MODERN MATHEMATICAL METHODS, MODELS AND INFORMATION TECHNOLOGIES IN ECONOMY

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THE FACTORS AFFECTING THE EFFICIENCY OF AIR TRANSPORT ANAGEMENT AND METHODOLOGY FOR DETERMINING THEIR IMPACT

The Georgian air market is a small but growing market; many important steps have been taken for its development. It was developing quite fast before the pandemic, but at this stage the big foreign airlines are no longer showing much initiative to establish themselves in Georgia. According to the recommendation of ICAO (International Civil Aviation Organization), the country should further increase the quality of flight safety, certification and control norms in order to bring its legal framework as close as possible to the criteria of internationally recognized legislation.

The successful work of airlines operating in the Georgian air market largely depends on the increase in the volume of transported passengers and cargo.

The dynamic change in the volume of transported passengers and cargo is affected by many factors, both internal and external. We used the correlation-regression analysis method to determine the relationships between them, since the relationship between the indicators and the factors acting on them does not have deterministic character [2, p. 85].

Table 1

Analytical characteristics of the volume of passengers and cargo transported from the georgian airports

Year	Number of Transported Passengers	Transported Cargo (Tons)
2015	2261006	14885
2016	2840455	34065
2017	4073959	31724
2018	5033323	25511
2019	5209505	24911

Source: [5]

This method means building an adequate model of the relationship and calculating the quantitative ratio of cause-effect relationship through it. We used the statistics from the last five years to conduct the analysis.

Table 2

Analytical characteristics of factors affecting the volume of transported passengers and cargo

№	Factors	2015	2016	2017	2018	2019
1.	GDP at current prices (billion GEL)	33,9	35,8	40,8	44,6	49,3
2.	Fixed assets in air transport and warehouses (billion GEL)	4.9	5.1	9.6	6.1	5.5
3.	Number of employees in the field of air transport (thousand people)	48,7	52,8	56,5	58,1	61,2
4.	Average monthly salary of employees in the field of air transport (GEL)	1153,2	1156,0	1240,3	1300,3	1384,7
5.	Total output of air transport (GEL billion)	3,1	3,1	3,7	4,1	4,6
6.	Foreign direct investment in the air transport sector (GEL billion)	1,38	1,37	1,21	0,52	0,15

Source: [4; 5]

During the analysis, in many cases, it is enough to consider only the influence of one factor that is interesting to us, such as the one-factor cause-effect relationship. Such a connection is called a «pair»

correlation, and its mathematical model can be represented as follows [3, p. 33]:

$$Y=f(Xi), \quad (1)$$

where Y – is a function, or result indicator (dependent variable);

Xi – is any i cause-factor (independent variable).

In our case, the number of passengers transported is Y_1 and the factors affecting it are $X_1, X_2, ..., X_6$.

Therefore, the volume of transported cargo was denoted as Y_2, and the factors acting on it are the same as in the first case.

The correlation coefficient is used to determine the density of the connection between the objective function and the factors [1, p. 122].

If its value in statistical calculations exceeds 0.5 and approaches 1, then there is a high correlation between the objective function and the factors, and in the case of a value less than 0.5 the correlation is negligible and it is no longer taken into account in subsequent calculations.

The correlation coefficient of the Y_1 function and the X_1 argument is denoted by r_1, the correlation coefficient of Y_1 and X_2 as r_2, and so on.

In general, the correlation coefficient is calculated using the following formula:

$$r = (n \cdot \sum xy - \sum x \cdot \sum y) / \sqrt{\{[n \cdot \sum x^2 - (\Sigma x)^2] \cdot [n \cdot \sum y^2 - (\sum y)^2]\}}, \quad (2)$$

where n – is the number of members in the taken set, i.e. in this case the number of years [1, p. 127].

Calculating the mentioned coefficients is usually quite labor intensive, so they are calculated in EXEL. Therefore, based on the data, we obtained the following values of the coefficients:

The correlation coefficients according to the transported passengers:

$r_1 = 0.971$; $r_2 = 0.283$; $r_3 = 0.971$; $r_4 = 0.949$; $r_5 = 0.957$; $r_6 = (-0.903)$.

The correlation coefficients according to the cargo:

$r_1 = 0.13$; $r_2 = 0.45$; $r_3 = 0.36$; $r_4 = 0.03$; $r_5 = 0.03$; $r_6 = 0.07$.

After the correlation coefficient, the magnitude of the determination coefficient must be calculated according to the following formula:

$$D = r^2. \quad (3)$$

The determination coefficients according to the transported passengers:

$D_1 = 0,943 = 94,3\%$; $D_2 = 0,08 = 8\%$; $D_3 = 0,943 = 94,3\%$; $D_4 = 0,9 = 90\%$;

$D_5 = 0,916 = 91,6\%$; $D_6 = 0,815 = 81,5\%$.

The determination coefficients according to the cargo:

$D_1 = 0,017 = 1,7\%$; $D_2 = 0,203 = 20,3\%$; $D_3 = 0,1296 = 12,96\%$;

$D_4 = 0,0009 = 0,001\%$; $D_5 = 0,0009 = 0,001\%$; $D_6 = 0,0049 = 0,05\%$.

As can be seen from the above values, the factors presented by us have different effects on the number of transported passengers and cargo by air, which requires further study.

Therefore, it is reasonable to clarify the relationship between the function and the factors acting on it.

Accordingly, the five factors have been selected that have the greatest impact on the function, in particular, the number of transported passengers. Depending on the correlation coefficients, in this case, the mathematical model will be the following:

$$Y_1 = A_2 X_2 + A_3 X_3 + A_4 X_4 + A_5 X_5 + A_6 X_6. \quad (4)$$

In order to obtain the xi coefficients, we need to compile a system of equations with the help of statistical-numerical characteristics.

Accordingly, according to the number of transported passengers, the system of equations will have the following form:

$4.9x_2 + 48.7x_3 + 1153.2x_4 + 3.1x_5 + 1.38x_6 = 2261006;$

$5.1x_2 + 52.8x_3 + 1156x_4 + 3.1x_5 + 1.37x_6 = 2840455;$

$9.6x_2 + 56.5x_3 + 1240.3x_4 + 3.7x_5 + 1.21x_6 = 4073959;$

$6.1x_2 + 58.1x_3 + 1300.3x_4 + 4.1x_5 + 0.52x_6 = 5033323;$

$5.5x_2 + 61.2x_3 + 1384.7x_4 + 4.6x_5 + 0.15x_6 = 5209505.$

The Gauss and Kramer methods are used to solve the system of linear equations, which are based on the addition of unknown coefficient matrices to the unit matrix if there are many variables.

In our case, the matrix according to the transported passengers will have the following form:

4.9 48.7 1153.2 3.1 1.38 2261006;

5.1 52.8 1156 3.1 1.37 2840455;
9.6 56.5 1240.3 3.7 1.21 4073959;
6.1 58.1 1300.3 4.1 0.52 5033323;
5.5 61.2 1384.7 4.6 0.15 5209505.

According to the studied indicators, the solutions of the system of linear equations according to the Y1 function using EXEL formulas (MINVERSE and MMULT) are as follows:

$x_2 = 864.6769881$;
$x_3 = 45.44418745$;
$x_4 = 44.17725818$;
$x_5 = (-13489.61097)$;
$x_6 = (-9649.611093)$.

Therefore, according to the mathematical model the number of transported passengers by air will be:

$$Y_1 = 864.6769881X_2 + 45.44418745X_3 + 44.17725818X_4 - 13489.61097X_5 - 9649.611093X_6,$$

where Y_1 – is the number of transported passengers;

X_2 – is he fixed assets in transport and warehouses;

X_3 – is the number of employees in the field of transport;

X_4 – is the average monthly salary of employees in the field of transport;

X_5 – is the total production of products in the field of transport;

X_6 – is the foreign direct investment in the transport sector.

The model of the number of transported passengers allows us to conclude that the number of passengers transported in civil aviation is positively affected by the first three factors (X_2, X_3, X_4).

The dynamic change in the number of transported passengers is influenced by the existing resources in the field of air transport, or the fixed assets, which increase with one million leads to the transfer of an additional 873 passengers and the second – the number of employees.

These two factors are interesting in many ways. In particular, the number of employees is a macroeconomic indicator that reflects the level of unemployment in the country and the state of economic

development, while the fixed assets indicate the need for better, more efficient use of resources in the sector.

Also, it is worth to pay attention to the fourth factor, such as the total product output of the air transport sector – the value of the condensed tons km, which by calculations has a negative impact on the number of transported passengers. Consequently, this indicates inefficiency in the use of resources and, in general, the defects in management.

The mathematical model and analysis of the objective function presented allowed us to conclude that the factors, which will contribute to the growth of these volumes must be taken into account when planning air transport volumes. Also, the attention should be paid to the negatively impacting factors, their worthy values should be measured and the specific measures should be taken to mitigate the negative effects and impacts.

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