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APPLICATION OF STD - METHODOLOGY IN SWOT – ANALYSIS

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Abstract

The article deals with the application of the methodology for constructing a strategy for the development of socio - economic systems using space - time diagrams (STD - methodology) to the analysis of the external and internal environment (SWOT - analysis). The factors of the internal environment are determined on the example of the regional socio - economic system. Numerical characteristics of each of the factors of the internal environment are introduced. Depending on the value, each factor is defined in terms of "strengths" ("weaknesses"). Then an integral indicator of the internal environment of the system is introduced - the state; the numerical values of the state at a given time are also interpreted as "strengths" ("weaknesses"). Then the factors of the external environment in which the development of the socio - economic system takes place are considered. Each factor is assigned an analytical model, the combination of which into a common numerical characteristic gives a model of the external environment (phase space). Depending on the value, the state of the external environment is determined from "opportunity" to "threat". The values of indicators of the internal and external environment can be identified not only as "strengths" ("weaknesses") or "opportunities" ("threats"), that is, in extreme cases. With the help of STD methodology, it is possible to determine the degree of influence of factors. In conclusion, the role of the STD methodology in eliminating some of the shortcomings of the SWOT analysis is emphasized.

Keywords: External environment, internal environment, SWOT - analysis, socio - economic system, STD - methodology

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1. Introduction

The most important stage in the strategic planning of the development of the regional socio - economic system is the analysis of its internal and external environment. The internal environment of a socio - economic system is a part of the organizational environment, limited by its framework. The internal environment determines the internal potential of the system, its ability to withstand external influences. The internal environment is the source of resources that enable the system to achieve its goal. Finally, the internal one determines the dynamics of the system's development. The internal environment is characterized by a combination of factors - its main characteristics. Factors are usually not quantified, they are qualitative indicators.

Any socio - economic system develops in the external environment, exchanges resources with it. The external environment consists of many structures, subjects, factors that are not elements of the system, but that affect it. From the external environment pressure is exerted on the system, which slows down its development. On the contrary, environmental factors can accelerate the development of the socio - economic system. It is in the vernal environment that the system's responses to the incoming action are sent. Therefore, the analysis of the external environment is an important task of strategic management. There are many methods for analyzing the internal and external environment of the system. Perhaps the most common is SWOT analysis. It is a universal tool and is used in various areas of the economy. The method can be adapted to any analyzed elements depending on the purpose of the analysis. In addition, SWOT analysis can be used both for a quick assessment of the external and internal environment, and for planning for the long term. However, the classical approach to SWOT analysis has a number of disadvantages. First of all - SWOT - analysis operates not with quantitative, but with qualitative indicators. This reduces the accuracy of the analysis and makes it difficult to objectively interpret its results. In addition, the lack of quantitative indicators makes it almost impossible to analyze the socio - economic system in dynamics. The importance of solving this problem has been repeatedly emphasized by leading economists (Anand & Gray, 2017; Arend et al., 2017; Crilly, 2017; Maritan & Lee, 2017; McIntyre & Srinivasan, 2017; Wolf & Floyd, 2017).

2. Problem Statement

So, the analysis of external and internal environments consists in studying their factors and determining the influence of these factors on the socio - economic system. To give an objective assessment of the influence of factors, it is necessary to move from qualitative assessments to quantitative ones. It is also desirable to introduce indicators that characterize both the external environment and the internal environment as a whole. This is the main task of the research. To solve it, it is necessary to research and predict the factors of the internal environment of the socio - economic system. Each factor of the internal environment must be assigned a numerical characteristic that determines the factor from the position of "strengths - weaknesses". The next task to be solved is to obtain an integral assessment of the internal environment, ranking the assessments and analyzing these assessments in terms of "strengths - weaknesses". The final task of the study is the need to obtain quantitative indicators of environmental factors and assess these factors from the perspective of "threats - opportunities".

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3. Research Questions

To solve the formulated tasks, it is necessary to answer the following questions. First, it is necessary to obtain a quantitative assessment of the factors of the internal environment. Further, each factor should be analyzed in terms of the degree of influence on the development of the socio - economic system. To determine the total influence of factors of the internal environment on the system, it is required to build an integral numerical characteristic. The next question requiring solutions is obtaining the numerical characteristics of the factors of the external environment of the system. Taking into account the stochastic nature of the influence of environmental factors, construct an analytical model of the phase space. At the same time, the phase space is a part of the external environment in which the development of the socio - economic system from the initial state to the intended goal takes place, in which the management of the system is modelled.

4. Purpose of the Study

Let us formulate the main goal of the study. First of all, it is necessary to modify the analysis of the external and internal environment of the socio - economic system. The modification consists in assigning numerical indicators to the factors of the external and internal environment. With the help of the obtained numerical characteristics, it is necessary to graduate the factors of the internal environment in the range of "strengths - weaknesses", and the factors of the external environment - in the range of "threats - opportunities". When determining the values of environmental factors, it is necessary to take into account their probabilistic, random, stochastic nature. When modeling the external environment, it is necessary to assess the influence of its factors on the rate of development of the system. Finally, the aim of the study is to obtain an analytical model of the phase space.

5. Research Methods

In a number of works, the author of (Krylov, 2017) proposed a methodology for constructing a model of a strategy for the development of a socio - economic system from its initial state to an intended goal (PVD - methodology). Modelling is performed using graphical objects - space-time diagrams (SPD). In accordance with it, the state of the system (generalized characteristic of the internal environment) is modelled as a point with coordinates (t; s) in the Cartesian coordinate system tOs, where t is time, and s is the state of the socio-economic system. System control in SPD - methodology is modelled in the form of a directed U line. When constructing the model, the factors of the external and internal environment of the socio - economic system were taken into account. At the same time, the SPD methodology allows one to obtain quantitative characteristics of these factors. Let's apply them to SWOT analysis.

6. Findings

Each factor f_i of the internal environment is assigned a number - the value of factors. It is determined by the degree of compliance of the factors with the criteria for numerical assessment. The values can be determined using one of the heuristic methods (for example, using the method of expert judgment).

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The factor f_i will be evaluated in the range from 1 to 10,

$$1 \le f_i \le 10.$$

If

$$1 \le f_i < 5,$$

then the factor can be attributed to the weaknesses of the system, it is necessary to introduce corrective actions to change the situation. If the factor is in the range from 5 to 10, if

$$5 < f_i \le 10,$$

then the factor can be considered a strong point.

The factor f_i is considered as a function of time,

$$f_i = f_i(t_j). \tag{1}$$

For simplicity, it is assumed that time is measured discretely at regular intervals,

$$t_j, j=1,2,\ldots,n. \tag{2}$$

The set of empirical estimates (1) of environmental factors at the observed points in time (2) form the matrix

$$F_{IE} = (f_i(t_j)) = \begin{pmatrix} f_1(t_1) & f_1(t_2) & \ldots & f_1(t_n) \\ f_2(t_1) & f_2(t_2) & \ldots & f_2(t_n) \\ \vdots & \vdots & \ldots & \vdots \\ f_5(t_1) & f_5(t_1) & \ldots & f_5(t_n) \end{pmatrix}. \tag{3}$$

Each factor plays a different role in the system of indicators of the internal environment. Therefore, it is necessary to introduce the value

$$p_i = p_i(t_j)$$

- factor weight. Weight is measured from 0 to 1,

$$0 \le p_i \le 1.$$

In this case, the sum of the weights of all factors of the internal environment at a given time t_j is equal to 1,

$$\sum_i p_i(t_j) = 1.$$

The weights can be determined by any known method. The values of the weights form a matrix

$$P = (p_i(t_j)) = \begin{pmatrix} p_1(t_1) & p_1(t_2) & \ldots & p_1(t_n) \\ p_2(t_1) & p_2(t_2) & \ldots & p_2(t_n) \\ \vdots & \vdots & \ldots & \vdots \\ p_m(t_1) & p_m(t_1) & \ldots & p_m(t_n) \end{pmatrix}. \tag{4}$$

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A variety of factors determines the need to introduce an indicator, which is an integral characteristic of the internal environment of the system. We will call this indicator the state of the socio - economic system.

So, the state of the system

$$s = s_j = s(t_j) \tag{5}$$

at a moment in time t_j is called a characteristic that unites all assessments of all factors of its internal environment. State *s* determines the internal potential of the system, the ability to both adapt and resist changes in the external environment. It is the value of the state that is the determining indicator of the possibility of achieving the goal. By calculating the state of the system, you can determine the control strategies and choose the optimal one from them. The state for a given moment in time is defined as the mathematical expectation of estimates of its internal environment factors:

$$s = s_j = s(t_j) = \sum_i f_i(t_j) \cdot p_i(t_j). \tag{6}$$

In this case, the condition scores will vary from 1 to 10,

$$1 \le s_j \le 10.$$

We have: if

$$1 \le s_j < 5,$$

then the weaknesses prevail over the strong, the system shows signs of crisis phenomena (the closer the value of the state is to 1, the stronger the crisis); when

$$s_j = 5,$$

it can be argued that the state of the system at the moment of time t_j is neutral; if

$$5 < s_j \le 10,$$

the state of the regional socio-economic system can be assessed as crisis-free; the closer the score is to 10, the more prosperous the system can be.

Prospective forecast of state values is carried out according to the following regression model

$$s = s(t_j). \tag{7}$$

For this, for each moment in time, the empirical value of the state is determined by formula (6) according to the available estimates of factors and their weights. This can be done by multiplying the matrix P^t transposed to the matrix *P* (4) by the matrix *F* (3).

Let's move on to the numerical characteristics of the external environment.

Let it be F_i a factor of the external environment influencing the development of the regional socio - economic system.

The development of the system is considered at discrete times $t_1, t_2, \ldots, t_m$. Also let be $s_1, s_2, \ldots, s_n$ the possible states of the system (7).

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The number $k_{F_i}^{t_j,s_l}$, $i = 1,2,...,m$, $l = 1,2,...,n$, will be called the coefficient of influence. The coefficient of influence determines the degree of influence F_i of the environmental factor on the system that is in a state s_l at a time t_j. It can take values from $-\infty$ to $+\infty$.

$$-\infty < k_{F_i}^{t_j,s_l} < +\infty .$$

If a

$$k_{F_i}^{t_j,s_l} < 0,$$

then the factor F_i is perceived as a threat. If

$$k_{F_i}^{t_j,s_l} > 0,$$

that F_i is an opportunity. When

$$k_{F_i}^{t_j,s_l} = 0$$

it is argued that the factor F_i is neutral and does not affect the system.

The set of values of the influence coefficients forms a matrix

$$F_i = \left(k_{F_i}^{t_j,s_l}\right)$$

dimensions $\dim F_i = n \times m$.

The matrix

$$F_{EE} = \sum_i F_i = \sum_i \left(k_{F_i}^{t_j,s_l}\right) = \left(\sum_i k_{F_i}^{t_j,s_l}\right),$$

equal to the sum of the matrices for each environmental factor.

The constructed matrix *F* is an analytical model of the external environment. Each of its elements is a coefficient of the influence of the external environment, corresponding to a certain state of the system at a given time.

Let us introduce indicators that affect the rate of development of the system. For this, the function

$$f = f\left(k_F^{t_j,s_l}\right). \quad (8)$$

It has properties similar to those of the exponential function: 1) $f\left(k_F^{t_j,s_l}\right)$ - monotonically increasing function; 2) $0 < f\left(k_F^{t_j,s_l}\right) < +\infty$; 3) $f(-\infty) = 0$; 4) $f(0) = 1$; 5) $f(+\infty) = +\infty$.

Using the method of obtaining the coefficient of the influence of the external environment as the sum of the coefficients of the influence of its factors, we have:

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$$f\left(k_F^{t_j,s_l}\right)=f\left(\sum_i k_{F_i}^{t_j,s_l}\right)=\prod_i f\left(k_{F_i}^{t_j,s_l}\right).$$

This means that the value of the function $f\left(k_F^{t_j,s_l}\right)$ corresponding to the external environment of the system, which is in the state s_l at the moment of time t_j, is equal to the product of the values of the function for each of the factors.

Let the system develop with speed v_0. After the action of the environmental factor, the speed changed and became equal v_1. The modified speed is calculated using the formula:

$$v_1 = f\left(k_F^{t_j,s_l}\right)\cdot v_0.$$

At the point $-\infty$ the value of the function $f(-\infty)=0$. From here

$$v_1 = 0\cdot v_0 = 0.$$

This means that the external environment hinders the development of the system so much that it becomes insurmountable for it.

With negative values of the coefficient of influence, the external environment perceives it as a threat. Speed

$$v_1 < v_0.$$

Moreover, the lower the value of the factor, the lower $f\left(k_{F_i}^{t,s}\right)$ and the lower the speed v_1.

As it grows $k_F^{t_j,s_l}$, the negative impact of the external environment on the system decreases, its changed speed v_1 is less and less different from the original v_0.

When $k_F^{t_j,s_l}=0$ the value of the function $f\left(k_F^{t_j,s_l}\right)=1$. In this case, the influence of the external environment on the organization is not felt,

$$v_1 = v_0,$$

it can be considered neutral.

Finally, at $k_{F_i}^{t,s}>0$ speed

$$v_1 > v_0.$$

This means that the external environment accelerates the development of the organization, becomes an opportunity for it. Moreover, the higher the value $k_F^{t_j,s_l}$, the higher the speed v_1 compared to v_0.

The constructed function (8) allows to obtain indicators of changes in the initial rate of development of the system, with the predicted value of the influencing factor. This will help both prevent undesirable consequences and prepare corrective actions to reduce possible losses from speed changes.

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7. Conclusion

Summarize. Based on the above, we can conclude that the STD methodology allows solving the following tasks. First, it turned out to be possible to quantify the factors of the external and internal environment of the system. Secondly, with the help of the STD methodology, it is possible to analyze the dynamics of the development of factors of the external and internal environment, to forecast the values of indicators. Finally, STD - methodology allows you to get rid of the subjective approach in SWOT - analysis, to exclude the human factor.

We hope that the proposals for the analysis of the external and internal environment set out in the article will make it possible to better analyze the external and internal environment of the system. The versatility of the proposed method makes it possible to apply it to various types of systems without restrictions and taking into account their specifics.

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