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Modeling of object competitiveness based on hybrid method assessment

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Abstract. The article covers the aggregation informal and mathematical methods in competitiveness of objects of different origin basing on hybrid assessment method. The given method includes principles of systemic analysis of structurization and quantification that leads to the analysis of the competitiveness problem and complex implementation of multicriteria method of optimization, and also methods of ranging of characteristics of the object to be assessed, methods of dual comparisons, methods of integral programming, Hungarian method, reduction, method of tests and errors. The feature of the method is the advantages integration of different quality methods of analysis with formal methods to obtain the quantitative characteristics of results of competitiveness for different consumer levels. The certain extracts of the big solved task are given together with a lot of single and integrated assessments. The certain parts of a huge task solved are also presented in the article. The result tables with conclusions are also presented here. The results change primary view of consumer, make mental outlook wider and change the attitude of consumer towards the competitiveness in particular. The description of transition from methods and models use to the assessment of object competitiveness is given. That shows the possibility of hybrid method application according to the object competitiveness of different origin.

1. Introduction

At present some organizations are more successful than the others. Some are in deep crises. That is the natural economical process. To provide the competitiveness of the enterprise it is needed to reach a certain level of profit that will help it to survive in future. It is evident, that the mechanism of enterprise adaptation to the changeable market conditions should be created. The mechanism of competitiveness management should be worked out to aggregate measures for systematic development of constituent parts of the object. Methodology of competitiveness assessment for practical use has not been worked out by the present time.

The basis of the competitiveness of the enterprise is the competitiveness of its product, that is its system generated component. All parts of the chain are concentrated on it. That is the basis of the entrepreneurial activity. [1] Goods are the basis of entrepreneurial activity. Business and market policy are defined by product, goods and services. It is evident that competitiveness assessment is advisable to do in complex according to the more accessible indexes and direction of activity. Competitiveness deflection means risks, and deflection value defines the program, content and necessary investment to provide the object competitiveness.

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2.Theoretical, Informational, Empirical, and Methodological Grounds of the Research

Target assessment of competitiveness is to reveal the readiness of staff and individual worker to fulfill the particular kind of activity and also to reveal the level of potential ability for professional and occupational development of individual worker [2].

Competitiveness of enterprise means: sales volume cost and quantity, profit, share of cost of unsold products in store, competitiveness index, profitability, costs. Assessment of competitiveness of object is a multi-complex task that defines a good deal of factors of different origin. However, we need to carry out the given task for fulfillment of a number of activities such as finding of the main strategic ways for goods production, working out the firm staff training program to provide the competitiveness of the staff and the whole organization itself. The methodology of competitiveness has not been worked out properly for practical use by the present time. The complexity of origin of competitiveness specifies a number of methods of its assessment. [3]

Methods of competitiveness assessment are multifarious and are limited in usage. Competitiveness is preferable to assess in complex way according to the most accessible indexes and ways of activity. Deviation of competitiveness defines risk, but the value of deviation defines the program, content and investments needed to provide the competitiveness of the organization. Competitiveness of organization is defined by the following: sales volume cost and quantity, profit, share of cost of unsold products in store, competitiveness index, profitability, costs.

Assessment methods can be divided into three categories, they are: qualitative, quantitative and combined. [4] The most objective methods are quantitative because all the results are obtained in digits with the help of which it's easier to compare them. To get more objective result the combination of qualitative and quantitative methods is used. It's called combined method. [5]

However, the methods mentioned in the article do not allow of getting the objective results for competitiveness assessment of the organization, personnel, group of workers, staff of the division and department. Moreover, the methods are labour intensive at initial data collection. [6] That gave cause for usage of advantages of the existing qualitative and quantitative methods in combining them with the other methods. To eliminate the given faults in the existing models of competitiveness assessment the hybrid method of competitiveness assessment of object, organization, staff or product is proposed to apply. Multitude of qualitative and quantitative indexes of any object is suggested to use as a background. In general we shall work with indexes that define its ability to dominate in the specific sphere of activity, then we shall work with ranging with the calculation of weight next following and estimation of integral characteristics along the all levels of hierarchical indexes tree, that makes the competitiveness of object. All mentioned above made us formulate the hybrid method of competitiveness assessment from the point of systems analysis which is suitable for the objects of different origin. Nowadays problems of competitiveness assessment and conducting the optimization of investments are the most popular discussed among the bosses within international forums. The purpose of competitiveness assessment is to reveal the readiness of the staff and individuals the ability to fulfil exactly that kind of activity which they should do. And also the task is to reveal the potential of the workers for defining the professional and official growth.

3. Results

The following methods are worked out basing on contraction of criteria, indexes or characteristics where one scalar criteria instead of multitude of different origin partial criterion is considered. It is acquired by combination of partial criterion. There are multiplicative and additive methods of criteria contraction. The criteria must be commensurate, for example, standardized and weight criteria defined, that characterizes the importance of every criterion. Then we build a new efficiency function and the task of scalar criterion optimization is fulfilled [7].

In this case, the method of transition from several i.e. multitude indexes P_1, P_2, …, P_m to one specified by a new function $Q = \sum(V_j P_j)$ is called compression or the method of generalized

criterion, where V_j are weight coefficient criteria, provided weight sum $\sum V_j = 1.0$ .B It's fairly evident that the more is V_j ,the more contribution j index is being contributed to the integrated criterion Q.

In this case, for each quality index $p_j(a_i)$ of the object $a_i \in A$ its weight V_j is calculated defining its meaning, after that the weighed sum of these indexes can be considered as a summarized assessment of the competitiveness of the object ai:

$$K(a_i) = \sum_{i=1}^{n} V_j p_j(a_i) \quad (1)$$

The suggested type of competitiveness assessment can be formulated as a three – level structure and modify the existing methods for competitiveness assessment of product, organization or personnel [8]. As a framework it's necessary to use individual, single, group and integral aggregation indices (table 1). In this case at the beginning a hierarchical, usually a three – level structure of indices of the object being under consideration is been graphed**.**

Table 1. Analyses of the object characteristics.

	X_1	X_2	X_3	X_4	X_5	X_6	X_7			X_8	X_9
							$X_{7.1}$	$X_{7.2}$	$X_{7.3}$		
A_1	150	1998	589	1580	170	12.8	10.2	6.3	7.7	182	124
A_2	150	1998	591	1601	170	11.2	10.6	6.8	8.2	180	18
A_3	150	1998	564	1469	172	11.2	10.6	6.8	8.2	180	31
A_4	150	1998	463	1455	210	9.8	8.20	5.9	6.7	187	0
A_5	150	1998	415	1455	195	11.9	10.5	6.8	8.1	188	7
A_6	141	1997	410	1454	200	11.3	10.8	6.8	8.2	178	62
A_7	167	2384	420	1750	200	11.0	12.8	7.3	9.3	175	2
A_8	148	1998	410	1580	180	11.5	9.60	6.5	7.6	180	85
A_9	152	1798	405	1505	180	9.0	10.6	6.8	8.0	192	6
A_{10}	150	1390	470	1621	200	9.6	10.1	6.7	8.0	192	3

To assess competitiveness of the object and to choose the preferable one we distinguished some models of vehicles: A_1 – Honda CR-V, A_2 – Hyundai ix 35, A_3 – KIA Sportage, A_4 – Mazda CX-5, A_5 – Mitsubishi ASX; A_6 – Nissan Qashqai; A_7 – Opel Antara; A_8 – Toyota RAV 4; A_9 – Skoda Yeti; A_{10} – Volkswagen Tiguan, their characteristics are given in Table 1 according to the indices: X_1 – engine capacity (h.p.), X_2 – volume of engine (cm^3), X_3 – boot volume (l), X_4 – laden mass (kg), X_5 – clearance (mm), X_6 – acceleration up to 100 km/h, X_7 – petrol consumption (l/100 km): $X_{7.1}$ – town, $X_{7.2}$ – motorway, $X_{7.3}$ – mixed; X_8 – max speed (km/h), X_9 – hijacking (item).

To estimate the weight of each index we use the following formula

$$V_i = \frac{S_i}{n^2} \quad (2)$$

Ranging of the indices to define their meaningfulness we follow the rule due to which the domination of matrix elements is defined

$$b_{ij} = \begin{cases} 1, if\ P_i\ equivalent\ P_j, \\ 0, if\ P_i\ ess\ important\ than\ P_j \\ 2, if\ P_i\ dominates\ over\ P_j \end{cases} \quad (3)$$

Ranging operations and defining the weight of indices we conduct foe each group of indices and we put the down into the table 2, for example, economic, technical, comfort ability, esthetics, safety. [9, 10]

By-turn, each group contains the characteristics. We conduct the ranging and also define the weight – meaningfulness of each index.

The above-mentioned method allows us to conduct an activity of indices convolution converting into a single integral one considering the weight of each and their absolute meanings. It is important to mention that the high index value is not always good, sometimes it's vice versa. For example, fuel consumption of the vehicle, it's necessary to introduce 5 or 10 grade assessment of indices $Б_i$ (p_i) due to the scale "worse-better", where the worst index gets low grade. For instance, vehicle operation costs to be compared with sale proceeds. Indeed, the higher the content of grade the $Б_i(p_i)$ the better index [11, 12]. Table 2 shows interval indices values in grades. So, we transform the model of competitiveness of the object to the following

$$К(a_i) = \sum_{i=1}^{n} V_j Б(p_j(a_i)) \quad (4)$$

Table 2. Interval assessments of indices.

$Б_i$ (P_i)	1	2	3	4	5
X_1	140.0 – 145.0	146.0 – 151.0	152.0 – 157.0	158.0 – 163.0	164.0 – 170.0
X_2	1390.0 – 1589.0	1590.0 – 1789.0	1790.0 – 1989.0	1990.0 – 2189.0	2190.0 – 2390.0
X_3	400.0 – 439.0	440.0 – 479.0	480.0 – 519.0	520.0 – 559.0	560.0 – 600.0
X_4	170.0 – 177.0	178.0 – 185.0	186.0 – 193.0	194.0 – 201.0	202.0 – 210.0
X_5	13.00 – 12.2	12.10 – 11.40	11.30 – 10.6	10.50 – 9.80	9.70 – 9.00
X_6	13.00 – 12.0	11.90 – 11.00	10.90 – 10.0	9.90 – 9.00	8.90 – 8.00
X_7	175.0 – 179.0	180.0 – 183.0	184.0 – 187.0	188.0 – 191.0	192.0 – 195.0
X_8	124.0 – 100.0	99.00 – 75.00	74.00 – 50.00	49.00 – 25.00	24.00 – 0.00
X_9	140.0– 145.0	146.0 – 151.0	152.0 – 157.0	158.0 – 163.0	164.0 – 170.0

Thus, the method was created on the basis of qualitative and quantitative indexes of object application basing on requirement usage [13]. The hybrid methods comprises aggregation of a few methods of research: interview method, expert judgment, method of paired comparison, rank method, method of grade assessment, method of integer programming, Hungarian method, reduction method, trial and error method.

So we have a decisive rule: object a_i is more preferable than object a_j, if $K(a_i)>K(a_j)$. Then we find integral indices $К_э, К_т$, $К_к, К_{эс}, К_б$ all through the groups, after that – weight – meaningfulness $V_э, V_т, V_к, V_{эс}, V_б$ of group indices, and at last, we find the integral index of competitiveness according to the formula:

$$K(a) = \sum V_i K_i \quad . \quad (5)$$

Thus, we define competitiveness of the object in the large:

$$К(a) = V_э К_э + V_т К_т + V_к К_к + V_{/с} К_{эс} + V_б К_б, \quad (6)$$

In the large the structure of object indices consists of several groups: technical, aesthetic, mechanical, safety, economical. Due to this we define the indices weight of group of characteristics by the method of paired comparison:

$$V_э = 0.36V_т = 0.28V_к = 0.04V_{эс} = 0.12V_в = 0.2К_б. \quad (7)$$

Thereupon we write the following target function:

$$К(a) = V_э К_э + V_т К_т + V_к К_к + V_{/с} К_{эс} + V_б К_б = 0.36V_т = 0.28V_к = 0.04V_{/с} = 0.12V_в = 0.2К_б, \quad (8)$$

After that we conduct the ranging of each group of characteristics by the method of paired comparison, involving experts – specialists. We define their weights, grades of characteristics and integral grades due to their aggregates (table 3). It allows us to calculate the following:

$$К_э = 3.82К_т = 2.8К_к = 1.6К_{эс} = 3.2К_б = 1.1. \quad (9)$$

Basing on the mentioned above we define general competitiveness:

$$К(а) = V_э К_э + V_т К_т + V_к К_к + V_{эс} К_{эс} + V_б К_б = 0.36 * 3.82 + 0.28 * 2 + 0.04 * 2.6 + 0.12 * 3.2 + 0.2 * 2.2 = 2.822, \quad (10)$$

Table 3. Integral grades of indices.

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
A_1	0.188	0.064	0.780	0.156	0.10	0.609	0.094	0.23	2.22
A_2	0.188	0.064	0.780	0.156	0.28	0.609	0.047	1.17	3.30
A_3	0.188	0.064	0.780	0.156	0.28	0.609	0.094	0.94	3.11
A_4	0.188	0.064	0.312	0.780	0.38	1.015	0.188	1.17	4.10
A_5	0.188	0.064	0.156	0.624	0.19	0.609	0.188	1.17	3.19
A_6	0.094	0.064	0.156	0.624	0.28	0.609	0.047	0.70	2.58
A_7	0.470	0.080	0.156	0.624	0.28	0.203	0.047	1.17	3.03
A_8	0.188	0.064	0.156	0.312	0.19	0.812	0.141	0.47	2.33
A_9	0.282	0.048	0.156	0.312	0.47	0.609	0.235	1.17	3.28
A_{10}	0.188	0.016	0. 312	0.624	0.47	0.609	0.235	1.17	3.11

Table 4 shows the following criteria of choice: Y_1 – correlation of price and quality (min), Y_2 – horse power cost (rub.), Y_3 – petrol consumption for 60000 km (rub.), Y_4 – cost of three Technical Checkup (rub.), Y_5 – Insurance (Compulsory Automobile Insurance) within 3 years (rub.), $Y_{6,7}$ – cost reduction within 3 years in% (thousand rub.), Y_8 – quality integral grades (max), Y_9 – total cost of possession.

Table 4. Calculations of choice criteria.

	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7	Y_8	Y_9
A_1	549346	8127	192780	30973	16632	31	841	2.219	618275
A_2	324332	7127	200340	18870	16632	42	620	3.296	684822
A_3	356995	7399	200340	26442	16632	43	632	3.109	720671
A_4	304177	8300	154908	26850	16632	30	871	4.093	571590
A_5	332287	7060	198450	23348	16632	25	794	3.187	503108
A_6	399534	7305	204120	29692	14256	38	638	2.578	639468
A_7	374340	6796	241920	27565	19008	31	783	3.032	640043
A_8	474023	7459	181440	26500	16632	31	762	2.329	566812
A_9	313528	6770	200340	18347	19008	40	618	3.282	649295
A_{10}	337837	7000	190890	25867	16632	41	602	3.108	681559

Various criteria given in the table 4 denote the choice A_5 – Mitsubishi ASX.

4. Conclusions and recommendations

The obtained results let us evaluate competitiveness of other objects to be compared. Thus we can choose one object out of multitude or formulate a set of choices in the long run. We can also conduct a comparison evaluation of competitiveness of organizations, enterprises, personnel. We can work out some management measures for various spheres of activity.

It's necessary to point out that the attention must be given to the analysis of risks in the system of organizations for it's a factor of competitiveness raise. Risk analysis is one of the widely spread in spheres of production and trading [14].

The given hybrid method can be used for competitiveness assessment of personnel where the etalon-indicators are the initial data. They are the requirements for every occupation (competence). Then the comparison of individual person of the staff is made both positive features (communicative skills, professional experience) and negative (aggressiveness, contentiousness, irritability). After that the comparison of the list of characteristics, ranging, weight defining is made. After that we proceed to the formulation of the integer-valued programming task which can be solved with the help of Hungarian method available for users in the internet. Consequently, the most complicated, force consuming and important is the collection of the initial data and the task formulation.

To be concluded, the hybrid method of competitiveness has been made basing on the implementation of quantitative and qualitative indices of object of different origin. The hybrid methodology includes a number of research methods and techniques: method of interview, method of expert assessment, method of paired comparisons, ranging method, grading evaluation, method of integer-valued programming, Hungarian method, method of reduction, method of trial and error. The hybrid method of competitiveness assessment has lots of advantages those are the various quality methods of analysis that means result comparison convenience all through the customers levels.

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