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# Mathematical Modeling of Company Activity

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**Abstract:** The article discusses the tasks of mathematical modeling of economic processes, particularly focusing on the mathematical modeling of tourism company activities. Under given conditions, a mathematical model is constructed, an optimal solution is found, and the results are analyzed.

**Keywords:** Mathematical model, optimal solution, tourism, linear programming, objective function, constraints.

**Introduction:**

Currently, mathematical models are widely used in such fields of science as physics, chemistry, biology, as well as in technical and economic directions. Mathematical models can be divided into analytical, numerical and statistical types.

A mathematical model is a set of mathematical formulas, equations, inequalities, systems of equations, which allow to express the happening events and processes with some accuracy.

Modeling of various interactions of management organizations, producers, consumers of utility services, as well as providing services to the residential stock is complex, multi-criteria and dynamic, and it is appropriate to use mathematical methods for solving them.

Mathematical models make it possible to express connections between various processes and realities in the economy, to estimate various economic indicators in advance, and to develop strategies for managing economic objects. The relevance of modeling all economic and management processes is based on the obtained results, preliminary assessment of the development of these processes, implementation of effective management.

Today, tourism has become one of the leading sectors of the world economy. In this regard, special attention is paid to the organization of services in the field of tourism in Uzbekistan based on international standards, because our country has many world-famous pilgrimage sites, cities and corners rich in historical monuments.

Therefore, the issue of optimizing tourist plans for tourist companies is urgent.

LITERATURE ANALYSIS

A lot of research has been done on solving economic problems with the help of mathematical models. Mathematical model and general methods of application of mathematical methods in economics have been developed (construction of functional relationships, analysis and solving optimization problems at various levels) [4].

In particular, researches aimed at optimization of advertising business, tourist flow, etc. are also being carried out. In general, to optimize the activities of tourist organizations, mathematical models are built and constraints and optimality criteria are formed [1]. These models differ according to the problem: organization of family vacations, expansion of activities with the help of advertising, modeling of the placement of tourists' luggage [2]. Studying the laws of tourist flows and their optimization is another important issue [3].

**RESEARCH METHODOLOGY**

This article is focused on the issue of optimizing the work of a tourist company, which requires simultaneous variation of several group variables. A mathematical model is built based on the results of the previous season of the tourist company, and the issue of creating an optimal plan for the next season is solved. This problem is reduced to a linear programming problem and is solved by the simplex method. Of course, computer programs were used to perform such calculations.

**MAIN PART**

n- the number of domestic tourist programs (n=1,2,...), let $x_j$ be the number of tourists in domestic tourist programs conducted according to j- program (j=1,2,...n). Let $a_{ij}$- be the coefficient of soum/tourist-sized expenses for i-service in j- program, $b_i$ soum- the total expenses of a service, c- the cost of each tourist.

If the privilege given to program j is $k_j$, then the objective is a function

$$\boldsymbol{P(x) = c(k_1x_1 + k_2x_2 + \cdots + k_nx_n) \rightarrow max} \quad (1)$$

and the constraints are expressed by the following n inequalities:

$$\begin{cases} a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n \leq b_1 \\ a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n \leq b_2 \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ a_{m1}x_1 + a_{m2}x_2 + \cdots + a_{mn}x_n \leq b_m \end{cases} \quad (2)$$

$$x_j \geq 0, j = \overline{1,n} \quad (3)$$

(1)-(3) is a well-known linear programming problem [4].

Using it, it is possible to determine the number of tourists $x_j$ that can be attracted to each program in the case where the distribution of costs $b_i$ for services is known.

If a more complicated issue is the issue of optimal distribution of V expenses allocated for total tourist programs with maximum attraction of tourists, then the above issue

$$b_1 + b_2 + \cdots + b_n \leq V$$

it will be necessary to fill with limitation.

Now we can solve this problem using the MS Excel program in the computer model method.

In the process of forming a mathematical model, it is difficult to determine the numerical values of coefficients $a_{ij}$ of system (2).

If any i- condition of (2).

$$a_{i1}x_1 + a_{i2}x_2 + \cdots + a_{in}x_n \leq b_i$$

If we analyze , we see that $(\boldsymbol{b_i})$ determines the distribution of service costs among tourists of group $(\boldsymbol{x_j})$ through coefficients $a_{ij}$.

Evidently, $\boldsymbol{a_{ij}}$ coefficient j – the number of tourists in the program $\boldsymbol{l_j}$ is related to the total costs $\boldsymbol{b_i}$ of type (i) service:

$$a_{ij} = Q_{ij}\frac{b_i\ soum}{l_j\ tourist} \quad (4)$$

here, $\boldsymbol{Q_{ij}}$- (i) type of service $\boldsymbol{b_i}$ is the part of the j-program corresponding to the total cost of $\boldsymbol{b_i}$.

We will consider how the coefficient $\boldsymbol{a_{ij}}$ is determined in a particular case in the following problem.

According to this year's plan, 3 tourist groups are planned:

1 group, university students $\text{У}_\text{т}(\boldsymbol{j = 1})$;

2 groups, factory workers $\text{З}_\text{и}(\boldsymbol{j = 2})$;

3 groups, retired parents $\text{Н}_\text{о}(\boldsymbol{j = 3})$.

The tourist company's plans for this year include four tourist destinations:

Samarkand;

Bukhara;

Khiva;

Shaxrisabz.

The results of the last tourism year were as follows:

Distribution of tourists by groups:

$\text{У}_\text{т} = \boldsymbol{50}$, $\text{З}_\text{и}$=45, $\text{Н}_\text{о} = \boldsymbol{30}$.

Distribution of costs by services:

Samarkand $(\boldsymbol{b_1}) = \boldsymbol{25000000}$, Bukhara $(\boldsymbol{b_2}) = \boldsymbol{20000000}$,

Khiva $(\boldsymbol{b_3}) = \boldsymbol{30000000}$, Shaxrisabz $(\boldsymbol{b_4}) = \boldsymbol{20000000}$

Based on last year's results, it was possible to fill in the following table 1.

1 table. Classification of tourists into $(l_j)$ groups

| $i$ | City | $l_j$ (tourist) | | | | |
|---|---|---|---|---|---|---|
| | | $j = 1$ | $j = 2$ | $j = 3$ | Expenses (сўм) $b_i$ | $\sum_{j=1}^{3} l_{ij}$ (tourist) |
| 1 | Samarkand | 17 | 12 | 8 | 25000000 | 37 |
| 2 | Bukhara | 11 | 7 | 7 | 20000000 | 25 |
| 3 | Khiva | 13 | 16 | 9 | 30000000 | 38 |
| 4 | Shaxrisabz | 9 | 10 | 6 | 20000000 | 25 |

We assume that the costs of i-type services are equally distributed among all customers in i-line, then the total costs of i-type services of j-programme customers is equal to

$$Ж_{ij} = \frac{b_i}{\sum_{j=1}^{3} l_{ij}} l_{ij} \qquad (5)$$

where $l_{ij}$ is the number of tourists in the j- program who used the i- type of service.

So, according to what has been said

$$a_{ij} = \frac{Ж_{ij}}{l_j} = \frac{b_i l_{ij}}{l_j \sum_{j=1}^{3} l_{ij}} \qquad (6)$$

where $l_j$ —is the number of tourists in the j program, $\sum_{j=1}^{3} l_{ij}$ —is the number of tourists in row i, $l_{ij}$ is the number of tourists at the intersection of row i and column j.

According to formulas (4) and (6).

$$Q_{ij} = \frac{l_{ij}}{\sum_{j=1}^{3} l_{ij}}$$

The calculated values of coefficients $a_{ij}$ according to the formula (6) are presented in Table 2.

Table 2

| $i$ \ $j$ | 1 | 2 | 3 |
|---|---|---|---|
| 1 | $a_{11} = 230000$ | $a_{12} = 180000$ | $a_{13} = 180000$ |
| 2 | $a_{21} = 176000$ | $a_{22} = 124500$ | $a_{23} = 124500$ |
| 3 | $a_{31} = 205000$ | $a_{32} = 280000$ | $a_{33} = 237000$ |
| 4 | $a_{41} = 144000$ | $a_{42} = 178000$ | $a_{43} = 160000$ |

putting the found values of the coefficients $a_{ij}$ into the mathematical model under the conditions $k_1 = k_2 = 1$ and $k_3 = 0{,}93$ (1)-(3)

$$\begin{cases} 230x_1 + 180x_2 + 180x_3 \leq 25000 \\ 176x_1 + 124{,}5x_2 + 124{,}5x_3 \leq 20000 \\ 205x_1 + 280x_2 + 237x_3 \leq 30000 \\ 144x_1 + 178x_2 + 160x_3 \leq 20000 \end{cases} \qquad (7)$$

in limitations

$$P(x) = c(x_1 + x_2 + 0{,}93x_3) \rightarrow max \qquad (8)$$

we find the optimal value of $x_1, x_2, x_3$ by checking the objective function to the maximum.

RESULTS AND CONCLUSIONS

Simplex calculations in MS Excel gave the results $\boldsymbol{x_1 = 51, x_2 = 49, x_3 = 25}$. So, if the values of $\boldsymbol{x_1, x_2, x_3}$are the same as above, the net income will be the highest if tourists are attracted. If the cost of each trip is the same c in all directions, the net revenue

$$\boldsymbol{P(x) = c(k_1x_1 + k_2x_2 + k_3x_3) = c(51 + 49 + 0{,}93 \cdot 25) = 123{,}25c}$$

we will be able to calculate through

In our case, the values of the coefficients $\boldsymbol{a_{ij}}$ are appropriate for the last tourist season, and the results obtained in the next year, when the conditions have not changed, give the exact solution. Otherwise, it can be considered as a target with some degree of accuracy for the next year, and according to the obtained results, it will be necessary to adjust the values of the coefficients in the above manner.

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