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Multi-Criteria Choice of the Preferred Type of Mobile Phone by the Analytic Hierarchy Process

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Abstract — **The theoretical and practical aspects of applying the analytic hierarchy process to choose the preferred type of mobile phone based on combination technical and economic parameters of quality and expert judgment.**

Keywords — the analytic hierarchy process, mobile phone, preferred variant, quality indicators, expert.

I. INTRODUCTION

The choice the optimal means of telecommunication considering of conflicting indicators of quality determines the need for applying the methods of multi-criteria optimization. The solution of this problem is quite a complicated problem, even with mathematical standpoint. However, after its formal solutions and receipt of the subset of efficient (Pareto-optimal) variants there is a need to formalize the choice of only compromise solution considering more subjective information from experts. For these purposes different methods can be used, one of which is the analytic hierarchy process (AHP).

This article deals with the theoretical and practical aspects of application of the AHP method for the determination of the preferred type of mobile phone considering five technical and economic performance of quality and expert judgment.

II. PECULIARITIES OF CHOICE ONLY THE PREFERRED VARIANT ON THE BASIS OF THE ANALYTIC HIERARCHY PROCESS

The method of analytic hierarchy process (AHP) [1] is the decomposition of the problem of choosing only draft version of a system on the simple components and getting experts judgments paired comparisons of different elements of the problem of choice.

Decomposition principle involves structuring the problem of choice in the form of a hierarchy of levels, which is the first step in the application of the AHP method. The hierarchy problem of choice is built from the top (target selection - Level 1) through intermediate levels (indicators of quality, level 2) to the lowest level 3 (alternative construction of the system) (Figure 1).

The principle of comparative judgment of experts in the MAI is that the problem of choosing the objects are compared pairwise experts by importance. Pairwise compares the importance of the different variants of systems (level 3) and the different indicators of quality (level 2). The results of pairwise comparisons of elements are to the matrix form (1). The diagonal of the matrix is filled with "1", and the matrix elements that lie below the diagonal, are filled with the appropriate reverse values.

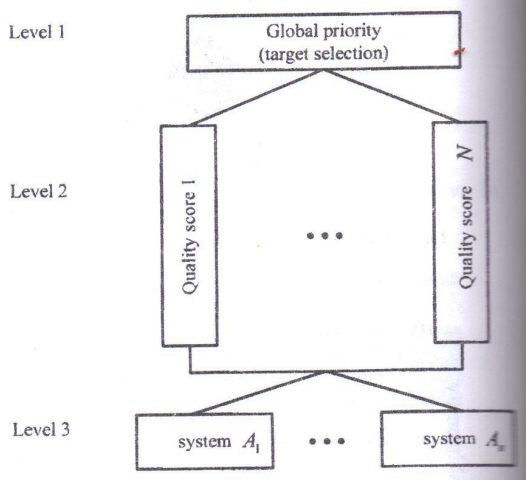

Fig. 1. Decomposition of the problem of choosing a hierarchy of levels

$$A = \begin{pmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_n} \\ \cdots & \cdots & \cdots & \cdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & \frac{w_n}{w_n} \end{pmatrix}, \quad (1)$$

where $\frac{w_i}{w_j}$ – evaluation of pairwise comparisons of elements.

Assessment elements are of pairwise comparisons using subjective judgments of experts are numerically defined on the scale of the relative importance of the elements.

Then processing is performed some paired comparisons matrix elements hierarchies at levels 2 and 3. From a mathematical point of view, these processing tasks are reduced to the calculation of the principal eigenvector, which after a certain normalization becomes a priority vector elements at an appropriate level in the hierarchy.

The main components of the eigenvector quality indicators are calculated as the geometric mean value in

the matrix of pairwise comparisons of elements at every level

$$V_i = \sqrt[n]{\prod_{k=1}^{n} \frac{w_i}{w_k}}, \quad P_i = \frac{V_i}{S}, \qquad (2)$$

where $S = \sum_{i=1}^{n} V_i$, P_i - priorities compared elements.

First, based on the matrix of pairwise comparisons quality indicators (1) obtained at the level 2, the main components of the computed eigenvector and the priority vector (2).

Similarly, evaluation matrices are of pairwise comparisons variants of systems of 3 level individually with respect to each indicator of quality. On the basis of these matrices the corresponding main components are computed eigenvectors and priority vectors systems $\overline{Q}_j$ with relative to the quality indicators. Using these data, calculated values of the components of the vector of global priorities $\vec{C}$ according to [1,2]:

$$C_j = \sum_{i=1}^{n} P_i Q_{ij}, \quad j = \overline{1, N}, \qquad (3)$$

where n – the number of quality indicators, N - the number variants compared systems.

At the maximum value of the components of global priorities (3) the only preferred variant of the system is selected.

III. Practical Application of Methods of Analysis of Hierarchies To Choose the Preferred Type as Mobile Telephones

As indicators of the quality of chosen main technical characteristics of 19 mobile phones, characterizing their consumer properties, in particular, the processor, random access memory (RAM), the screen, the camera, the price. For ease of conversion was made of the data. In particular, it performs normalization parameters to the maximum values. Then the indicators have been converted into comparable form, all parameters were the same type of character, depending on the specifications of mobile phones.

The resulting estimates priority vectors of mobile phones relative to the performance of the processor, memory, display, camera and the price, as the columns are shown in table 1.

Using these vectors calculated priority values of the components of the global priority vector according to (3) shown in the last column of table 1.

At the maximum value of the components of global priorities chosen preferred type mobile phone according to the entered parameters of quality and additional information from the experts. That is the type of mobile phone Lenovo Vibe Z2 which has the following quality indicators: the characteristics of the processor - 2.5 GHz, RAM - 3 GB, Screen - 6 "camera - 16Mp. and the price - 4500grn.

TABLE I. Results of Calculating the Value of the Vector Component of the Global Priorities

The types of phones	Q_{ij}					C_j
	Proces-sor	Display	Camera	Memory	Price	
Samsung Galaxy S5	0,059	0,044	0,139	0,066	0,090	0,064
Samsung Galaxy S4	0,051	0,029	0,071	0,066	0,037	0,052
Samsung Galaxy S3	0,028	0,015	0,017	0,021	0,009	0,065
Samsung Galaxy Note	0,184	0,116	0,134	0,144	0,169	0,162
Samsung Galaxy A7	0,025	0,083	0,071	0,066	0,069	0,048
Samsung Galaxy Ace 4	0,007	0,005	0,006	0,005	0,004	0,007
HTC Desire Eye	0,113	0,051	0,071	0,066	0,104	0,09
HTC One E8	0,14	0,029	0,071	0,066	0,142	0,104
HTC Desire 700	0,017	0,029	0,017	0,013	0,054	0,02
HTC Desire 510	0,017	0,011	0,006	0,013	0,011	0,015
HTC Desire 610	0,017	0,011	0,178	0,013	0,018	0,021
Asus ZenFone 6	0,081	0,153	0,071	0,066	0,045	0,085
Asus ZenFone 5	0,017	0,029	0,017	0,066	0,023	0,032
Lenovo Vibe Z2	0,138	0,153	0,139	0,149	0,142	0,144
Lenovo S90	0,017	0,029	0,071	0,066	0,037	0,035
Lenovo S580	0,017	0,029	0,017	0,013	0,005	0,017
Lenovo S856	0,017	0,083	0,017	0,013	0,016	0,025
Lenovo A7000	0,038	0,083	0,017	0,066	0,007	0,049
Sony Xperia L C2105	0,007	0,008	0,017	0,013	0,007	0,009
P_i	0,509	0,135	0,036	0,263	0,057	

IV. Conclusions

On the example of mobile phones it is illustrated how method of analytic hierarchy process enables the construction of strictly formalized procedures for choosing only preferred variants of means of telecommunications considering combination quality indicators and other subjective judgments of experts.

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