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ONE OF THE METHODS OF GEOMETRIC FORMALIZATION OF THE SEPARATE FACTOR SITUATIONS

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The method of geometrical formalization of discrete information submitted in the form of a table of initial data of a certain factor is developed in which the situation with respect to the existing model types of this factor and their characteristics of economic, technological, ecological, artistic and aesthetic and any other direction are reflected.

Key words: composite method, factor situation, discrete curve, renovation of buildings, energy efficiency.

Formulation of the problem. In the process of renovating buildings in order to increase their energy efficiency, for each of the components (factors - materials, equipment, etc.), which are components of these processes, in the modern market there are a number of proposals for the timothy of this factor. These proposals differ in their economic, environmental, physical, artistic and aesthetic and other indicators. Selection, according to certain criteria, of all the available variants of the thymomodels, the best that most closely corresponds to the tasks of renovating the buildings, is a problem. This article is intended to solve this problem.

Analysis of recent research and publications. Due to the constant increase of utility tariffs, renovation of buildings to increase their energy efficiency, more and more attention is paid. The first stage in such a complex of works is energy audit, which must be carried out in accordance with the current standards [6, 7]. For educational institutions, on energy audit, a methodology has been developed to identify the main problems and propose measures for energy conservation [8]. In the field of energy management, on the basis of mathematical modeling, there is a significant improvement of domestic and foreign scientists. In particular, from energy-saving technologies [8, 9], on the selection of optimal geometric parameters of buildings [10], on the study of multi-criteria models using fuzzy logic [11]. The authors of this article develop a composite method of geometric modeling of multifactorial processes, which makes it possible not to limit the number of factors to include them in the simulation process [12, 13]. The composite method of geometric simulation is developed on the basis of a point BN-number [14], which allows for the geometric formalization of situations and processes without limiting the number and nature of factors.

A large number of factors included in the model increases the adequacy of the geometric formalized model. This article is aimed at further development of the composite method of geometric modeling of multifactorial situations and processes.

Formulating the goals of the article. Propose a method and develop a geometric formalization algorithm for analyzing discretely presented information about the trigonometric factors for a particular situation that they (tiomodels) form.

Main part. As is well-known [1], the situation is a set of conditions, circumstances and elements that occur randomly and create a certain position. One of the features of the situation is that its elements are not functionally linked to each other, the replacement of one of the elements does not entail the replacement or change of others. When changing elements, the composition of the situation changes [2].

In the process of renovating buildings, in order to increase their energy efficiency, for each of the components used to carry out work, there are many situations due to the large number of offers of timodomists that are available on the market. Therefore, an economically sound selection of components from a situation that is composed of each factor is an important task. Consider, for example, the factor "Window", a way to select an element economically justified by a certain criterion. The situation for the "Window" factor on the windows offer market is given in Table 1. The combination that defines the situation (Table 1) is random and incomplete, because windows are offered on the market much more than 20, and not all they are included in Table 1 for consideration. Therefore, in any case, the number of windows can be increased or reduced, some can be deleted, others added. With such actions, the situation in Table 1 will change. The sequence of recording these 20 windows is also random, it may, if necessary, be changed.

Thus, using tables, situations are presented. For the geometric formalization of the situation, each tiomodel window will be perceived as a point, and the parameters characterizing the tiompodel will be its coordinates. Note that the sequence of recording the parameters of the point does not matter, which means - the change of the sequence of recording coordinate-parameters does not change the point-tyomopodel. This implies that the two points of the timodellet are the same if the parameter names have the same values and, thus, it is not important in which sequence these parameters are written in the first and second points-tyomodels.

The situation in the tables can be tipomodel points, which do not match the coordinates by number and names, however, in the geometric formalization method proposed in this article, it is possible to analyze such situations.

So, below, we give Table 1, which creates a composition by the factor "Window". It defines the situation with twenty point windows, which are characterized by fifty coordinate parameters.

Table 1

«Window» factor

№	Parameters	unit wim	Window 1	Window 2	…	Window 19	Window 20
1	**Economic**	-	-	-	…	-	-
	1.1. The cost of the window,	UAH	2754.50	1657.20		7255.39	7255.39
	1.2. Installation cost,	UAH	275.30	243.80		0	0
	1.3. Total cost of the window with installation,	UAH	3029.80	1901.00		7255.39	7255.39
	1.4. Compliance with the requirements of the program "warm loans"	Yes / No	No	No		Yes	No
	1.5. Saving on heating for the season (thermal energy)	Gcal	0.19	0.07		0.19	0.05
	…	…	…	…	…	…	…
2	**Ecological**	-	-	-	…	-	-
	2.1. Reducing emissions CO_2 in a year	kg	185	77	…	188	40
	2.2. Profile material	Name	metal-plastic	metal-plastic	…	wood	wood
	…	…	…	…	…	…	…
3	**Physical**	-	-	-	…	-	-
	3.1. Number of leaflets	pcs	3	3	…	3	3
	3.2. Window width	m	1.92	1.92	…	1.92	1.92
	3.3. Heat transfer coefficient of a double-glazed window	wt/(m^2·K)	1.14	2.33	…	1.27	2.7
	…	…	…	…	…	…	…
4	**Technological**	-	-	-	…	-	-
	4.1. Related materials and equipment	Name	brackets	profile		brackets	brackets
	…	…	…	…	…	…	…
5	**Artistic and aesthetic**	-	-	-	…	-	-
	5.1. Color	Name	white	white		beige	beige
	5.2. Texture	Name	glossiness	glossiness		matte	matte
	…	…	…	…	…	…	…

The task is: to find out, on the basis of analysis of the initial parameters, which of these 20 points to give preference to the formed evaluation criterion. Note that for any factor, several criteria may be formed, depending on which the advantages of the window points will change.

For an example, we will choose the price-quality ratio for the criterion. For a price we will choose, in accordance with the sequence of parameters in Table 1, parameter 1.3. "The total cost of the installation window". However, if you look at the dispersal of the values of economic parameters for point 2 (Window 2), then they are in the range from 0.07 Gcal to the parameter 1.5 to 1901.00 UAH for the parameter 1.3. In addition, the parameters have different nature and, accordingly, different units of measurement. Consequently, their comparison in absolute terms is not possible. To achieve the possibility of their comparison, we introduce relative values, which are called "coefficients of coherence (coherence)", through which the form of influence of all parameters is aligned on the overall assessment of the situation for each of the points of the factor. When entering the coercivity factors, the quantitative value of the parameter is lost in the analysis, but its effect on the qualitative evaluation of each of the timothy factors of the factor remains. The introduction of coercive measures is necessary in order to find the same effect of all the parameters (coordinates) of the point on the adoption of managerial decisions, that is, for small numerical values not to lose a large qualitative their influence on the decision.

Here is an example of determining the coercive ratio (C_i) for parameter 1.5. "Savings on heating for the season" based on point 2 (Window 2). For this, for the second tiomodelii, let's look at the relation "1.1. The cost of the window ", UAH, up to 1.5. "Savings on heating for the season", Gcal., that is:

$$C_{1.5} = \frac{1657{,}2}{0{,}07} = 23674 \approx 23000. \qquad (1)$$

Coefficient $C_{1.5}$ 23000 accepted to simplify the test calculations.

Then, for all points from the 2nd to the 20th, we expect, keeping the constant coefficient $C_{1.5}$=23000, the value of parameter 1.5, the result of calculations are given in Table 2.

The changed value of parameter 1.5 "Save on heating for the season" is denoted $П_{1.5}$, which is calculated as $П_{1.5}=ВП_{1.5}\cdot C_{1.5}$ and will serve as a Quality Score for parameter 1.5 (column 4 of Table 2). Then the "price / quality" ratio $C_{П1.5}$ we will find:

$$C_{П1.5} = \frac{B_{1.5}}{П_{1.5}}.$$

By results of calculations $C_{П1.5}$ (column 6 of Table 2) we will construct a graph (Fig. 1).

Table 2

Calculation of the "price / quality" relationships for the parameter "1.5"

№ window	$C_{1.5}$	Value of param. $ВП_{1.5}$	Quality score $П_{1.5}$	Cost $B_{1.5}$	Price / Quality value $C_{П1.5}$
2	23000	0,07	1610	1901	1,1807
3	23000	0,26	5980	2998,3	0,5014
4	23000	0,21	4830	2632,5	0,5450
5	23000	0,17	3910	3894,2	0,9960
6	23000	0,04	920	2059,13	2,2382
7	23000	0,11	2530	2429,76	0,9604
8	23000	0,11	2530	783,12	0,3095
9	23000	0,16	3680	783,12	0,2128
10	23000	0,3	6900	4647,78	0,6736
11	23000	0,26	5980	4531,23	0,7577
12	23000	0,19	4370	9374,71	2,1452
13	23000	0,14	3220	9350,33	2,9038
14	23000	0,04	920	2395,59	2,6039
15	23000	0,31	7130	5195,58	0,7287
16	23000	0,11	2530	3202,4	1,2658
17	23000	0,21	4830	7255,39	1,5022
18	23000	0,25	5750	7255,39	1,2618
19	23000	0,19	4370	7255,39	1,6603
20	23000	0,05	1150	7255,39	6,3090

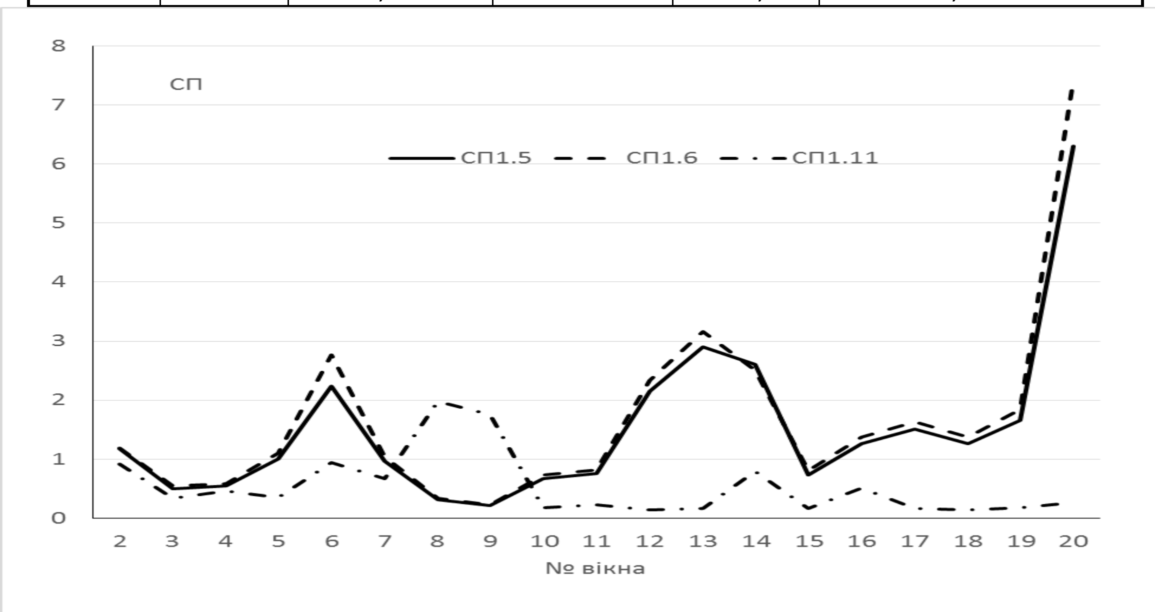


Fig.1 Estimation of output points by the criterion "price / quality" for parameters 1.5, 1.6, 1.11.

Similarly, we make calculations for parameter 1.6 "Save on heating for the season" (UAH), we determine the compatibility factor in the same way (1), using point 2 (Window 2):

$$C_{1.6} = \frac{1.1}{1.6} = \frac{1657{,}2}{106{,}27} = 15{,}59 \approx 15.$$

The results of calculations are reduced to Table 3.

Table 3

Calculation of "price / quality" relationships for the parameter "1.6"

№ window	$C_{1.6}$	Value of param. $BП_{1.6}$	Quality score $П_{1.6}$	Cost $B_{1.6}$	Price / Quality value $C_{П1.6}$
2	15	106,27	1594,05	1901	1,1926
3	15	364,16	5462,4	2998,3	0,5489
4	15	303,23	4548,45	2632,5	0,5788
5	15	235,22	3528,3	3894,2	1,1037
6	15	49,59	743,85	2059,13	2,7682
7	15	155,87	2338,05	2429,76	1,0392
8	15	155,87	2338,05	783,12	0,3349
9	15	228,13	3421,95	783,12	0,2289
10	15	426,5	6397,5	4647,78	0,7265
11	15	368,41	5526,15	4531,23	0,8200
12	15	267,81	4017,15	9374,71	2,3337
13	15	196,96	2954,4	9350,33	3,1649
14	15	63,76	956,4	2395,59	2,5048
15	15	433,59	6503,85	5195,58	0,7988
16	15	155,87	2338,05	3202,4	1,3697
17	15	296,14	4442,1	7255,39	1,6333
18	15	351,41	5271,15	7255,39	1,3764
19	15	263,55	3953,25	7255,39	1,8353
20	15	65,18	977,7	7255,39	7,4209

The results of calculations on the "price / quality" criterion for the parameter 1.6 will also be shown on the graph (Fig. 1) by a dashed line. As we see (Fig. 1), the charts of economy of heating in gigacaloria (SP1.5) and in UAH (SP1.6) practically repeat each other. This is understandable because they are related and indicate that the windows under study 8 and 9 are the best ones. However, if you deepen the requirements by studying the parameter 1.11, which indicates the total energy consumption per year in kWh, that is, the operating the costs that will occur annually, the situation will change. Calculate, as in the previous cases, according to indicators of the second point (Window 2), the coefficient of proportionality $C_{1.11}$ for total energy expenditure per year:

$$C_{1.11} = \frac{1657,2}{583,46} = 2,84 \approx 3.$$

The results of all subsequent calculations, in relation to the correlation of parameter 1.11, are reduced to Table 4.

Table 4

Calculation of the "price / quality" relationships for the parameter "1.11"

№ window	$C_{1.11}$	Value of param. $BП_{1.11}$	Quality score $П_{1.11}$	Cost $B_{1.11}$	Reverse "price / quality" $C_{П1.11} = \frac{П_{1.11}}{B_{1.11}}$
2	3	583,46	1750,38	1901	0,9208
3	3	334,46	1003,38	2998,3	0,3346
4	3	397,46	1192,38	2632,5	0,4529
5	3	454,81	1364,43	3894,2	0,3504
6	3	646,7	1940,1	2059,13	0,9422
7	3	543,2	1629,6	2429,76	0,6707
8	3	516,05	1548,15	783,12	1,9769
9	3	457,52	1372,56	783,12	1,7527
10	3	278,27	834,81	4647,78	0,1796
11	3	338,22	1014,66	4531,23	0,2239
12	3	426,63	1279,89	9374,71	0,1365
13	3	510,15	1530,45	9350,33	0,1637
14	3	634,91	1904,73	2395,59	0,7951
15	3	271,95	815,85	5195,58	0,1570
16	3	543,2	1629,6	3202,4	0,5089
17	3	392,56	1177,68	7255,39	0,1623
18	3	335,13	1005,39	7255,39	0,1386
19	3	418,73	1256,19	7255,39	0,1731
20	3	618,34	1855,02	7255,39	0,2557

We draw attention to the fact that in Table 4 in the last column in the calculations $C_{П1.11}$ the inverse value to the "price / quality" criterion was taken. This was done in order to perform only the addition operations (instead of subtraction) of the relationships. The results of calculations from Table 4 are shown in the graph (Fig. 1) by a dotted dotted line. Find the sum of these relationships $C_{Пi}$ "Price / quality" from Tables 2. 3, 4, we reduce the results in Table 5.

Table 5

Calculation to superposition $C_{Пi}$

№ window	$C_{П1.5}$	$C_{П1.6}$	$C_{П1.11}$,	∑CПi 1 year	∑CПi 2 years
2	1,18075	1,1925598	0,920768	3,29407319	4,2148
3	0,50139	0,5488979	0,3346496	1,38493551	1,7196
4	0,54503	0,5787686	0,4529459	1,57674552	2,0297
5	0,99596	1,1037043	0,3503749	2,45003833	2,8004
6	2,23818	2,768206	0,942194	5,94858477	6,8908
7	0,96038	1,039225	0,6706835	2,67028797	3,3410
8	0,30953	0,3349458	1,9769001	2,62137948	4,5983
9	0,2128	0,228852	1,7526816	2,1943379	3,9470
10	0,67359	0,7264994	0,1796148	1,5797055	1,7593
11	0,75773	0,8199615	0,223926	1,80161818	2,0255
12	2,14524	2,3336719	0,1365258	4,61544027	4,7520
13	2,90383	3,1648829	0,1636787	6,23239079	6,3961
14	2,6039	2,5047992	0,7950985	5,90379991	6,6989
15	0,72869	0,7988468	0,1570277	1,68456739	1,8416
16	1,26577	1,3696884	0,5088683	3,14432752	3,6532
17	1,50215	1,6333243	0,1623179	3,29779341	3,4601
18	1,26181	1,376434	0,1385715	2,7768124	2,9154
19	1,66027	1,8352975	0,1731389	3,66870872	3,8418
20	6,30903	7,4208755	0,2556747	13,9855851	14,2413

In Table 5 it is calculated:

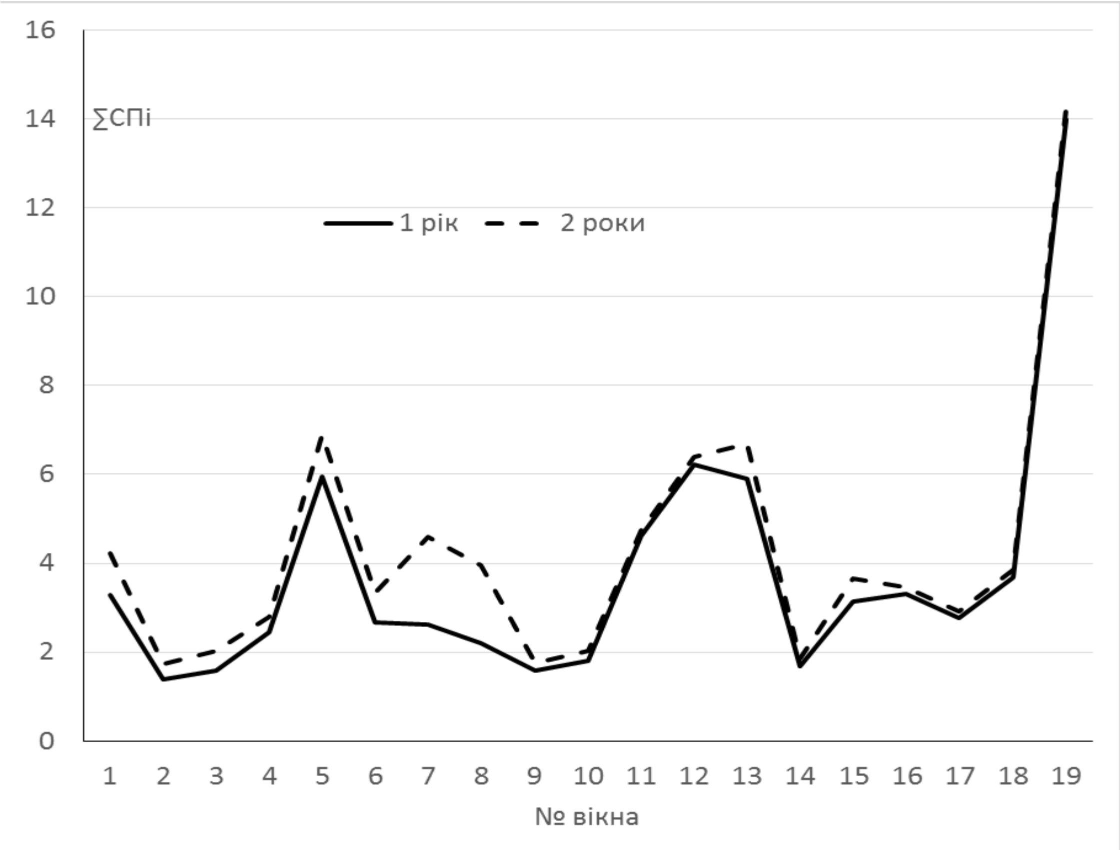
$$\sum_{1\,рік} C_{Пi} = C_{П1.5} + C_{П1.6} + C_{П1.11}.$$

$$\sum_{2\,роки} C_{Пi} = C_{П1.5} + 2 \cdot C_{П1.6} + 2 \cdot C_{П1.11}.$$

Expenses 1.11 are annual, therefore their accumulation will reduce the efficiency of cheap installation due to increased operating costs (Fig. 2).

In fig. 1, points 8 and 9 are least costly for installation and cost, but in Fig. 2 for two years of operation, they completely lost the effect of initial low cost. At the expense of qualitative indicators, points 3, 4, 5, 10, 11, 15, 18. And with each passing year, due to small energy losses, they will give even greater advantage of their application.

One of the options for determining, according to the "price / quality" criterion, is the one-way sampling of windows that have the greatest advantage for their application. With the change of criteria, the benefits of the tyomodels will also change. It is chosen and the tipologist who will have advantages over the most criteria.



The question arises why the B-surface of the response [2-5] for the "Window" factor was not applied in the proposed method of geometric formalization? The point is that any situation is presented in the form of a table in which the point-points are defined, which means that the source information is discrete. That is, the intermediate tiomodelies between the i-th and + 1-th do not exist in the market of windows. At the same time, the B-surfaces provide geometric shapes, either continuously or discretely, to which the process of thickening can be applied. Concentrating the points serving the windows does not make any sense. Proceeding from the above, a discrete way of geometric formalization of situations with respect to the "Window" factor was developed, which can be applied to any other factor in the compositional method of geometric modeling.

Conclusions. The method of analysis of discrete information is proposed in order to determine, according to certain criteria, the best option from the situation, which is reflected by the composition of the timothy for any factor. This method of geometric formalization allows us to determine the typology of the factor, the use of which in the renovation of buildings will give the best, according to certain criteria, economic, ecological, technological, artistic and aesthetic, and so on.

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ОДИН ИЗ СПОСОБОВ ГЕОМЕТРИЧЕСКОЙ ФОРМАЛИЗАЦИИ СИТУАЦИЙ ОТДЕЛЬНОГО ФАКТОРА

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В статье разработан способ геометрической формализации дискретной информации, представленный в виде таблицы исходных данных определенного фактора, в которой отражена ситуация относительно существующих типомоделей этого фактора и их характеристики экономического, технологического, экологического, художественно-эстетического и любого другого направления.

Ключевые слова: композиционный метод, ситуация по фактору, дискретная кривая, реновация зданий, энергоэффективность.

ОДИН ІЗ СПОСОБІВ ГЕОМЕТРИЧНОЇ ФОРМАЛІЗАЦІЇ СИТУАЦІЙ ОКРЕМОГО ФАКТОРУ

Адоньєв Є.О., Верещага В.М.

У статті розроблено спосіб геометричної формалізації дискретної інформації, поданої у вигляді таблиці вихідних даних певного фактору, у якій відображено ситуацію відносно існуючих типомоделей цього фактору та їхні характеристики економічного, технологічного, екологічного, художньо-естетичного та будь-якого іншого спрямування.

Ключові слова: композиційний метод, ситуація за фактором, дискретна крива, реновація будівель, енергоефективність.