

Methods of Fuzzy Set Theory in the Purpose of Expansion of the Value Chains Based on the Main Factors of Corporate Culture

Larisa Anatolievna Tselykh¹

Elena Anatolievna Panfilova²

Olga Sergeevna Prichina³

Aksana Georgievna Karasheva⁴

Anzor Khasanbievich Karanashev⁴

¹Chekhov Taganrog Institute (branch) of Rostov State University of Economics (RSUE)

²Rostov State University of Economics (RSUE)

³Branch of Moscow Witte University in Penza

⁴Kabardino-Balkarian State University; Email: karasheva05@inbox.ru

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Abstract

In the context of the economy modernization recognition of the dominant of corporate culture in the creation of the innovative capacity of companies and competitive advantages through value chain is an organizational phenomenon. Using the methodological tools of fuzzy sets allows considering the multidimensionality and the quality diversity of influence (contribution) factors of corporate culture in the creation of competitive value chains of the company. The purpose of the fuzzy logic method is to improve the quantitative information substantiation of strategic planning processes, particularly in the regional aspect of the corporate culture formation in the region. The method of application of fuzzy set theory is based on inaccurate and inconsistent factors corresponding to the real economic situation, in which an enterprise functions, characterizing by inaccurate information, fuzzy processes of management decision making and consequences of events. The result is characterized by analytical determination of priorities for the factors included in the analysis that makes them comparable.

Keywords: fuzzy conditions; compatibility, corporate culture factors; competitiveness, value chains.

1. Introduction

Problem formulation. The aim of this study is to adapt the existing tools of the fuzzy set theory for the problem solving in the area of social and economic systems in the framework of such objective organizational institute as corporate culture.

The problem to be solved in the study is the justification of the functional significance of the dominant corporate culture factors in the creation of competitive value chains of the company in its quantitative and qualitative definability.

The *hypothesis* of the study states that the corporate culture, as an intangible asset of the company in its quantitative and qualitative definability, is a poorly structured element of external and internal environment of the company, which determine the formation of competitive value chains of the company on the basis of trust capital that requires consideration of factors of corporate culture using methodological tools of fuzzy sets. It allows taking into account the multidimensionality and qualitatively heterogeneous factors of economic activity of the company.

The objectives of the study are to:

1. Characterize the thematic area of research.
2. Conduct a conceptual analysis of modern trends of development of value chains in terms of comprehensiveness of innovative potential of the corporate culture.
3. Justify the choice of methodological investigation tools.
4. Conduct a modeling of the system influence of the corporate culture and its innovation potential on expansion of the company value chain.
5. Determine the degree of interaction between market factors of the company management and its corporate culture in the context of the formation of competitive value chains.

In the area of the formation and management of the corporate culture, economic practice is ahead of economic theory. In

particular, management models and methods of measurement and development of value chains of company have not been developed on the basis of added value in the frame of corporate business generated by factors of corporate culture (Hyson, 1950). In the context of the economy modernization, recognition of the dominant corporate culture in the creation of the innovative capacity of companies and the competitive advantages through value chain, is an organizational phenomenon that is reflected in the following points:

- first, in modern conditions the *boundaries* of the enterprise as the *subject* of competitive relations have been transformed. These relations are dependent on location (specialization) of the enterprise in the value chain of the goods and on chain form, so the dynamics of competitive "niches" of the enterprise can be considered in four cases: a) with *constant* place of the enterprise and the value chain of the goods *itself*; b) when the place of enterprise is *changing* within the constant of the value chain c) when *changing* the value chain of the product, apart from the immutability of the enterprise place; d) when *both* shifting the chain of values and the place of the enterprise;
- second, the *object* of competitive advantages of enterprises have changed. Now it includes not only the market price of the goods, but all the added value along the entire value chain – from the receipt of raw materials, technologies, marketing, brand to the bringing of the finished product or service to the final consumer and disposal of waste;
- third, the *sources* of competitive advantages have changed the origins of which are not only in the internal environment, but also in environment management during the cooperation with the main stakeholders of the company - relational and symbolic capital of the company that are becoming increasingly strategic and intangible in nature;
- fourth, depending on different *types of value chains* of goods, the stability of the parameters of the competitive advantages of companies is determined by certain type of management and allocation of market power in the value chain, for whom value chain of the company is focused on - the end user, all the stakeholders of the company, shareholders, market intermediaries etc.;
- fifth, there is an increasing of the importance of management tools aimed at maintaining a competitive advantage not only in the internal environment of the company, but also in foreign one, biased towards intangible assets (corporate culture, corporate brand, corporate identity, corporate image, and reputation);
- sixth, external, internal and dual instruments of corporate culture in general, reducing the level of transaction costs of economic agents interaction, increasing the level of trust between the participants of the value chain of the company, and affecting the flow of the risks and value of companies, thus providing a competitive advantage throughout the value chain of the company.

Modern researchers of the value chains of companies indicate the formation of not only national, but also of the global chains of creation of company value (Surroca *at al.*, 2010), so that such intangible factors as reputation and corporate codes of conduct that affect the level of trust between the participating companies of a network chain (Tulder *at al.*, 2009), (Drake *at al.*, 2008), to determine not only the relationship between the company and its stakeholders, but also the level of risks and ways of distribution of market power across the network chain that also affect the competitive development and sustainability of the value chain of the company.

As opposed to M. Porter, who studied the gaining of competitive advantages in the immutability of the place of the enterprise and the value chain of the product, R. Kaplinsky developed value chain theory (Kaplinsky *at al.*, 2003), in which the problems of getting of a competitive advantages is increasingly viewed in the change of enterprise place within the same value chain, when changing the value chain of the product with the same enterprise place, and by changing both the value chain and enterprise place in it.

In Russian economic literature in the theory of value chains different types of chains, market adaptation of the companies, which is the nature of the network (Avdasheva, 2005) and "strategic alliances" of competitive interaction of firms are considered (Yakovlev, 2004) Depending on the types of chains, the competitive position of the company, sources of competitive advantage, the redistribution of market power in the supply chain are changed: 1) "independent" chain - chain participants are independent producers, vendors, implementers of goods. This chain is characteristic of the market with perfect competition. 2) a vertically integrated chain of manufacturer of the goods, including the vertical integration of producer goods from raw materials to enter the market under its own brand (for the markets with exclusive competition). 3) the modular value chain "network of networks" as a combination of vertical and horizontal chains throughout the product life cycle - for the oligopoly markets.

2. Methods

Process modeling of the systemic influence of the corporate culture and its innovation potential to increase the value chain of the company is represented in the form of impact, on the one hand, of its components: human, organizational, relational and symbolic capital on the environment and, on the other hand, the impact of innovation potential foreign environment on the development of innovative potential of a particular corporate entity, which defines a system of macro and micro-economic control (Figure 1).

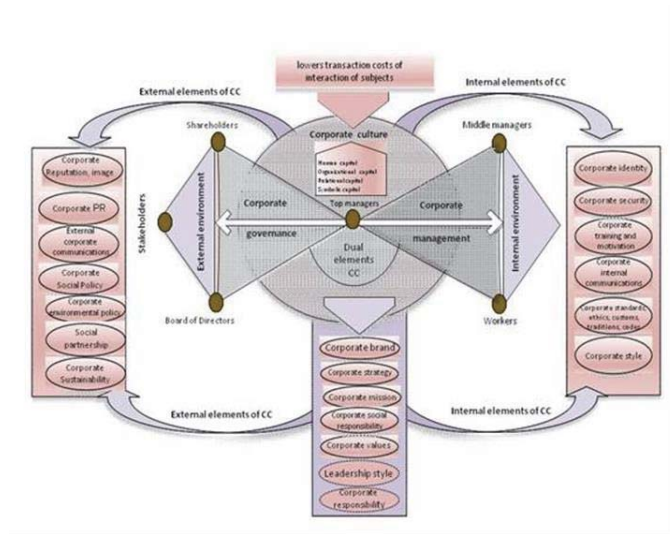


Figure 1 – Elements of the systemic influence of the corporate culture

Human capital and organizational capital are referred to the domestic environment and internal elements of corporate culture (corporate identity) mostly, and relational capital and symbolic capital - to the external environment (corporate image, reputation). CC and its dual elements (corporate brand, corporate strategy, corporate values, corporate and social responsibility) have their own specific impact on the human, organizational, relational and symbolic capital (four areas of CC).

The economic approach of creating of value chains comes from the fact that the level of effective influence of corporate culture, its potential for innovation, is needed to be truly measured. Such an approach for a typical problem can be treated with the use of the fuzzy set theory.

The basis of this investigation method forms the fuzzy set theory (Yager, 1982), which operates a fuzzy representation of concepts and events.

In this study, the starting point is the substantiation of partition of strategic alternatives based on compatibility factors (concepts). This approach is illustrated by a model in which the social-psychological and economic variables with heterogeneous properties are considered as factors, influencing the decision making process of entrepreneurs (business owners) about the establishment / development of entrepreneurial firms.

In the model, the following assumptions are made (Tselykh, 2012):

- 1) existence of the market as an external factor of economic activity of the company;
- 2) management of the company presents as a subject of administrative decisions, endowed with certain powers, and responsible for the consequences of adopted and implemented management decisions regarding the formation and development of the company;
- 3) factors influencing management decisions are the characteristics of the company's business and the subjects of administrative decisions, which play a key role in management decisions on the operation and development of the company;
- 4) opportunity factors of administrative decisions interact in a certain way with influence factors;

- 5) extent of the impact on influence factors, while decision making about business is varied based on strength factors;
- 6) one possibility is preferred to the other, if the influence factors are closer to strength factors based on their estimation.
- 7) within one model one implementation is considered (two models are presented: the first one - the interaction of the external CC factors with external possibilities, the second one - the interaction of the external CC factors with external threats).

Let

$X = \{x_1, x_2, \dots, x_n\}$ - the set of strength factors (internal factors);

$Y = \{y_1, y_2, \dots, y_n\}$ - the set of influence factors;

$Z = \{z_1, z_2, \dots, z_n\}$ - the set of opportunity factors (external factors).

Let $\Phi_R : X \times Y \rightarrow [0, 1]$ is a membership function of odd binary relation R. For all $x \in X$ and $y \in Y$ function $\Phi_R(x, y)$ is the extent of impact of strength factors x to the influence factors y in determining the degree of their compatibility with factors of external opportunities.

The ratio of R (incidence matrix) can be represented in matrix form:

$$R = \begin{matrix} & \begin{matrix} y_1 & y_2 & \dots & y_n \end{matrix} \\ \begin{matrix} x_1 \\ x_2 \\ \dots \\ x_n \end{matrix} & \begin{bmatrix} \Phi_R(x_1, y_1) & \Phi_R(x_1, y_2) & \dots & \Phi_R(x_1, y_n) \\ \Phi_R(x_2, y_1) & \Phi_R(x_2, y_2) & \dots & \Phi_R(x_2, y_n) \\ \dots & \dots & \dots & \dots \\ \Phi_R(x_n, y_1) & \Phi_R(x_n, y_2) & \dots & \Phi_R(x_n, y_n) \end{bmatrix} \end{matrix}$$

Let $\pi : X \times Y \rightarrow [0, 1]$ is a membership function of fuzzy binary relation S. For all $y \in Y$ and all $z \in Z$ function $\pi_S(y, z)$ is the degree of membership or compatibility of opportunity factors z with influence factors y . In matrix form, the ratio is defined as follows:

$$S = \begin{matrix} & \begin{matrix} z_1 & z_2 & \dots & z_n \end{matrix} \\ \begin{matrix} y_1 \\ y_2 \\ \dots \\ y_n \end{matrix} & \begin{bmatrix} \pi_S(y_1, z_1) & \pi_S(y_1, z_2) & \dots & \pi_S(y_1, z_n) \\ \pi_S(y_2, z_1) & \pi_S(y_2, z_2) & \dots & \pi_S(y_2, z_n) \\ \dots & \dots & \dots & \dots \\ \pi_S(y_n, z_1) & \pi_S(y_n, z_2) & \dots & \pi_S(y_n, z_n) \end{bmatrix} \end{matrix}$$

We get the matrix T:

$$T = \begin{matrix} & \begin{matrix} z_1 & z_2 & \dots & z_n \end{matrix} \\ \begin{matrix} x_1 \\ x_2 \\ \dots \\ x_n \end{matrix} & \begin{bmatrix} \mu_{A1}(x_1, z_1) & \mu_{A2}(x_1, z_2) & \dots & \mu_{Am}(x_1, z_m) \\ \mu_{A1}(x_2, z_1) & \mu_{A2}(x_2, z_2) & \dots & \mu_{Am}(x_2, z_m) \\ \dots & \dots & \dots & \dots \\ \mu_{A1}(x_n, z_1) & \mu_{A2}(x_n, z_2) & \dots & \mu_{Am}(x_n, z_m) \end{bmatrix} \end{matrix}$$

whose elements are determined by the membership function (Yager, 1982):

$$\mu_{Ai}(x_i, z_i) = \frac{\sum_y \Phi_R(x, y) \cdot \pi_S(y, z_i)}{\sum_y \Phi_R(x, y)} \quad (1)$$

for all $x \in X, y \in Y, z \in Z$.

The sum $\sum_y \Phi_R(x, y) \cdot \pi_S(y, z_i)$ is equal to the degree of fuzzy subset (Tselikh, 2012), indicating the number of the most important characteristics of y - the influence factors that interact with external opportunities, which are influenced by strength factors (the elements of corporate culture in the region). They are characterized by the state of the corporate culture of the region. Then $\mu_{Ai}(x_i, z_i)$ can be interpreted as a weighted degree of implementation of external opportunities in the region z_i using the strength factors x (elements of corporate culture formed in the region), in relation to the implementation of the intended target.

To cover the external factors with influence factors (implementation (combining) zone of external opportunities by strong sides), we use the concept of partition level (Yager, 1982). The application of a unified partition level for all implementations of the partition of external opportunities, in our view, can only be applied in the case of homogeneity of factors of set Z. Otherwise, the obtained values are proposed to be grouped based on the selected reference scale. Then partition level I may be, for instance, limited by median (or other) value:

$$I < M[\mu_{ij}(x_i, z_j)] \quad (2)$$

Thus, for selected level I the area of the implementation of the external opportunities M_i , for each external opportunity factor z_m , is determined by the fuzzy subset of level I . By choosing different values for I , we get a different area of implementation of external opportunities. That is, if the level I is selected, the area of the implementation of external opportunities M_i is described by the level set:

$$M_i = \{x \mid \mu_{Ai}(x) \geq I\} \quad (3)$$

for all $x \in M_i$.

3. Analysis Result

Methods of fuzzy logic in the purpose of expansion of the value chains of company. Consider the practical use of theoretical calculations on the example of the influence of strength factors of corporate culture of the region on the implementation of external opportunities in order to achieve a certain goal.

Example. The cognitive analysis is needed to be done for the region in terms of achieving the following goal - "an increase in the region's GDP by 10% through the development of strong regional components of the corporate culture, as a necessary innovation factor in the creation of value chains of companies".

Objective: To determine the factors of corporate culture that are necessary to be strengthened (developed) in order to increase the number of businesses in the region.

The solution is given in respect of the goal achievement on the basis of:

- 1) the use of factors of development of regional corporate culture and corporate sector of the region on the background of the external features of the economy;
- 2) counteraction to the external political and economic threats.

Let

$X = \{x_1, x_2, \dots, x_n\}$ – the set of strength factors (factors of the region development);

$Y = \{y_1, y_2, \dots, y_n\}$ – the set of influence factors (factors of development of the corporate sector in the region);

$Z = \{z_1, z_2, \dots, z_n\}$ – the set of external opportunity factors (the economy).

Strength Factors - the components of the corporate culture of the region, describing its condition, the development and capabilities (Karanashev, 2015):

x_1 – mission, goals, innovative orientation of the corporate culture of the region;

x_2 – system of healthy competition;

x_3 – priorities in resource allocation in the region;

x_4 – environment for innovation in the region;

x_5 – declaration of social responsibility in the region;

x_6 – social and psychological climate in inter corporate relations;

x_7 – family traditions, customs and aims of the past ethnic motivation;

x_8 – entrepreneurial leadership style;

x_9 – knowledge oriented human capital in the region;

x_{10} – susceptibility of philosophy of total quality in the professional environment of the region;

x_{11} – public mentality of the human capital of the region;

x_{12} – selection principles of personnel;

- x_{13} – open model work culture;
- x_{14} – demand of the soft competencies of employees;
- x_{15} – philosophy of social recognition of labor;
- x_{16} – transparency of decision-making at different levels;
- x_{17} – democratic control of management;
- x_{18} – traditions of inter-corporate relations.

Influence factors - the characteristics of the company's business itself and the subjects of administrative decisions that play a key role in management decisions on the operation and development of the company.

1. Characteristics of the company's management as a subject of administrative decisions:

- y_1 – leadership;
- y_2 – personality type;
- y_3 – interest.

2. The conditions of doing business in the region:

- y_4 – infrastructure for conducting this type of business;
- y_5 – competition for this type of business;;
- y_6 – trained staff (sufficient professional competence);
- y_7 – business climate.

3. Characteristics of goods (works, services) and the business itself:

- y_8 – new technologies;
- y_9 – low initial investment (the "price" of entering the business);
- y_{10} – high margin of products (works, services);
- y_{11} – uniqueness of staff competencies.

Factors of external opportunities - external development opportunities in the region, especially in the aspect of doing business, promoting the creation and development of businesses. They have certain characteristics:

- z_1 – demand from the government in relation to priority directions of development (in the region);
- z_2 – global trends, scientific and technological progress;
- z_3 – reserves of mineral resources;
- z_4 – the emergence of new consumer preferences;
- z_5 – export demand;
- z_6 – regional preferences and privileges (the regional tax climate);
- z_7 – investment activity in the region.

For the second model of implementation, we consider the use of strength factors of CC that have debilitating effect to the negative impact of economic, political and other factors of the business environment in the region.

Factors of external threats - external threats to the development of the region, hindering the creation and development of entrepreneurial business activity, especially in the aspect of the doing business. They have certain characteristics:

- z_1 – increasing pressure from the public authorities;
- z_2 – unfriendly monetary policy (exchange rates, % on loans, reduced credit availability);
- z_3 – increase in political risk (sanctions, taboos);
- z_4 – the emergence of new consumer preferences;
- z_5 – growth of tariffs of state monopolies (gas, water, electricity);
- z_6 – increase in regional tax burden (regional tax climate);

z_7 – emergence of large (network) agents (sellers).

Based on the expert interviews, values of the interaction force between strength factors and influence factors were obtained that have shaped the incidence matrix R of fuzzy binary relation and the membership matrix (Figure 2).

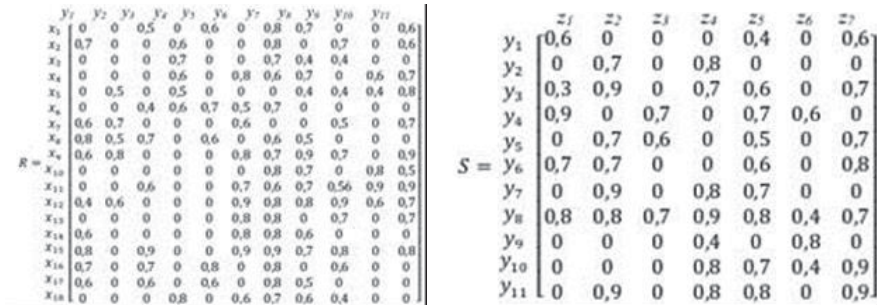


Figure 2 – The incidence matrix R and membership matrix S

Then the fuzzy graph is the fuzzy assessment of the impact (significance) of strength factors (characteristics of the corporate culture of the region) on the influence factors (factors of the decision-making on the establishment / development of business) - is:

$$R'(x_2) = \{0,7/y_1; 0,6/y_4; 0,8/y_7; 0,7/y_9; 0,6/y_{11}\}$$

and it is presented in Figure 3. Thus, on the influence factor y_2 (personality type) extent of impact of strength factors formed a fuzzy set:

$$X'(y_2) = \{0,5/x_5; 0,7/x_7; 0,5/x_8; 0,8/x_9; 0,6/x_{12}\}$$

Fuzzy sets for the other factors are formed similarly.

$$R'(x_2) = \{0,7/y_1; 0,6/y_4; 0,8/y_7; 0,7/y_9; 0,6/y_{11}\}$$

$$X'(y_2) = \{0,5/x_5; 0,7/x_7; 0,5/x_8; 0,8/x_9; 0,6/x_{12}\}$$

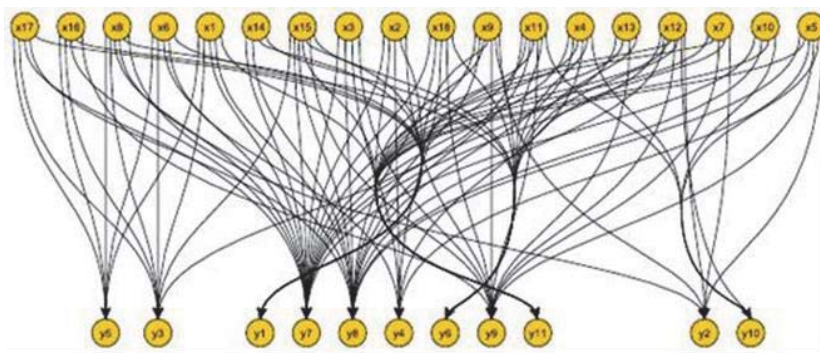


Figure 3 – Fuzzy graph for the evaluation of the strength factors' significance of CC

Analysis of matrix R reveals *the most significant strength factors* for each influence factor. In this matrix the elements of each line reflects the relative degrees of influence force of the strength factors (factors of corporate culture) to influence factors (factors of choice for creating business decision). The higher the value, the more important the feature. It is observed that there is no strength factor, which would be compatible with all influence factors.

The elements of each column of the matrix S are the degrees of membership or the degrees of compatibility of external opportunities with relevant influence factors (Figure 1). Degree of membership (matrix S) is detected by an expert estimation (Surveys of entrepreneurs-owners) when answering the following question: "To what extent the external

opportunities influence on the implementation of factors of choice for the decision to create/develop business?"

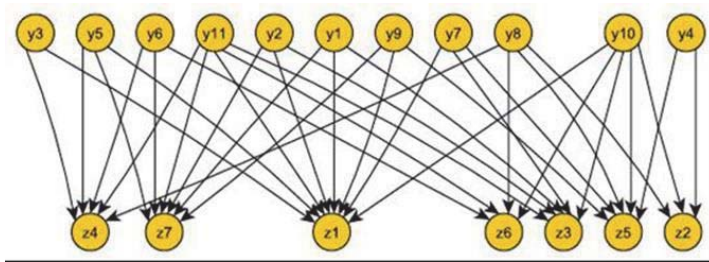


Figure 4 – Fuzzy graph for the evaluation of the interaction (influence factors with those of the external opportunities)

Then the fuzzy graph for the display - the fuzzy evaluation of influence (importance) of influence factors (factors of decision-making by the business owner) on factors of external opportunities in order to achieve established goal - is:

$$S'(z_3) = \{0,7 / y_4; 0,6 / y_5; 0,7 / y_8\}$$

and it is shown in Figure 4.

Factors of external opportunities in the interaction with the influence factor y_1 (leadership) formed a fuzzy set:

$$Z'(y_1) = \{0,6 / z_1; 0,8 / z_5; 0,6 / z_7\} \text{ etc.}$$

Thus, external opportunities z_1 (increased demand from the government in relation to development priorities) can interact to the maximum extent with influence factors y_4 (infrastructure) and y_8 (new technologies), and in zero degree with the influence factors $y_2, y_5, y_7, y_9, y_{10}, y_{11}$ (personality type, competition, the business climate, the initial investment, margin of products, unique competences, respectively), in moderate with influence factor y_1 (leadership) and y_6 (trained personnel) and to a small extent with the factor y_3 (interest). At the same time, a factor of external opportunities z_5 (export demand) can interact with almost all influence factors.

In the values of matrix T and S the possibility of implementing of strength factors of CC is considered through influence factors that meet the business characteristics for achievement of strategic goal: increase of the region's GDP by 10%. In general, the implementation tree (the fragment of it) of external opportunities using the strengths of the corporate culture of the region based on the influence factors is shown in Figure 5.

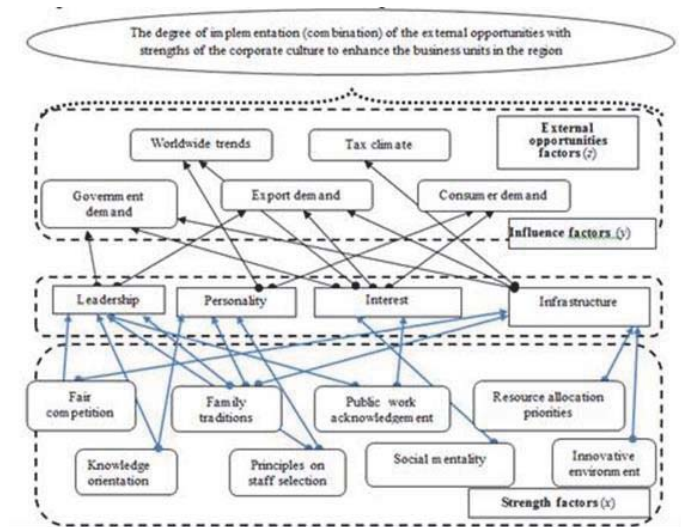


Figure 5 – The fragment of implementation tree (external opportunities)

The degree of implementation of (overlapping) of the external opportunities and strengths of the corporate culture to enhance the business units in the region

To determine the area of implementation (combination) of external opportunities M_i and strengths of the corporate culture, it is necessary to coordinate their interaction. For that, using equation (1), we obtain the matrix T (Figure 6).

	z1	z2	z3	z4	z5	z6	z7
x1	0,222	0,841	0,266	0,656	0,688	0,088	0,563
x2	0,282	0,371	0,124	0,412	0,512	0,271	0,282
x3	0,432	0,432	0,350	0,491	0,591	0,409	0,127
x4	0,415	0,573	0,228	0,538	0,715	0,220	0,575
x5	0,257	0,463	0,210	0,627	0,530	0,313	0,453
x6	0,348	0,631	0,290	0,290	0,621	0,124	0,403
x7	0,252	0,497	0,000	0,426	0,374	0,129	0,474
x8	0,295	0,632	0,192	0,492	0,503	0,054	0,470
x9	0,304	0,607	0,117	0,557	0,491	0,170	0,452
x10	0,200	0,618	0,175	0,825	0,743	0,214	0,593
x11	0,246	0,588	0,098	0,642	0,622	0,224	0,618
x12	0,265	0,533	0,098	0,568	0,505	0,225	0,472
x13	0,187	0,637	0,000	0,493	0,533	0,187	0,423
x14	0,500	0,629	0,150	0,421	0,629	0,086	0,507
x15	0,334	0,609	0,084	0,507	0,557	0,159	0,524
x16	0,175	0,531	0,133	0,381	0,461	0,133	0,408
x17	0,303	0,671	0,229	0,487	0,600	0,065	0,500
x18	0,523	0,494	0,316	0,406	0,610	0,335	0,290

Figure 6 – Matrix of implementation (combination) of external opportunities T

We apply the partition level $I=0,5$ and define zones of implementation of external opportunities M_i through strengths of CC (Figure 7), thus we obtain the level sets for all $x \in M_i$: $M_7 = \{0,563/x_1; 0,575/x_4; 0,593/x_{10}; 0,618/x_{11}; 0,507/x_{14}; 0,524/x_{15}\}$, and similarly for all other M_i .

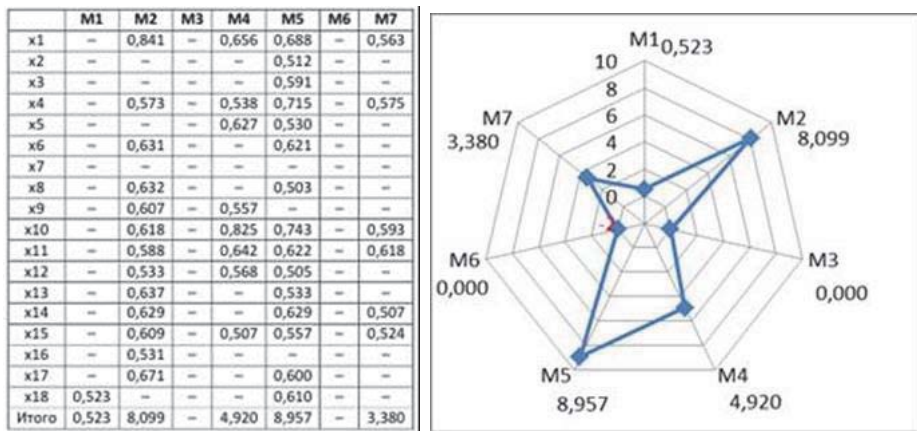


Figure 7 – Matrix and chart of the implementation (combining) of external opportunities T for partition level $I=0,5$

Due to the features of external opportunities z_3 , and z_6 (resources of mineral resources and regional preferences), their implementation (M_3 , M_6) is feasible in cooperation with the least amount of influence factors expressed in groups, characterizing the business environment and its production, but not the personal characteristics of top management. The strength of facilitating their implementation on the part of the corporate culture expressed with values below partition level that we have adopted and it ranges preferably $0,1 \div 0,2$ (from minimum to weak). The highest degree of realization (M_2 , M_5) can be traced to factors z_2 and z_5 (global trends, and export demand), which is supported to a great extent, on the one hand, by all three groups of influence factors and, on the other hand, by the strength factors of the corporate culture.

The average degree of implementation supported by factors of corporate culture is shown to external opportunities z4 and z7 (consumer preferences, investment activity).

The quantitative expression of the cumulative effects of strength factors for the implementation of external opportunities represents the sum of the factors of the set M_i :

$$M_1 = 0,5; M_2 = 8,1; M_4 = 4,9; M_5 = 8,9; M_7 = 3,4.$$

Graphic display of the results is illustrated by the diagram of the implementation of opportunities (Figure 7).

4. Conclusion

The method of substantiation of partition of strategic alternatives is proposed for solving the problem of modeling the vector and development priorities of the regional corporate culture using the compatibility of strength factors of corporate culture based on fuzzy logic.

This method of application of the fuzzy set theory enables to achieve analytically identified priorities for the factors, included in the analysis that makes them comparable. The purpose of the method of fuzzy logic is to improve the quantitative information substantiation of strategic planning processes. Moreover, the factors with the best obtained results can be chosen and, with this in mind, a strategy using the strengths of the corporate culture to achieve the goals can be developed.

This research presents the rationale of functional significance of dominant factors of corporate culture in the making of competitive value chains of the company in its qualitative and quantitative determination based on the theory of fuzzy sets.

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