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GEOSTRATEGY OF UKRAINE: A MATHEMATICAL MODEL OF BUILDING SECTORAL INSTITUTIONAL-ORGANIZATIONAL STRUCTURES

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Abstract. Structuring the geostrategic landscape entails using integrated modeling methods to expand strategic horizons to forecast the development vectors of political and economic systems. The reasons for the barbarous war of the Moscow regime against the Ukrainian state have a significant basis both for theoretical study and further practical implementation of the obtained data into political and security practices. Examining the cause-effect complex of articulation of destructive paradigms has become the subject of many sciences. However, requiring their completed conceptualization within the political reality, individual phenomena are poorly studied from the standpoint of economic representation in the context of mathematical modeling of institutional implementing strategic national interests in the most crucial areas of life. Thus, public infrastructure policy is one of the reference areas. The development of the geostrategy of the modern Ukrainian state actualizes the task of elaborating precise mathematical models for assessing geostrategic processes, primarily the economic component. Clarifying the economic foundation of the war against Ukraine makes it possible to identify the facts of falsification in the modern political reality of those economic concepts which focus on the genocide of the Ukrainian nation under the guise of the development concept, reform, modernization, integration, etc. The paper articulates the conditionality of referring to the mathematical dimension of geostrategy implementation as exemplified by state infrastructure policy, analyzes the models of rendering political and economic decisions, specifies essential characteristics of institutional structures, and determines the algorithm for selecting experts. The article extends the central author's idea of a clear distinction between geopolitics and geostrategy. Therefore, mathematical modeling assists in proving the nullity of argumentation and the lack of logical and other prerequisites for implementing Ukraine's economic policy in the interests of third countries. It is concluded that the scientific study of alternatives to building institutional structures carrying out geostrategy, combined with articulating the economic dimension of their efficiency in the most important areas of life, constitutes an essential layer of political and economic doctrines. They should lay the groundwork for the design of the geostrategy of the modern Ukrainian state outside the context of stigmatization and attempts to rewrite history, semblance of the geostrategic landscape in a space-time format, and imposing destructive economic models on Ukraine.

Key words: political and economic dimension of geostrategy, economic policy, geostrategy of modern Ukrainian state, mathematical model, development alternatives, economic ideology, Ukrainianness, passionarity of titular ethnic group.

JEL Classification: P10, C10

1. Introduction

The development of the modern Ukrainian State is increasingly facing expressive forms of its rejection as an independent and self-sufficient entity of international relations. Studying only political or military roots is insufficient to model modern complex processes within the geostrategic landscape. There is a need to apply interdisciplinary metho-

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dology, including mathematical modeling methods, which make it possible to reach superior abstractions through the use of reference models.

Since public policy is a systemic phenomenon, the application of extrapolation models should be preceded by the use of a reference model for building institutional-organizational structures in the separate most challenging and complex system. In this article, the system of state infrastructure policy is regarded as a reference given the scale.

The issues covered in research are raised for the first time in such interpretation; thus, there is no practical need to cite and point out those who have not dealt with them.

The purpose of the article is to present a mathematical model of building sectoral institutional-organizational structuring as exemplified by the system of state infrastructure policy.

During the analysis of literature sources (Afonichkin, Mihalenko, 2009; Maliarets, Minienkova, 2017; Morozov, 2013; Putiatyn, 2015; Tsiutsiura, Kryvoruchko, Tsiuriupa, 2012; Shtoyer, 1992; Linkov, Moberg, 2012; Alireza Afshari, Majid Mojahed and Rosnah Mohd Yusuff, 2010), it was found that in order to substantiate decisions on an optimal institutional-organizational structure for implementing the strategy of Ukraine's state infrastructure policy, it is advisable to refer to multi-criteria analysis, because assessment along with the developed criteria will allow ranking alternatives by the degree of benefits to select the optimal option of an adequate solution. An analysis of alternatives contributes to the identification and overcoming of limitations arising when making unstructured decisions, and the integration of objective indicators with subjective assessments, particularly under the active use of subjective judgments, can act as a basis for generating a set of all possible options for analytical work on making a decision relevant to specified conditions.

It seems appropriate to develop a decision-making algorithm in view of the *multi-criteria management decisions analysis* (MCMDA) to justify the chosen approach to selecting alternatives for institutional-organizational structures for carrying out the strategy of state infrastructure policy.

It should be kept in mind that the problem solution through applying the MCMDA methodology requires compliance with the following steps:

1) selection of alternatives, which involves analysis and selection of the most significant alternatives from the range of possible or given options to solve a specific problem;
2) determination of the best alternative from the considered ones;
3) alternative ranking (from the best to the least optimal given assessments and benefits).

2. Reference management decision model based on a multi-criteria analysis

A decisive advantage in applying the MCMDA approach is an option to arrange expert judgments by descending importance and compare specific criteria without considering units of their measurement that is achieved by standardizing the judgments.

To formalize the choice problem, criteria must have quantitative characteristics because a criterion is a quantitatively expressed goal or a quantitative model of this goal. In general, criteria can be presented as some evaluation function which acquires value based on a set of evaluations.

One of the approaches to solving multi-criteria management problems is related to the procedure for creating a generalized function: $f\ (a_1,\ a_i,\ a_{i3};\ ...,\ a_{in})$, which is monotonically dependent on the criteria $a_{i1},\ a_{i2},\ a_{i3},\ ...,\ a_{in}$. The relevant approach is realized through the method of criteria convolution. Following the research objectives and set tasks, it is expedient to apply the ***method of additive convolution of criteria***.

This method is grounded on criteria standardization, that is, bringing them to comparability. In addition, the vector of the weighting factors of the criteria $\lambda = (\lambda_1, \lambda_2, \ldots, \lambda_j)$, which can facilitate assessing the importance of a particular alternative, is determined. At the same time, the requirement for (1) is met:

$$\sum_{j=1}^{n}\lambda_j = 1,\ \lambda_j \geq 0. \quad (1)$$

A new objective function (2) is built for the additive criterion:

$$F(A_i) = \sum_{j=1}^{n}\lambda_j \alpha_{ij} \quad (2)$$

The problem of optimizing the scalar criterion $z = f\ (A) \to max\ (min)$ is solved under the conditions that $A \in D$, where $A = (a_1, a_2, \ldots, a_n)$ – a plurality of points which comply with a system of constraints $g(a_1, a_2, \ldots, a_n) \leq b_i$, $i=1,2,\ldots,m$; A – an allowed area of solutions. The elements of the D set are admissible solutions or alternatives, and the numerical functions f_j, $j=1,2,\ldots,n$ are objective functions or criteria defined for the A set.

In general, the objective function has the following form (3):

$$F(A) = \sum_{j=1}^{n}\lambda_j \frac{F_j(A)}{F_j^0(A)} = \sum_{j=1}^{n}\lambda_j f(A) \to max(min) \quad (3)$$

where: n – the number of combined partial criteria;
λ_j – the weighting factor of a j-th partial criterion;
$F_j(A)$ – the numerical value of a j-th criterion;
$F_j^0(A)$ – j-th standard divisor;
$f_j(A)$ – the standardized value of the j-th partial criterion.

As can be seen from an expression (3), the criterion for choice optimality is the objective function's maximum (minimum) value.

The generalized objective function can be used to convolute the partial criteria of optimality if: 1) partial (local) criteria are quantitatively measurable in order of importance, that is, each of them can be assigned some number λ_j, which quantitatively characterizes its importance to other criteria; 2) partial (local) criteria are homogeneous (they have the same dimension).

In this case, for solving a multi-criteria optimization problem, it is worthwhile to apply the additive criterion of optimality.

An additive criterion, or an optimality criterion, is found by adding the standardized values of the partial criteria.

Given the additive formula (2), the following conditions must be met: 1) the availability of m variant solutions (alternatives); 2) developed criteria (n) which stipulate the optimal solution choice; 3) weighting factors (λ_j, where: $j=1,...,n.$) to assess the degree of importance of each criterion; 4) evaluation of alternatives upon each criterion a_{ij}, $i=1,..., m, j=1,...,n$.

Taking into account the above conditions, a matrix is built. The relevant matrix conveys the alternatives (A_m) in the rows and the criteria (a_{mn}) in the columns. According to the described conditions (Table 1), the value of the optimality criteria (objective function) is determined (4):

$$F_1 = \sum_{j=1}^{n} \lambda_j \alpha_{1j}; \;\; F_2 = \sum_{j=1}^{n} \lambda_j \alpha_{2j}; \; ... \; F_m = \sum_{j=1}^{n} \lambda_j \alpha_{mj} \quad (4)$$

Due to the heterogeneity of criteria by optimization vectors (max/min) or if different measurement scales are used, these criteria should be subject to standardization which means such a sequence of procedures which reduces all criteria to a single, dimensionless scale of measurement.

Table 1

Matrix of Multicriteria Alternative Selection

Alternatives	Local Criteria			
	k_1	k_2	…	kn
A_1	a_{11}	a_{12}	…	a_{1n}
A_2	a_{21}	a_{22}	…	a_{2n}
…	…	…	…	…
A_m	a_{m1}	a_{m2}	…	a_{mn}
Weighting coefficient	λ_1	λ_2	…	λ_n

Source: author's development based on [2; 10]

The maximum and minimum of each local criterion is determined given:

– criteria to be maximized (5)

$$a_j^+ = \max a_{ij}, \; i = \overline{1,m} \quad (5)$$

– criteria to be minimized (6):

$$a_j^- = \min a_{ij}, \; i = \overline{1,m} \quad (6)$$

According to the principle of maximum efficiency, the standardized criteria are determined by relying on the following ratios:

– for the criteria to be maximized, the standardized estimates are calculated by the formulas (7; 8):

$$\overline{\alpha_{ij}} = \frac{\alpha_{ij}}{\alpha_j^+}, \; j = \overline{1,e}; \quad (7)$$

$$\overline{\alpha_{ij}} = \frac{\alpha_{ij} - \alpha_j^-}{\alpha_j^+ - \alpha_j^-}, \; j = \overline{1,e}; \quad (8)$$

– for the criteria to be minimized, the standardized estimates are calculated by the formulas (9; 10):

$$\overline{\alpha_{ij}} = 1 - \frac{\alpha_{ij}}{\alpha_j^+}, \; j = \overline{e+1,n}; \quad (9)$$

$$\overline{\alpha_{ij}} = \frac{\alpha_j^+ - \alpha_{ij}}{\alpha_j^+ - \alpha_j^-}, \; j = \overline{e+1,n}; \quad (10)$$

An alternative providing the maximum value of the target function will be optimum (2).

According to the minimum loss principle, the standardized criteria are determined from the ratios:

– for criteria to be maximized, the standardized estimates are calculated by the formulas (11; 12):

$$\overline{\alpha_{ij}} = 1 - \frac{\alpha_{ij}}{\alpha_j^+}, \; j = \overline{1,e}; \quad (11)$$

$$\overline{\alpha_{ij}} = \frac{\alpha_j^+ - \alpha_{ij}}{\alpha_j^+ - \alpha_j^-}, \; j = \overline{1,e}; \quad (12)$$

– for criteria to be minimized, the standardized estimates are found by the formulas (13; 14):

$$\overline{\alpha_{ij}} = \frac{\alpha_{ij}}{\alpha_j^+}, \; j = \overline{e+1,n}; \quad (13)$$

$$\overline{\alpha_{ij}} = \frac{\alpha_{ij} - \alpha_j^-}{\alpha_j^+ - \alpha_j^-}, \; j = \overline{e+1,n}; \quad (14)$$

An alternative providing the minimum value of the target function will be optimum (2).

The proposed methodology underlies the scientific and practical approach to selecting alternatives to drafting one of the sectoral strategies – the strategy of state infrastructure policy (hereinafter – SIP). To substantiate a theoretical and applied model of the SIP strategy, it is necessary to pay attention to its organizational and functional frameworks. First of all, the SIP system operation is dased on the coordinated interaction of horizontally and vertically integrated functional systems, which implement their functions through synthesizing reference models of the relevant system.

Given the scale of functions and the availability of a ramified public administration system, it seems relevant the study relies on the organizational and functional level, which involves coordination and synchronization of communications in two directions: *horizontal* (at the level of central executive bodies and other state bodies); *vertical* (at the level of territorial units of central executive bodies and other state bodies, regional and local authorities). The division of powers between the mentioned authorities should be realized under the principle of observance of a unified legal framework, which will ensure the best division of labor for the performance of state tasks and functions and the provision of appropriate services, thus promoting the interaction of system elements by uniting them into a single system.

Considering research objectives, there is a need to identify the most efficient from a perspective of the organizational framework of the executive body, which will be able to formulate and directly implement the strategy of state infrastructure policy most effectively.

3. Analysis of alternatives to institutional and organizational structures implementing Ukraine's geostrategy

To solve the relevant problem, it is expedient to analyze a range of organizational structures as appropriate alternatives, which have a single purpose but differ in the legally specified scope of the authority's legal action given its rights, obligations, purpose, tasks, and functions.

The first alternative to the formation and implementation of the SIP strategy *is the establishment of a separate public administration body*, which is empowered to draft and implement the relevant state policy in the specific area.

The second alternative provides for the establishment of a public administration body subordinated to a special-purpose law enforcement agency (a national counter-terrorism system can be used as a reference model).

The third alternative is the establishment of the Government Office for the Development and Implementation of the SIP Strategy.

The fourth alternative is proposed in view of the creation of the Center for the Protection of Critical Infrastructure under the Office of the President of Ukraine (OPU) and the Office for Critical Infrastructure Protection in the CMU structure with subordinated SE "Ukrainian Institute".

The alternatives put forward for the analysis were named considering the existing in political science and security practice rights to justify the organizational structures for the implementation of the SIP strategy in the public administration system.

The key **benefits of establishing a separate state body** are as follows: 1) merger of various objects of the strategic infrastructure into a single management system, which allows for effective and efficient control over the performance of tasks, powers and functions within a single state body; 2) scale saving stimulated by operational management and response to state variability.

Shortcomings in the establishment of a separate state body should be considered within the categories of time and costs, that is, the duration of all organizational procedures for the establishment of a specific central executive body and the costs for implementing the project. In addition, the scope of financial support of the new-established state body requires more funding from the state budget compared to other organizational structures. The scale of such an organizationally ramified structure leads to tight control over the vertical. As a result, there is evident pressure on performers and an increase in the document flow.

The following alternative justifies the creation of a body subordinated to a separate special-purpose law enforcement agency (national security entity/ security policy entity) *(this article refers to the SBU model)*. The benefits of the organizational structure under consideration originate from the SBU legal status, which envisages the assessment of critical infrastructure security, the procedure for responding to some incidents of information security violations and their elimination. In addition, the advantages also include the availability of formed communications, which are realized through a smooth-running system of inter-agency interaction and coordination of the performance of ministries, which makes it possible to formulate and implement joint inter-agency communication programs.

The main disadvantage of developing such a structure is a niche expertise of the sectoral executive body, which is regulated by the Law of Ukraine "On the Security Service of Ukraine" (Pro Sluzhbu bezpeky Ukrainy: Zakon Ukrainy), as well as its dependence on the political climate taking place in the geostrategic landscape.

Alternative no. 3 provides for the establishment of a Government Office for Critical Information Protection. *The advantages* of such an organizational entity are as follows: mobility of response to events arising during the implementation of the SIP strategy; structured and adaptive budget financing compared to the above-mentioned public authorities; the possibility of accumulating a powerful expert and analytical capacity; attraction of additional investments.

The shortcomings of this unit's organization comprise the minimization of its functions arising from its status, powers and subordination, as well as the need for constant involvement of highly-qualified specialized experts.

The Center of Critical Infrastructure Protection under the Office of the President of Ukraine and the Office for Critical Infrastructure Protection in the CMU Structure with subordinated SE "Ukrainian Institute", described by the ***fourth alternative***, has the following main advantages: a) established interaction and relations with public authorities at all levels, taking into account the general provisions of the Law of Ukraine "On the Cabinet of Ministers of Ukraine" (Pro Kabinet Ministriv Ukrainy: Zakon Ukrainy); b) moderation of time and costs for the establishment and development of such a budgetary institution; c) flexibility in information flow management. The threat of functions' duplication due to the extensive functional responsibilities and the need for specialists in various branches with the appropriate qualifications can be considered the main *shortcomings*.

In order to obtain competent judgments on the alternatives put forward and test the methodology of a multi-criteria analysis using empirical objects and considering the tasks set, it is expedient to resort to expert assessment.

Expert assessment refers to the procedure for obtaining an estimate of a problem based on the opinion of specialists (experts) to make a further decision (choice) (Danelyan, 2015).

Experience, intuition, and feelings of perspective combined with information allow the subjects of expert assessment (experts) to more accurately choose the most important objectives and directions of development and find the best options for solving complex problems in the absence of information sources about the solution of similar problems in the past.

Despite the predicted bias – the use of the above characteristics for the selection of experts – expert assessments can be often one of the most effective, fast and accurate decision-making tools (Maryicheva, 2018). However, to increase the accuracy, objectivity of assessments and the quality of the decision-making procedure, several experts should be involved and, hence, their opinions should be regarded when analyzing alternatives.

Expert assessments can provide generalized information about the object (phenomenon) under study to substantiate a certain decision that is set by expert evaluation purpose. The information obtained is not conclusive. It is subject to processing using the selected evaluation methodology. The application of a particular method when analyzing individual expert assessments depends on the complexity of the current problem and the specifics of the study area.

By relying on the analyzed sources (Azgaldov, Kostin, 2012; Danelyan, 2015; Maryicheva, 2018; Kalinina, Hozhyi, Musenko, 2012; Morozov, 2013; Podolianchuk, 2014), it was visualized the process of assessing expert competence, which was grounded on traditional evaluation criteria and available approaches and methods of examination: 1) evaluation requirements (credibility, efficiency, and reliability); 2) competence criteria (work experience, a number of successfully completed projects, and a qualification level); 3) evaluation methods (self-assessment, mutual assessment, assessment by a working group).

The issue of assessing expert competence is quite complex. However, given the tasks set, such formal general competence criteria as position, academic degree and rank, seniority, the number of examinations or projects completed, the number of scientific research, developments in the relevant field, etc. can be used for evaluation.

The selection of the above criteria originates from the hypothesis that to solve the problem, there is an available amount of information sources for making a decision. Therefore, in terms of the problems, experts act as qualitative sources and fairly accurate measures of information. As for the ways of evaluation, they have both some advantages and disadvantages associated with the influence of subjective factors. In particular, if the assessment uses a method involving mutual evaluation, each candidate elected to the expert group assesses the competence of others. In the other case, an analytical group, which organizes and runs expertise, is formed. However, the analyzed methods entail awareness of each expert regarding the qualifications and professionalism of other selected specialists. The method's significant drawback also be evident when there is a confrontation between experts, or a coalition of experts. This considerably affects assessment objectivity and, thus, the questionnaire results that can distort the examination of findings. Such methods are not applicable towards the purposes set in the paper. In this context, it is advisable to use such a method as self-assessment, when the expert himself provides an assessment of the awareness of the expertise subject and his competence. That sort of method is the most acceptable amidst the relevant assessment since the competence criteria are based on the analysis of documentary data.

If the selection of experts to perform tasks and objects is carried via maximum estimates under the coefficient of competence, it is possible to use a combined method for ranking experts, which envisages the application of a methodological toolkit of the analytic hierarchy process (Saati, 1993; Bratushka, Novak, Khailuk, 2010).

A hierarchical structure consists of three levels: 1) the purpose is set – the choice of experts; 2) the criteria for choosing experts; 3) alternatives – the experts themselves.

4. Algorithm for selecting experts by assessing their competence according to the hierarchical method

The structuring of tasks as a hierarchical structure needs the following:
1) to build a hierarchy meeting the analysis objectives (in our case, it is the choice of *n* experts from the set of *N*) using factors (criteria) through comparison of options to the lower level, which contains a set of alternatives;
2) to select factors for assessing competence, which should comprise: an expert's area of expertise given education (legal, economic, political, or public administration); employment history in central executive bodies; scientific qualification (the availability of a scientific degree: candidate of sciences, doctor of sciences, or lack of a scientific degree); work experience associated with the subject of expertise, that is, work in public administration; experience in conducting expert evaluation, that is, the practice of conducting examinations on the establishment, creation and liquidation of organizational structures in public administration; experience in the economic appraisal of the costs for realizing a decision.

The solution to the problem of selecting specialists for an expert assessment consists of three stages: 1) drawing up a list of prospective candidates for performing an expert examination of certain objects; 2) selection of an expert group with a smaller number, considering the qualitative components of the assessments, that is, the sample includes experts who have gained the maximum coefficients of competence; 3) the determination of average sampling error.

To assess the professional competence of an expert, relevant test questions are drafted. For this purpose, it is used a test form, which includes questions on the professional qualification of an expert (Table 3) and the assessment of alternatives to deciding on the choice of a particular organizational form meeting the profile of critical infrastructure protection.

The survey involved ten specialists (experts), considering the research area, the subject of examination, and professional activity. By applying the documentary method, the respondents answered the test questions. The survey results are presented in Table 3.

At the first stage of assessing the experts' competence, the issue of choosing the weight coefficients of the experts upon the specific factors is solved.

Table 2
Test questions on the professional competence of experts upon specific factors (criteria)

Factors (criteria)	Weighting coefficient value under the specific scales		
Expert specialization by education *(F1)*	Legal	Economic	Public administration
	0.2	0.3	0.5
Employment history in central executive bodies *(F2)*	1 – 5 years	5 –10 years	More than 10 years
	0.2	0.3	0.5
Scientific qualification *(F3)*	without a scientific degree	PhD	DSc
	0	0.4	0.6
Experience with the subject under examination *(F4)*	none	5 – 10 years	more than 5 years
	0	0.4	0.6
Experience in conducting expert assessment *(F5)*	none	1 – 3 times	More than 3 times
	0	0.4	0.6

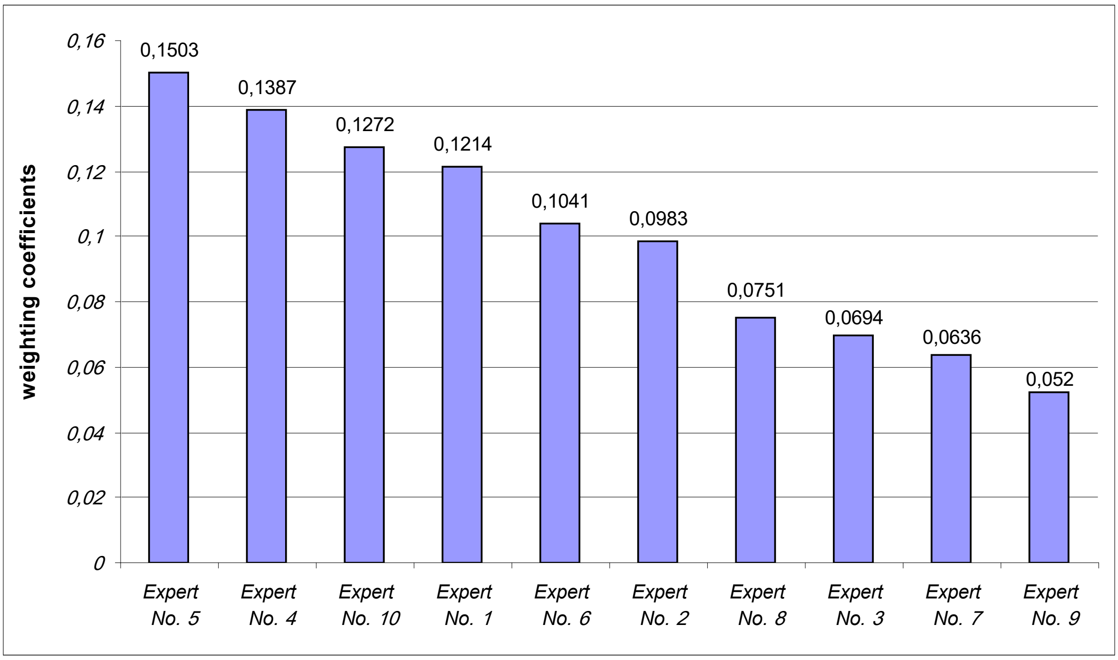
Source: the authors' development

Table 3
Results of the expert survey and calculation of weighting coefficients

	F1	*F2*	*F3*	*F4*	*F5*	*Sum* X_i	W_i
Expert No. 1	0,5	0,4	0,4	0,4	0,4	2,1	0,121387
Expert No. 2	0,5	0,2	0	0,4	0,6	1,7	0,098266
Expert No. 3	0,3	0,5	0,4	0	0	1,2	0,069364
Expert No. 4	0,5	0,3	0,4	0,6	0,6	2,4	0,138728
Expert No. 5	0,5	0,5	0,6	0,6	0,4	2,6	0,150289
Expert No. 6	0,2	0,2	0,4	0,6	0,4	1,8	0,104046
Expert No.7	0,3	0,4	0	0	0,4	1,1	0,063584
Expert No. 8	0,2	0,5	0,6	0	0	1,3	0,075145
Expert No. 9	0,3	0,2	0,4	0	0	0,9	0,052023
Expert No.10	0,3	0,3	0,4	0,6	0,6	2,2	0,127168
SumΦ_j	3,6	3,5	3,6	3,2		17,3	1

Note: an expert's specialization by training *(F1)*; employment history in CEA *(F2)*; scientific qualification *(F3)*; experience in terms of the subject of examination *(F4)*; experience in conducting expert assessment *(F5)*. *Calculated by the authors.*

Table 4
Ranking of experts upon professional competence according to weighting indicators



Source: the authors' development

The developed weights were based on the following statement (15):

$$\sum_{i=1}^{m} W_i = 1, \quad (15)$$

where W_i – the weighting coefficient of the i-th expert; m – the number of experts.

Calculation of the weight assessment of the i-th expert upon j – the factor (criterion) is performed according to the following algorithm:

1. The overall estimates of $SumX_i$ points scored by the i-th expert upon all specific factors are calculated (16):

$$SumX_i = \sum_{j=1}^{n} \alpha_{ij} \quad (16)$$

where: n – the number of criteria; a_{ij} – the point obtained by the i-th expert upon the j – factor (criterion).

2. The sum of points ($Sum\ \Phi_j$) is calculated, where – Φ_j – the factor for each expert, which is calculated by the formula (17):

$$Sum\Phi_j = \sum_{i=1}^{m} \alpha_{ij} \quad (17)$$

3. The weight coefficient of experts is calculated upon all factors (criteria) by the formula (18).

$$W_i = \frac{\sum_{i=1}^{m} \sum_{j=1}^{n} a_{ij}}{\sum_{j=1}^{n} a_{ij}} \quad (18)$$

The findings on the calculation of weighting factors presented in Table 4 allow analyzing the obtained weighting factors and performing the ranking of the set of options, which can be described by the equation $V = \{v_1, v_2, \ldots, v_n\}$. The options are ranked as follows: the larger the weighting factor, the higher the rank (Table 4).

As shown in Table 4, the largest ratings are achieved by an expert no. 5; 4; 10; 1; the moderate group of ratings can be attributed to an expert no. 6; 2; other experts – 8; 3; 7; 9 – have significantly lower ratings.

To understand which experts' points can be used to select alternatives, it is necessary to identify priority vectors by normalizing points. Therefore, a pairwise comparison matrix of factors (criteria) is used.

Identification of the vector of local priorities (L_i) is accomplished by calculating the geometric mean of the rows of a pairwise comparison matrix R (19):

$$R = \begin{pmatrix} r_{11}\, r_{12} \ldots r_{1n} \\ r_{21}\, r_{22} \ldots r_{23} \\ \ldots\ldots\ldots\ldots \\ r_{n1}\, r_{n2} \ldots r_{nm} \end{pmatrix} \quad (19)$$

In view of the matrix, sum is calculated by matrix columns $\sum_{i=1}^{n} r_{ij}$.

The next step is the standardization of all the components of the priority vector (20):

Table 5
Matrix of paired comparisons of factors (criteria)

Factors	F1	F2	F3	F4	F5	$\sqrt[5]{\prod_{j=1}^{5} ij}$	Li
F1	1	3	2	0,5	2	1,43097	0,25656
F2	0,3333	1	0,5	0,5	0,5	0,52961	0,09495
F3	0,5	2	1	0,3333	0,3333	0,64439	0,11553
F4	2	2	3	1	2	1,88818	0,33853
F5	0,5	2	3	0,5	1	1,08447	0,19443
Total	4,3333	10	9,5	2,8333	5,8333	5,57762	1

Note: an expert's specialization by training *(F1)*; employment history in CEA *(F2)*; scientific qualification *(F3)*; experience in terms of the subject of examination *(F4)*; experience in conducting expert assessment *(F5)*.

Source: calculated by the authors

Table 6
The results of calculating the global priorities of the surveyed experts

	F1	F2	F3	F4	F5	G
L_i	0,256	0,095	0,116	0,339	0,194	
Expert No. 1	0,122	0,114	0,111	0,129	0,120	0,122
Expert No. 2	0,122	0,057	0	0,129	0,160	0,112
Expert No. 3	0,074	0,143	0,111	0	0,160	0,076
Expert No. 4	0,122	0,086	0,111	0,194	0,160	0,149
Expert No. 5	0,122	0,143	0,167	0,194	0,120	0,153
Expert No. 6	0,122	0,057	0,111	0,194	0,120	0,138
Expert No.7	0,074	0,114	0	0	0	0,097
Expert No. 8	0,046	0,143	0,167	0	0	0,045
Expert No. 9	0,074	0,057	0,111	0	0	0,037
Expert No.10	0,122	0,086	0,111	0,160	0,160	0,138

Note: an expert's specialization by training *(F1)*; employment history in CEA *(F2)*; scientific qualification *(F3)*; experience in terms of the subject of examination *(F4)*; experience in conducting expert assessment *(F5)*. L_i – priority vector (local priorities); *G* – global priorities.

Source: calculated by the authors.

$$L_i = \sqrt[n]{\prod_{j=1}^{n} r_{ij}} \Big/ \sum_{i=1}^{n} \sqrt[n]{\prod_{j=1}^{n} r_{ij}} \qquad (20)$$

n – the number of hierarchy level criteria.

The obtained results are shown in Table 5.

According to Table 5, F1 (an expert's specialization by training) and F4 (experience in conducting expert research) prevail when assessing the professional competence of experts. Thus, subsequent normalization identifies global priorities (Table 6).

Based on the above data, it can be concluded that Expert No. 5, Expert No. 4, Expert No. 6 and Expert No. 10 have the highest global priority. Hence, their opinions can be regarded as a basis for assessing specific alternatives. However, it is necessary to clarify the limits of the group of key experts. To this end, it is used a relevant mathematical toolkit, which determines the number of experts forming the above group (21):

$$n = \frac{t^2 \times \sigma^2 \times N}{\Delta^2 \times N + t^2 \times \sigma^2} \qquad (21)$$

where: *t* (table) = 3 under probability 0.997; σ^2 = 0.003397, sample variance for data (Table 5, 6), *N* – totality (N=10); Δ – sampling error (not more than 7%) or Δ = 0.07.

Following data substitution, a result is obtained, where *n* = 3.841898.

Thus, the required number of experts for examining alternatives is 4 persons upon the general sample *N* = 10.

Proceeding from the calculations by the formula (21), it is possible to choose experts who have rank No. 1;2;3;4 for assessing the identified alternatives. In particular, they should be represented by Expert No. 5, Expert No. 4, Expert No. 10, and Expert No. 6, because of their maximum rating among the general sample, which is confirmed by weighting factors: 0.153, 0.149, 0.138, and 0.138, respectively.

By relying on the above, the generalized opinion of the expert group is average regarding their individual judgments, and therefore it can be considered adequate to the realities.

To rendered the final decision, it makes sense to calculate the competence coefficient by the formula (22):

$$KK_i = \frac{\sum_{j=1}^{m} k_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{m} k_{ij}}, \qquad (22)$$

Table 7
Calculation of the competence coefficient

Experts	Points defining the competence of experts					Total points of each expert	KK_i
	F1	*F2*	*F3*	*F4*	*F5*		
Expert No. 5	0,5	0,5	0,6	0,6	0,4	2,6	0,29
Expert No. 4	0,5	0,3	0,4	0,6	0,6	2,4	0,27
Expert No. 10	0,3	0,3	0,4	0,6	0,6	2,2	0,24
Expert No. 6	0,2	0,2	0,4	0,6	0,4	1,8	0,2
Total points						9	1,0

Source: calculated by the authors

where n – the number of experts; m – the number of criteria for assessing experts;

k_{ij} – the score obtained by the i-th expert upon the j-th criterion.

Based on the expert responses in the questionnaires and the points presented in Table 7 upon the formula (22), the competence coefficient of the expert group is determined.

Having selected the experts participating in the questionnaire, the next step should focus on the criteria for assessing alternatives. The proposed organizational structures of SIP are considered as alternatives, which should be created for the implementation of the relevant tasks.

Criteria for assessing alternatives comprise the following: a level of capacity to carry out inter-agency coordination (Cr_1); admissibility to distinguish between political and state communications (Cr_2); coverage of strategic and executive functions (Cr_3); time required for creating an organizational structure (Cr_4); costs of creating an organizational structure (Cr_5).

The defined criteria were assessed by the experts via a questionnaire in the Google form. Points were given in different ranges considering the growth vectors, requirements, and assessment objectives. For example, for growth vectors, the maximum point given to Cr_1; Cr_2; Cr_3 – the maximum point was given for the maximum score in the range from 1 to 5, that is, the higher the point value, the greater advantage of the alternative. In other words, the function strives to the maximum (Cr_1, Cr_2, $Cr_3 \rightarrow$ max). Cr_4 and Cr_5 obtained a maximum score given the minimum value, that is, the lower the score value, the greater the alternative's advantage, and therefore Cr_4, $Cr_5 \rightarrow$ min. Responses to pairwise comparisons of alternatives were based on the Saaty's scale from 1 to 9 points (Saati, 1993; Bratushka, Novak, Khailuk, 2010).

Experts expressed their views based on their practical experience and according to the occupational level and knowledge in public administration, the specifics of strategic communications and the possibilities of adapting them to the system of public administration.

Subsequent to the expert assessments, the data of Table 8 were calculated.

To evaluate alternatives, the weighting factors of each criterion must be determined. As a result, it is expedient to resort to the analytic hierarchy process given the experts' responses in the questionnaire, where they assessed the advantages of one criterion over another. Following the latter statements, a pairwise comparisons matrix for the criteria of selected alternatives was created (Table 9).

The results obtained during the analysis (Table 9) convey the criteria weight by significance levels (rating). However, it is essential to check the consistency of experts' opinions by identifying the consistency index (I_n) and the consistency ratio (I_0).

The consistency index is calculated by the formula (23):

$$I_t = \frac{\lambda_{max} - n}{n-1} \tag{23}$$

where: λ_{max} – the maximum value of the matrix R (24):

$$\lambda_{max} = \sum_{j=11}^{n} \left(L_j \sum_{i=1}^{n} r_{ij} \right) \tag{24}$$

Based on the data (Table 9), the maximum matrix value is R, namely λ_{max} = 7.516. The random consistency index (I_c) is calculated by the tabular method and is: I_c = 1.24 according to the reference table, and the consistency ratio (I_0) is calculated:

$$^2{}_{\hat{\imath}} = \frac{^2{}_{\hat{\imath}}}{^2{}_{\hat{a}}} \text{ or } {}^2\hat{\imath} = \frac{0,0860}{1,24} == 0,0694$$

By relying on the fact that the consistency index determines a satisfactory state at I_0 < 0.10, it can be argued that the consistency level of the R matrix is sufficiently acceptable, since the obtained results meet the requirement (0.0694 < 0.10). Thus, according to the research finding, it can be concluded that the highest rating (Table 9) belongs to the criterion "the level of capacity to carry out inter-agency coordination", which weights (Cr_1) 0.469. The next in the rating is the criteria which have minor differences in values, in particular, the criterion "time required to create an organizational structure" (Cr_5) – 0.187; the criterion "level of coverage of strategic and executive functions" (Cr_3) – 0.154; the criterion "time required to create an organizational structure" (Cr_4) – 0.125. The lowest rating belongs to the criterion "ability to

Table 8

Calculation of criteria values given the competence coefficient

Experts	KKi	A1	A2	A3	A4
1	2	3	4	5	6
Assessment of Cr_1 (level of capacity to carry out inter-agency coordination)					
Expert No. 5	0,29	5	3	1	2
Expert No. 4	0,27	5	4	2	3
Expert No. 10	0,24	5	3	1	2
Expert No. 6	0,2	5	5	1	2
Cr_1 weight given expert competence	1	5	3,67	1,27	2,27
1	2	3	4	5	6
Assessment of Cr_2 (ability to distinguish between political and state communications)					
Expert No. 5	0,29	4	3	2	1
Expert No. 4	0,27	3	2	3	2
Expert No. 10	0,24	4	4	3	2
Expert No. 6	0,2	5	3	1	2
Cr_2 weight given expert competence	1	3,93	2,97	2,31	1,71
Assessment Cr_3 (coverage of strategic and executive functions)					
Expert No. 5	0,29	5	5	2	1
Expert No. 4	0,27	5	4	3	2
Expert No. 10	0,24	4	4	2	3
Expert No. 6	0,2	5	4	2	2
Cr_3 weight given expert competence	1	4,76	4,29	2,27	1,95
Assessment of Cr_4 (time required to create an organizational structure)					
Expert No. 5	0,29	1	4	4	5
Expert No. 4	0,27	2	4	3	5
Expert No. 10	0,24	2	3	4	4
Expert No. 6	0,2	2	2	4	5
Cr_4 Weight given expert competence	1	1,71	3,36	3,73	4,76
Assessment of Cr_5 (costs of creating an organization)					
Expert No. 5	0,29	1	4	4	5
Expert No. 4	0,27	2	4	3	5
Expert No. 10	0,24	2	3	4	4
Expert No. 6	0,2	2	2	4	5
Cr_5 weight given expert competence	1	1,71	3,36	3,73	4,76

Source: calculated by the authors

Table 9

Pairwise comparisons matrix for alternative criteria

	Cr_1	Cr_2	Cr_3	Cr_4	Cr_5	$\sqrt[5]{\prod_{j=1}^{5} ij}$	L_i
Cr_1	1	9	5	0,25	0,143	3,178	0,469
Cr_2	0,111	1	0,333	0,143	0,5	0,437	0,065
Cr_3	0,2	3	1	5	3	1,045	0,154
Cr_4	7	2	0,333	0,5	1	0,844	0,125
Cr_5	4	7	0,2	1	2	1,267	0,187
Total	12,311	22,000	6,867	6,893	6,643	6,771	1,000

Source: calculated by the authors

Table 10

Summary assessments of alternatives

Alternatives	Cr_1	Cr_2	Cr_3	Cr_4	Cr 5
A_1	5,0	3,93	4,76	1,47	1,71
A_2	3,67	2,97	4,29	3,36	3,36
A_3	2,27	1,71	1,95	4,76	4,56
A_4	1,27	2,31	2,27	3,49	3,73
Weighting coefficients (λ)	0,469	0,065	0,154	0,187	0,125

Source: calculated by the authors

Table 11
Normalized assessments

Alternatives	Cr_1	Cr_2	Cr_3	Cr_4	Cr_5	$F_{n\,(aij)}$
A_1	1	1	1	0,691	0,625	0,895
A_2	0,734	0,756	0,901	0,294	0,263	0,620
A_3	0,454	0,435	0,410	0,000	0,000	0,303
A_4	0,254	0,588	0,477	0,267	0,182	0,304
Weighting coefficients (λ)	0,469	0,065	0,154	0,187	0,125	x

Source: calculated by the authors

distinguish between political and state communications" Cr_2 – 0.065.

Following the results shown in Tables 8 and 9, the authors shaped a summary table, which is the basis for applying multi-criteria analysis by convoluting local criteria to calculate the additive criterion through the application of normalized values of local criteria (Table 9).

5. Conclusions

In Table 10, the values of the weighting coefficients are the result of the calculation of local criteria (Table 9). Based on the data, we can calculate additive optimization criteria upon the provided alternatives using the formula (4). In accordance with the objective function of the task, the following mathematical expressions are obtained:

$$F_{1(aij)} = \lambda_1 \cdot a_{11} + \lambda_2 \cdot a_{12} + \lambda_3 \cdot a_{13} + \lambda_4 \cdot a_{14};$$

$$F_{2(aij)} = \lambda_1 \cdot a_{21} + \lambda_2 \cdot a_{22} + \lambda_3 \cdot a_{23} + \lambda_4 \cdot a_{24};$$

$$F_{3(aij)} = \lambda_1 \cdot a_{31} + \lambda_2 \cdot a_{32} + \lambda_3 \cdot a_{33} + \lambda_4 \cdot a_{34};$$

$$F_{4(aij)} = \lambda_1 \cdot a_{41} + \lambda_2 \cdot a_{42} + \lambda_3 \cdot a_{43} + \lambda_4 \cdot a_{44}.$$

To solve the task, it is necessary to normalize experts' assessments by identifying a group of the maximum criteria (Cr_1, Cr_2, $Cr_3 \rightarrow$ max) and a group of the minimum criteria (Cr_4, $Cr_5 \rightarrow$ min).

The next step ascertains the overall optimization problem given maximizing or minimizing the objective function. Taking into account the conditions, the general problem should be solved as a maximization problem, because the maximization criteria prevail over the minimization criteria. Consequently, a formula (7) is used to normalize the scores to the maximum. For criteria under minimization, normalized assessments are calculated using formulas (9).

Normalization results are shown in Table 11.

As can be seen from Table 11, the obtained assessments have the following rating: A_1 = 0.895; A_2 = 0.620; A_4 = 0.304; A_3 = 0.303.

This allows stating that when a function seeks the maximum, the most acceptable alternative should be an alternative with a maximum value of $F_{n\,(aij)}$, i.e., A_1 that **justifies the decision to establish a separate state executive body**.

Thus: if we consider geostrategy as a holistic and adaptive macro-system [19], containing all the functionality of state policy, then following the above (the case of state infrastructure policy (Lipkan, 2021)), the relevant measures are taken before distributing all functions:
1) the most important spheres of life are formed;
2) according to the specific areas, separate central executive bodies are established, which should implement well-defined functionality through the implementation of relevant sectoral strategies;
3) all sectoral strategies, as types of political and security practices in certain areas of life, are interconnected systemic links in the context of the geostrategy implementation as a whole;
4) strategies as acts of strategic law-making should be drafted exclusively by relying on an overall geostrategy that specifies the development principles for the political system as a whole.

Mathematical methods of economic modeling can render a reference approach to developing institutional and organizational structures in various areas of public policy.

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