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Principal components soft computing in strategic management

Abstract: A new approach to strategic management is proposed, based on qualitative methods of surveying an organization using the method of soft computing. There are many examples of assessing risk states of an organization. A comparison of traditional analysis and business planning, empirical models and the method of the analysis of principal components of business activity is shown. The advantage of assessing by groups of indicators is the simplicity of identifying the states of individual resources of the organization. The application of the calculation method allows the use of a minimum indicators in the analysis of the organizational activity. The new approach enables qualitative diagnostics, risk assessment and strategic decision making.

Keywords: strategic management, soft computing, risk estimation, efficiency, safety, principal components

Introduction

Well-known modern theories and methods of strategic management contain diagnostics of the state of organizations, analysis, development of guidelines, planning for the implementation of the goal. A new

approach to strategic management is proposed, based on qualitative methods of surveying an organization using the method of soft computing (SC). The basis for the development of the method were the works [1] and others. There were postulated universal concepts of effective management by qualitative assessments of objects of various nature [2, 3]. The beginning of SC is human thinking Calculation is possible according to selected parameters, a set of indicators. The content of the method is revealed in a practical application on the example of an air transport organization - an airline. A comparison of traditional analysis and business planning, empirical models and the SC method of the principal components of business activity is shown. The new approach enables express diagnostics, risk assessment and strategic decision making.

Organization reference model design

An organization subjected to reorganization is called a crisis company (CC). An analysis of production activities is carried out and the values of actual indicators (AI) are displayed, which are considered as crisis states of the CC. To design strategic future, desired states (benchmarks), a business reference model (RM) is being developed. In special procedures, a parametric analysis of CC and RM is compiled. For the design of RM production activities, the external environment of the company and information about analogue companies are examined. In accordance with the target indicators of the strategy of CC, reference indicators (RI) are compiled. To derive the values of RI, the market of CC is studied and a generalized model of the reference company (RC) is compiled, the indicators of which are comparable with the same of CC (figure 1):

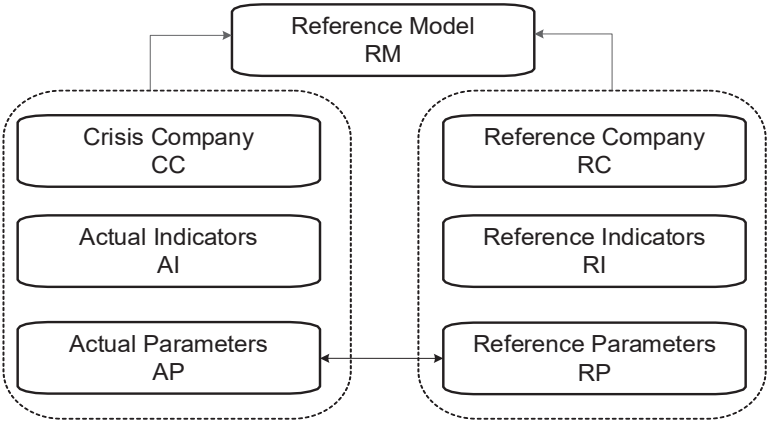

Figure 1 – Reference model

Together, RI are interpreted as successful, competitive states and form strategic activities. For indicators of CC, and for indicators of RM, the calculation of actual parameters (AP) and reference parameters (RP) is performed. The parameters are displayed in numbers of absolute value. To compare and display their multiplicity, the value of RC is reduced to one.

Risk assessment model

To assess the risks of activities through the values of the properties of an object, a model of heat maps or a "traffic light" is used in non-linear scales of clear and fuzzy areas of the risk matrix. The smallest space has a green range, the largest has a red range. Clear and fuzzy boundaries of the intervals are set in accordance with the definitions of the method of SC. To evaluate the values of AI and RI in the risk matrix, the following non-linear scale of fuzzy intervals is displayed in terms of numerical values of risks:

$$\vec{R} = \left\{ \begin{pmatrix} \text{green} \\ 1\ \text{RI} < AI < 1{,}3\ \text{RI} \end{pmatrix} \begin{bmatrix} \text{yellow} \\ 1,3\ \text{RI} < AI < 2\ \text{RI} \end{bmatrix} \begin{bmatrix} \text{red} \\ \text{AI} > 2\ \text{RI} \end{bmatrix} \right\}, \quad (1)$$

where the boundaries of the values of the magnitudes of the range indicators on the left and on the right are set fuzzy (parentheses) and clear [square brackets] [4].

The method of principal components

The resource method of managing organizational objects is based on the derivation of the principal components as a set of indicators – parameters, displaying the organization's resources. The method allows to reduce the number and dimension of the initial data for analysis for subsequent interpretation and decision-making. In the economy of airlines 11 most important indicators have been identified. Indicators RC data received from available databases and directories, approximately equal in terms of fleet and personnel of CC. The model defines 13 of principal components (parameters), which are determined by the ratio of one indicator to another indicator. Example: the number of passengers carried per year per the number of employees of the company Passengers 439379 / Employees 2284 = 186. The calculations consist of the following procedures (P).

Calculate annual actual performance indicators of CC (table 1):

Table 1 – Actual performance indicators of the air carrier

Indicators	**Code**	**Values**	**Comment**
Employees	E	2284	human resources
Airline Fleet	AF	78	value of production
Fleet Seats	FS	3343	value of capacities
ASK/RPK	CU	0,65	capacity used (load factor)
Available Seat Kilometers	ASKs	2092	passenger market
Revenue Passenger Kilometers: regular 1244, irregular 116	RPKs	1360	passenger market activity
Available Tons Kilometers	ATKs	209	cargo market
Revenue Tonne Kilometers: regular 112, irregular 24	RTKs	136	cargo market activity
Annual Passengers	AP	439379	sales
Revenue, thuds USD	R	47186808	operation cash
Operation Costs, thuds USD	OC	59041063	operation expenses

P-1. Compile a set of indicators for the RC in the same way as the above calculation of CC. Corresponding RC table omitted.
P-2. Determine the principal components.
P-3. Calculate efficiency ratios (ER) of CC (table 2):

Table 2 – Efficiency ratios of crisis company

Efficiency ratios	**Formula**	**Calculation**	**Comment**
Passenger per Employee	AP/E	425486 / 2284 = 186	human resource efficiency
Employee per Seat	E/FS	2284 / 3343 = 0,68	personnel and technology efficiency
Employee per Airplane	E/AF	2284 / 78 = 29	technical level and structure of fleet
Revenue per Employee	R/E	47186808 / 2284 = 20660 USD	human resource efficiency
Expenses per Employee	OC/E	59041063 / 2284 = 25849 USD	human resource efficiency
Revenue per Passenger	R/AP	47186808 / 425486 = 111 USD	market demand
Revenue per Seat	R/FS	47186808 / 3343 = 14115 USD	efficiency of aircraft use

Efficiency ratios	Formula	Calculation	Comment
RPKs per Seat	RPKs/FS	1360 / 3343 = 0,407	market demand and supply balance
RPKs per Employee	RPKs/E	1360 / 2284 = 0,596	quality and cost of human resources
ASKs per Seat	ASKs/FS	2093 / 3343 = 0,63	efficiency of capacity used
ASKs per Employee	ASKs/E	2092 / 2284 = 0,916	ability of demand for supply
Revenue per ASKs	R/ASKs	47186808 / 2092590100 = 0,022	rate of return on offer
Expenses per ASKs	OC/ASKs	59 041 063 / 2 092 590 100 = 0,028	operating expense rate

P-4. Calculate efficiency ratios (ER) of RC in the same way as the above calculation of CC. Corresponding RC table omitted.

P-5. Calculate the numerical values of risks on a 10-point scale. Example: Expenses per ASKs: 0,04 / 0,028 = 1,43. This corresponds to the range of the matrix risk assessment model [1,3–2], points 5, color “yellow”.

P-6. Summarize calculations in a common table of ER. For a numerical ratio of CC and RC, relative parameters are introduced, which are taken as a unit (table 3):

Table 3 – Calculation of risk states from efficiency ratios

Efficiency ratios	**CC**		**RC**		**Risk: points, color**	
Passenger per Employee	186	1	2200	11,83	10	red
Employee per Seat	0,68	1	0,35	0,51	2	green
Employee per Airplane	29	1	40	1,38	3	green
Revenue per Employee, USD	20660	1	150000	7,26	8	red
Expenses per Employee, USD	25849	1	46998	1,82	5	yellow
Revenue per Passenger, USD	111	1	120	1,08	1	green
Revenue per Seat, USD	14115	1	100000	7,08	10	red
RPKs per Seat	0.407	1	1.227	3,01	7	red
RPKs per Employee	0.596	1	3.06	5,13	8	red
ASKs per Seat	0.63	1	1.1	1,75	4	yellow
ASKs per Employee	0.916	1	8.1	8,84	10	red
Revenue per ASKs	0.022	1	0.05	2,27	7	red
Expenses per ASKs	0.028	1	0.04	1,43	5	yellow

P-7. Build charts. Mark the levels of risk (Figure 2).

The method of computing principal components gives the following results: three parameters are in the "green" range, three parameters are in the "yellow" range, seven parameters are in the "red" range. Conclusion: the state of the CC is critical, both in terms of safety and economics. Recommendations: provide revision the strategy of business and management of the CC; develop and implement a crisis management plan.

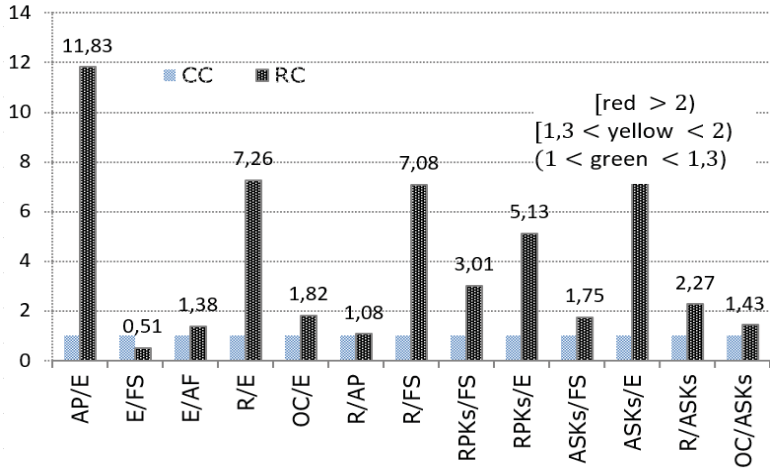

Figure 2 – Assessment of CC and RC efficiency ratios

Conclusion

The method is used: a) for continuous company self-assessment and analysis of the state of safety and business performance within the organization; b) for quick expert assessment of the position in the market by external agents; c) to compile integrated ratings of local, regional and international industry markets; d) to use as analytical data for the development of national transport strategies. The method of principal components is developed and evidence of its practical implementation is presented through assessment of states of safety, risks, effectiveness of the organizational activities.

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