalization of the performance indicators' set, their values range from 0 to 1.

It is worth noting that increasing the number of indicators inevitably raises the question of determining their significance.

Therefore, *the fourth stage,* in order to determine the *k*-th rolling stock's weighting coefficient for the particular motor transport enterprise which influences the proper *i*-th indicator of the *j*-th subsystem on the *n*-th enterprise we'll apply weight components matrix B_{ij}.

The determination of the B_{ij} matrix's coefficient is performed in the expert way, which algorithm is shown in Fig. 1.

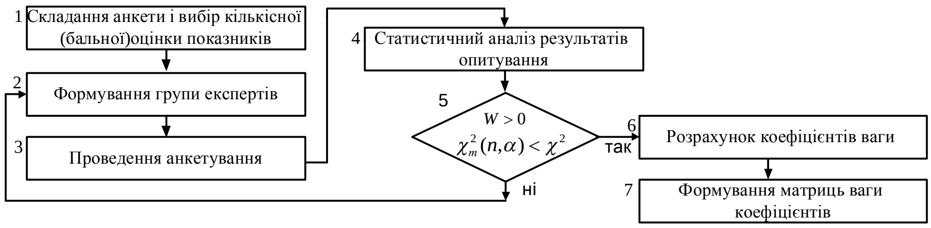

Fig. 1 – Expert estimation algorithm.

As the result of calculation of significance level coefficients generated by the suggested method, there shall be formed the weight coefficient matrix

$$B_{ij} = \begin{bmatrix} b_{11ij} & b_{12ij} & \dots & b_{1kij} \\ b_{21ij} & b_{22ij} & \dots & b_{2kij} \\ \dots & \dots & \dots & \dots \\ b_{n1ij} & b_{n2ij} & \dots & b_{nkij} \end{bmatrix}$$

At the fifth stage, taking into account the importance of *k*-th rolling stock group for the *n*-th motor transport enterprise, which affects each *i*-th indincator of the *j*-th subsystem we get matrix

$$P_{ij} = \begin{bmatrix} p_{11ij} & p_{12ij} & \cdots & p_{1kij} \\ p_{21ij} & p_{22ij} & \cdots & p_{2kij} \\ \cdots & \cdots & \cdots & \cdots \\ p_{n1ij} & p_{n2ij} & \cdots & p_{nkij} \end{bmatrix}.$$

The value of the P_{ij} matrix elements is obtained by multiplying the corresponding matrix elements U_{ij} on the corresponding matrix elements B_{ij} following the formula:

$$p_{nkij} = u_{nkij} b_{nkij}. \tag{4}$$

On the sixth stage. on the basis of the P_{ij} matrix we create a generalized values matrix $P_j^{узаг}$ of the *j*-th subsystems for *i*-th indicators on the *n*-th enterprises

$$P_j^{узаг} = \begin{bmatrix} p_{11j}^y & p_{12j}^y & \cdots & p_{1ij}^y \\ p_{21j}^y & p_{22j}^y & \cdots & p_{2ij}^y \\ \cdots & \cdots & \cdots & \cdots \\ p_{n1j}^y & p_{n2j}^y & \cdots & p_{nij}^y \end{bmatrix}.$$

The matrixes $P_j^{узаг}$ elements' p_{nij}^y values are defined as the sum of the *k*-th components of the motor transport enterprise, which affect the *i*-th indicator in the *j*-th subsystem

$$p_{nij}^y = \sum_{k=1}^{z} p_{nkij} , \tag{5}$$

where: *z* a number of the rolling stock groups.

When considering the management of transformation we start off with the this phase because *i*-th efficiency indexes of management do not depend on the weight of the *k*-th rolling stock group for the *n*-th motor company . For getting a matrix of administration transformation similar to the matrix $P_j^{узаг}$, first you must create a one of output data for managerial transformation , and then find the maximum value of all the items in each *i*-th column and divide the corresponding column by their respective maximum values. As a result, we obtain the transformation matrix $P_j^{узаг}$ for management transformation, that leads to the new notion of the *j*-th subsystem being understood as structural, functional , organizational and managerial .

On the seventh stage, there must be used the matrix of the indicators weight V_j, to determine the effect of each i-th parameter on the corresponding *j*-th subsystem to apply weight matrix indices.

Determination of matrix coefficient V_j is carried out in the expert way. The algorithm of undertaking the expert evaluation is similar to the performed one at the fourth stage.

Consequently, we can built matrix coefficients of weight V_j , after making the calculations following the mentioned-above method

$$V_j = \begin{bmatrix} v_{11j} & v_{12j} & \dots & v_{1ij} \\ v_{21j} & v_{22j} & \dots & v_{2ij} \\ \dots & \dots & \dots & \dots \\ v_{n1j} & v_{n2j} & \dots & v_{nij} \end{bmatrix}$$

The eighth stage is to build the matrix of $W_{рез}$ results considering the value of the i-th index for estimating the j-th subsystem;

$$W_{рез} = \begin{bmatrix} w_{11}^{рез} & w_{12}^{рез} & \dots & w_{1j}^{рез} \\ w_{21}^{рез} & w_{22}^{рез} & \dots & w_{2j}^{рез} \\ \dots & \dots & \dots & \dots \\ w_{n1}^{рез} & w_{n2}^{рез} & \dots & w_{nj}^{рез} \end{bmatrix}$$

The value of elements $w_{nj}^{рез}$ in $W_{рез}$ matrix are found as a sum of the *i*-th indexes regarding to the *j*-th subsystem for *n*-th enterprise

$$w_{nj}^{рез} = \sum_{i=1}^{d} (p_{nij}^{y} \cdot v_{ij}) , \qquad (6)$$

where d - a number of the characterizing indexes.

Дану матрицю значень $W_{рез}$ можна представити у вигляді таблиці 1

The matrix of $W_{рез}$ values may be presented as Table 1

Table 1
Integral Indexes of Subsystems' Efficiency

Enterprise	Structural	Functional	Organization	Managerial
1	$w_{11}^{рез}$	$w_{12}^{рез}$	$w_{13}^{рез}$	$w_{14}^{рез}$
…	…	…	…	…
n	$w_{n1}^{рез}$	$w_{n2}^{рез}$	$w_{n3}^{рез}$	$w_{nj}^{рез}$

Relative integral indexes of subsystems efficiency are calculated as follows:

$$W_{\text{від.j}} = \frac{W^{рез}_{дosл.j}}{W^{рез}_{\max j}} \quad (7)$$

where: $W^{рез}_{досл.j}$ – the integral index of the j-th subsystem efficiency relating to the under research enterprise; $W^{рез}_{\max j}$ – the maximum value of the integrated index efficiency in the j-th subsystem among the competing users.

Let's assign such values as: structural $S_{ei\delta}$, functional $F_{ei\delta}$, organizational $Q_{ei\delta}$, managerial $Y_{ei\delta}$, to outline the calculated values of the relative integrated indexes with regard to subsystems efficiency .

This technique allows to determine how each subsystem of the researched enterprise differs from the similar subsystems examining the competing users. The closer the calculated value of the relative integrated efficiency indicator to 1, the better the state of the researched ATE subsystem in comparison with competing users subsystems and vice versa.

For easy and fast assessment of the subsystems it is necessary to develop an assessment scale:

$0.7 < W_{ei\delta.j} < 1$ – a good state of the subsystem and if the external environment is stable, the company then will not require transformation changes in this direction;

$0.35 < W_{ei\delta.j} < 0.7$ – an average state of the subsystem – it is necessary to conduct transformation changes;

$0 < W_{ei\delta.j} < 0.35$ – a poor state of the subsystem that hereby requires immediate responses.

For the verification of the developed method, there had been selected a real public company "Vinnitsa Transport Enterprise 10554" as the object of the research

The main activity of the public company "Vinnitsa Transport Enterprise 10,554" is to render services for freight transportation throughout the city, long-distance routes and international goods transportation.

The main competitors a public company "Vinnitsa ATE 10554" in the transportation of goods are: including "Trans Nazareth" Limited Liability Company , private enterprise "Berkut-trans", Vinnitsa ATE," "Trans - Legion Ukraine", Private enterprise " Ukrtrans Vinnytsia"".

Software is used [4] to speed up the calculation while determining the lagging behind subsystems by the method of integral evaluation.

The results of the computer simulation of structural, functional, organizational and management subsystems efficiency are shown in Table 2.

Table 2
Integral Indicators of Subsystems Efficiency on Auto Transport Enterprises

Enterpise / Indicator	Public company“ Vinnitsa ATP 10554”	“Trans Nazareth” Llc	Private enterprise “Berkut-trans”	Public company “Vinnitsa ATP 0161”	“Trans-Legion kraine” Llc	Private enterprise “ Ukrtrans Vinnytsia ”
1	2	3	4	5	6	7
The efficiency of structural subsystem $S_{вiд}$	0.493	0.470	0.465	0.428	0.543	**0.878**
$, F_{вiд}$ The efficiency of functional subsystem $, F_{вiд}$	0.627	0.850	0.847	0.755	**0.949**	0.698
The efficiency of organizational subsystem $Q_{вiд}$	0.691	0.779	0.789	**0.996**	0.716	0.896
The efficiency of administration al subsystem $Y_{вiд}$	0.324	0.185	**0.359**	0.176	0.227	0.357

The reference value concerning the integrated indicators of subsystems efficiency are identified in Table with a black type.

Relative integrated indexes of the studied enterprise subsystems performance in comparison with the corresponding reference values equal to $S_{вiд}$ $\approx$ 0,562, $F_{â³ä}$ $\approx$ 0,661, $Q_{вiд}$ $\approx$ 0,694, $Y_{вiд}$ $\approx$ 0,903 respectively.

Analyzing the calculated values , we make a conclusion that the structural , functional and organizational subsystem of the public company" Vinnitsa Auto transport Enterprise 10554 " needs transformation changes, because their corresponding integrated indices of efficiency are of smaller value than 0.7. According to the management subsystem, its relative integral index of efficiency is of higher value than 0.7 and it does not require the conduction of any transformation changes under the condition of stability.

4. Conclusions

Thus, there was put forward the method of multidimensional comparative analysis taking into account the weight of the indicator to determine the estimated indexes of subsystems efficiency , the selection of reference values and calculation of ratios while determining the highway transportation enterprises development strategies through the transformation in the working process .

Distinctive features of the integrated assessment subsystems technique are:

a) comprehensive assessment of several subsystems of a motor company;

b) the use of a wide range of indicators to measure ATE subsystems;

c) the use of expert methods;

d) lack of connection between the calculated indexes and with standard (average) criteria;

e) the possibility of building the ATE rankings on the basis of integrated assessment subsystems result;

f) the possibility of adjusting a set of indicators;

g) the possibility of considering the integrated assessment dynamics within one ATE. This technique does not depend on the units of measurement and their values.

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METODOLOGIA DE ESTIMARE INTERGRALĂ A SUBSISTEMELOR UNEI ÎNTREPRINDERI DE TRANSPORT ÎN DETERMINAREA STRATEGIILOR DE DEZVOLTARE PRIN TRANSFORMARE

(Rezumat)

Se tratează determinarea factorilor de evaluare a eficienţei subsistemelor, alegând valorile de referinţă şi calculul indicelui relativ în determinarea strategiilor dezvoltării întreprinderilor de tresport auto prin transformare.