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MODELLING RENEWAL OF CONSTRUCTION OBJECTS APPLYING METHODS OF THE GAME THEORY

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Abstract. The paper analyses modelling renewal of construction objects applying methods of the game theory. Rational construction management variants are usually selected under various conditions, using the efficiency criteria. A choice of rational alternatives can be absolutely uncertain when influences of external factors are unknown. In the current paper, selecting of rational renewal variants of derelict buildings from the viewpoint of sustainable development is presented. Sustainable development always involves great uncertainty; accordingly, the methods of the Game Theory are used for a particular problem. Bayes's and Laplace's rules are applied for searching rational renewal variants of derelict buildings in Lithuanian rural areas. The case study proved that the methods of the Game Theory are effective in a real life situation and can be successfully applied to solving similar problems.

Keywords: renewal of construction objects, decision-making, Game Theory, Bayes's rule, Laplace's rule.

1. Introduction

Establishment of efficiency of construction or reconstruction and renewal projects as well as substantiation of their rationality is the main problem of estimation of projects.

A large number of methods have been developed for solving multi-criteria optimization problems. The methodology and classification of the above methods have been presented in various publications [1–11]. Publications represent the full review of existing methods and one can come to a conclusion, that in the last two decades the main models of the qualitative evaluation methods were submitted, statistical and economic properties of such methods were determined. Methods were successfully applied in many fields, including transportation, power, civil construction and market. The authors of the paper have been applying the multi-criteria decision-making methods for construction decisions [12–16].

In the present paper, renewal of derelict and mismanaged buildings in Lithuanian rural areas is analyzed. These structures were built during the Socialist Years, mostly for developing farming and, partly, for rural infrastructure. Due to political and economical changes as well as restructuring of the agricultural sector, they have become derelict and are mismanaged at present. There is an urgent need for redevelopment of rural buildings because this property is a national asset of Lithuania and must be protected and used more effectively.

Sustainable development approach is used for identifying rational development trends of abandoned rural buildings. Revitalization of buildings should be a contribution towards sustainable construction, incorporating protection of natural and social environmental, improvement of life quality and implementation of economic goals. Therefore, it was suggested to describe renewal variants of buildings by a set of objectives, i.e. sustainability indicators [17, 18].

To decide on a mathematical theory so as to model the sustainable renewal of buildings, the type of uncertainty related to sustainable development should be considered. The type of uncertainty, due to incomplete and inconsistent information, is proposed to evaluate by applying methods of the Game Theory.

Accordingly, the aim of the paper is to select rational renewal variants of derelict buildings from the viewpoint of sustainable development by applying the Game Theory. Method LEVI allows us to solve the problem. In the method LEVI and in program LEVI 3.0 that is based on the above method various solution rules of the discrete optimization problem under uncertain conditions are suggested. According to these rules the most suitable alternative can be selected from possible set of decisions [19, 20].

2. Initial data of the problem

In the present case study, three alternatives and fifteen objectives are considered. The alternatives include reconstruction of rural buildings and adapting them for production or commercial activities (alternative A_1), farming (alternative A_2) or demolition and recycling of the demolished waste (alternative A_3). The objectives present three main conflicting types of interest: economic, ecological and social. The considered objectives are based on sustainability indicators and represent three typological groups in sustainable decision-making: current state of abandoned buildings and their environment, revitalization possibilities and impact produced by implementing a particular redevelopment alternative. The following fifteen attributes in evaluating building revitalization alternatives have been taken into consideration. They include the average soil fertility grade in the area x_1 (cardinal numbers), quality of life of the local population x_2 (cardinal numbers), population activity index x_3 (%), GDP in proportion to the average GDP of the country x_4 (%), material investments in the area x_5 (Lt per inhabitant), foreign investments in the area x_6 (Lt × 10^3 per inhabitant), building redevelopment costs x_7 (Lt × 10^6), increase of income of the local population x_8 (Lt × 10^6 per year), increase of sales in the area x_9 (%), increase of employment x_{10} (%), state income from business and property taxes x_{11} (Lt × 10^6 per year), outlook of business x_{12}, difficulties of purpose-built changes x_{13}, degree of contamination x_{14}, attractiveness of the countryside (i.e. image, landscape quality, etc.) x_{15}. Variables x_2, x_7, x_{13} and x_{14} are associated with minimization, while the remaining attributes are associated with maximization. Significance coefficients of the attributes q_i were determined according to the technique used in previous research [17, 18].

The management problems of the abandoned buildings were analyzed separately in three zones of development activity (i.e. the area of active development, the area of regressing development and the 'buffer' area) as presented in the concept of spatial development of Lithuania. The calculations were made taking into consideration two main strategic goals of the regional policy set in the Master Plan of the territory of Lithuania. It provides for maintaining the existing economic state of a region and harmonization of regional development.

3. The main characteristics of the applied methods

Mathematical models of a choice of rational decisions in construction depend on type of the initial data, restrictions and functions of the purpose. Problems can have certain or uncertain information, which depends on casual circumstances and influences. According to the Game Theory, a choice of rational alternatives can be stochastic uncertain (conditions of acceptance of decisions are described according to statistical laws of distribution) or absolutely uncertain (conditions of acceptance of decisions and influences of external factors are unknown or can not be determined). In absolutely uncertain problems the decision is accepted, comparing advantages and lacks of probable variant under various influences of external space.

Various rules for the decision of optimization problems are offered under conditions of uncertainty. In this paper two rules of the Game Theory are applied: Bayes's and Laplace's.

In the game theory, used for the solution of discrete optimization problems of construction, possible alternatives are described by objectives. The objectives should not have measurements, express the relation with optimum size and not have dependence on type of a matrix. In the presented case study, the linear transformation of an initial matrix is applied.

The linear transformation [19, 20] uses a scale of the existing values. The calculated values depend on the size of the interval [$x_{i\min}$, $x_{i\max}$]:

$$b_{ij} = \frac{x_{ij} - x_{i\min}}{x_{i\max} - x_{i\min}}, \text{ if } b_{ij} \text{ should be maximised,} \quad (1)$$

$$b_{ij} = \frac{x_{i\max} - x_{ij}}{x_{i\max} - x_{i\min}}, \text{ if } b_{ij} \text{ should be minimised,} \quad (2)$$

where $x_{i\max}$ – maximum value, $x_{i\min}$ – minimum value; x_{ij} is as the response of alternative j on objective i, $i = 1, 2, \ldots, m$ as the objectives, $j = 1, 2, \ldots, n$ as the alternatives.

Afterwards, Bayes's and Laplace's rules [19, 20] are applied, that represent the two-sided problem. In the Game Theory the two sided problem aims at finding the rational behaviour equilibrium for two parties (persons) having opposite interests or at finding the equilibrium in a game against nature. S_i, $i = 1, 2, \ldots, n$ is a set of strategies of a player.

Laplace's rule – the solution is calculated under the condition, that all probabilities for the strategies of the opponents are equal:

$$S_1^* = \left\{ S_{1i} / S_{1i} \in S_1 \cap \max_i \left(1/n \sum_{j=1}^{n} x_{ij} \right) \right\}. \quad (3)$$

Bayes's rule – if the probabilities for the strategies of the opponents are given, the maximum for the expected value can be used:

$$S_1^{\ *} = \left\{ S_{1i} \,/\, S_{1i} \cap \max_i \left(\sum_{j=1}^{n} q_j x_{ij} \right) \cap \sum_{j=1}^{n} q_j = 1 \right\}. \quad (4)$$

4. Results of the solution

The transformed matrixes of the performance measure of the j-th alternative of buildings renewal in terms of the i-h objective and calculation outputs according to Bayes and Laplace, taking into consideration the regional policy, are presented in Figures 1–6.

Comparison of calculation outputs according to Bayes and Laplace when maintaining the existing economic state of a region and harmonizing regional development in areas of different development is presented in Fig 7.

Bayes's and Laplace's rules that represent the two-sided problem were applied for searching rational renewal variants of derelict buildings in Lithuanian rural areas. The main difference was that according to Laplace's rule the solution was calculated under the condition that all probabilities for the strategies of the opponents are equal, while applying Bayes's rule the probabilities for the strategies of the opponents were given. However, analysis indicated that there were no differences between the calculation outputs of the methods when estimating the most favourable variant of renewal of buildings (Fig 1–7).

Different priorities of sustainable redevelopment alternatives were determined in areas of active, middle and regressing development. In area of active development A_1 has a great priority when maintaining the existing economic state of a region, while in a case of harmonizing regional development the difference between the utility of A_1 and A_2 is small (see Fig 7: A_{1a}, A_{2a} and $A_{1'a}$, $A_{2'a}$). In area of

Transformation

Primary matrix

Var.	x01 (+)	x02 (-)	x03 (+)	x04 (+)	x05 (+)	x06 (+)	x07 (-)	x08 (+)	x09 (+)	x10 (+)	x11 (+)	x12 (+)	x13 (-)	x14 (-)	x15 (+)
IF															
1	1.000	0.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000	1.000
2	0.334	0.666	0.333	0.333	0.333	0.333	0.816	0.236	0.137	0.304	0.212	0.000	1.000	0.333	0.500
3	0.000	1.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.667	0.250	1.000	0.000

Solution according to Laplace

Favourable variant according to Laplace: 1

(Unequivocal solution)

VAR.	x01	x02	x03	x04	x05	x06	x07	x08	x09	x10	x11	x12	x13	x14	x15		Result
1	20.130	15.680	26.600	51.600	902.830	876.980	358.430	114.030	18.470	5.030	26.870	0.900	0.900	0.700	0.700		0.733
2	12.080	9.410	15.960	30.960	541.700	526.190	77.600	27.370	2.530	1.530	5.900	0.300	0.100	0.500	0.500		0.391
3	8.050	6.270	10.640	20.640	361.130	350.790	14.400	0.630	0.001	0.000	0.270	0.700	0.700	0.100	0.300		0.261

Solution accorging to Bayes

Favourable variant according to Bayes: 1

(Trivial solution)

VAR.	x01	x02	x03	x04	x05	x06	x07	x08	x09	x10	x11	x12	x13	x14	x15		Result
q	0.060	0.073	0.075	0.061	0.067	0.061	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067		
1	20.130	15.680	26.600	51.600	902.830	876.980	358.430	114.030	18.470	5.030	26.870	0.900	0.900	0.700	0.700		0.726
2	12.080	9.410	15.960	30.960	541.700	526.190	77.600	27.370	2.530	1.530	5.900	0.300	0.100	0.500	0.500		0.394
3	8.050	6.270	10.640	20.640	361.130	350.790	14.400	0.630	0.001	0.000	0.270	0.700	0.700	0.100	0.300		0.268

Fig 1. Calculation outputs when maintaining the existing economic state of a region in area of active development

Transformation

Primary matrix

Var.	x01 (+)	x02 (-)	x03 (+)	x04 (+)	x05 (+)	x06 (+)	x07 (-)	x08 (+)	x09 (+)	x10 (+)	x11 (+)	x12 (+)	x13 (-)	x14 (-)	x15 (+)
IF															
1	0.00	1.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	1.00
2	1.00	0.00	1.00	1.00	1.00	1.00	0.00	0.18	0.14	0.30	0.21	0.00	1.00	0.33	0.50
3	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.67	0.25	1.00	0.00

Solution according to Laplace

Favourable variant according to Laplace: 1

(Unequivocal solution)

VAR.	x01	x02	x03	x04	x05	x06	x07	x08	x09	x10	x11	x12	x13	x14	x15		Result
1	8.05	6.27	6.27	10.64	20.64	361.13	350.79	358.43	18.47	5.03	26.87	0.90	0.90	0.70	0.70		0.53
2	24.16	18.82	18.82	31.92	61.92	1083.40	1052.38	77.60	2.53	1.53	5.90	0.30	0.10	0.50	0.50		0.51
3	8.05	6.27	6.27	10.64	20.64	361.13	350.79	14.40	0.00	0.00	0.27	0.70	0.70	0.10	0.30		0.26

Solution accorging to Bayes

Favourable variant according to Bayes: 1

(Trivial solution)

VAR.	x01	x02	x03	x04	x05	x06	x07	x08	x09	x10	x11	x12	x13	x14	x15		Result
q	0.060	0.073	0.075	0.061	0.067	0.061	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067		
1	8.05	6.27	6.27	10.64	20.64	361.13	350.79	358.43	18.47	5.03	26.87	0.90	0.90	0.70	0.70		0.54
2	24.16	18.82	18.82	31.92	61.92	1083.40	1052.38	77.60	2.53	1.53	5.90	0.30	0.10	0.50	0.50		0.50
3	8.05	6.27	6.27	10.64	20.64	361.13	350.79	14.40	0.00	0.00	0.27	0.70	0.70	0.10	0.30		0.27

Fig 2. Calculation outputs when harmonizing regional development in area of active development

Transformation

Primary matrix

Var.	x01 (+)	x02 (-)	x03 (+)	x04 (+)	x05 (+)	x06 (+)	x07 (-)	x08 (+)	x09 (+)	x10 (+)	x11 (+)	x12 (+)	x13 (-)	x14 (-)	x15 (+)
IF															
1	0.000	1.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	0.500	0.000	0.000	1.000
2	1.000	0.000	1.000	1.000	1.000	1.000	0.846	0.235	0.137	0.305	0.202	1.000	1.000	1.000	1.000
3	0.748	0.250	0.750	0.750	0.750	0.750	1.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	0.000

Solution according to Laplace

Favourable variant according to Laplace: 2

(Unequivocal solution)

VAR.	x01	x02	x03	x04	x05	x06	x07	x08	x09	x10	x11	x12	x13	x14	x15		Result
2	18.370	14.610	28.200	51.920	779.820	731.960	58.900	23.830	13.700	1.170	5.130	0.500	0.100	0.100	0.700		0.715
3	14.670	11.690	22.560	41.530	623.850	585.560	12.600	0.570	0.001	0.001	0.230	0.100	0.100	0.100	0.500		0.467
1	3.670	2.920	5.640	10.380	155.960	146.390	312.300	99.370	100.200	3.830	24.470	0.300	0.500	0.500	0.700		0.433

Solution accorging to Bayes

Favourable variant according to Bayes: 2

(Trivial solution)

VAR.	x01	x02	x03	x04	x05	x06	x07	x08	x09	x10	x11	x12	x13	x14	x15		Result
q	0.076	0.061	0.063	0.061	0.076	0.068	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.067		
2	18.370	14.610	28.200	51.920	779.820	731.960	58.900	23.830	13.700	1.170	5.130	0.500	0.100	0.100	0.700		0.723
3	14.670	11.690	22.560	41.530	623.850	585.560	12.600	0.570	0.001	0.001	0.230	0.100	0.100	0.100	0.500		0.471
1	3.670	2.920	5.640	10.380	155.960	146.390	312.300	99.370	100.200	3.830	24.470	0.300	0.500	0.500	0.700		0.425

Fig 3. Calculation outputs when maintaining the existing economic state of a region in area of regressing development

Transformation

Primary matrix

Var.	x01 (+)	x02 (-)	x03 (+)	x04 (+)	x05 (+)	x06 (+)	x07 (-)	x08 (+)	x09 (+)	x10 (+)	x11 (+)	x12 (+)	x13 (-)	x14 (-)	x15 (+)
IF															
1	1.000	0.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	1.000	1.000	0.500	0.000	0.000	1.000
2	0.000	1.000	0.000	0.000	0.000	0.333	0.846	0.235	0.137	0.305	0.202	1.000	1.000	1.000	1.000
3	0.750	0.250	0.750	0.750	0.750	0.000	1.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	0.000

Solution according to Laplace

Favourable variant according to Laplace: 1

(Unequivocal solution)

VAR.	x01	x02	x03	x04	x05	x06	x07	x08	x09	x10	x11	x12	x13	x14	x15		Result
1	18.370	14.610	28.200	51.920	779.820	876.980	312.300	99.370	100.200	3.830	24.470	0.300	0.500	0.500	0.700		0.700
2	3.670	2.920	5.640	10.380	155.960	526.190	58.900	23.830	13.700	1.170	5.130	0.500	0.100	0.100	0.700		0.471
3	14.690	11.690	22.560	41.530	623.850	350.790	12.600	0.570	0.001	0.001	0.230	0.100	0.100	0.100	0.500		0.417

Solution accorging to Bayes

Favourable variant according to Bayes: 1

(Trivial solution)

VAR.	x01	x02	x03	x04	x05	x06	x07	x08	x09	x10	x11	x12	x13	x14	x15		Result
q	0.076	0.061	0.063	0.061	0.076	0.068	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.067		
1	18.370	14.610	28.200	51.920	779.820	876.980	312.300	99.370	100.200	3.830	24.470	0.300	0.500	0.500	0.700		0.708
2	3.670	2.920	5.640	10.380	155.960	526.190	58.900	23.830	13.700	1.170	5.130	0.500	0.100	0.100	0.700		0.463
3	14.690	11.690	22.560	41.530	623.850	350.790	12.600	0.570	0.001	0.001	0.230	0.100	0.100	0.100	0.500		0.420

Fig 4. Calculation outputs when harmonizing regional development in area of regressing development

Transformation

Primary matrix

Var.	x01 (+)	x02 (-)	x03 (+)	x04 (+)	x05 (+)	x06 (+)	x07 (-)	x08 (+)	x09 (+)	x10 (+)	x11 (+)	x12 (+)	x13 (-)	x14 (-)	x15 (+)
IF															
1	0.008	1.000	0.000	0.000	1.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000	1.000
2	0.000	1.000	0.000	0.000	0.000	0.000	0.845	0.236	0.137	0.139	0.202	0.000	1.000	1.000	0.000
3	1.000	0.000	1.000	1.000	0.806	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.500	1.000	0.500

Solution according to Laplace

Favourable variant according to Laplace: 1

(Unequivocal solution)

VAR.	x01	x02	x03	x04	x05	x06	x07	x08	x09	x10	x11	x12	x13	x14	x15		Result
1	11.860	9.000	16.430	23.580	341.860	85.220	378.330	120.400	113.070	12.470	29.630	0.500	0.900	0.300	0.900		0.534
3	15.820	12.000	21.910	31.440	322.470	113.630	15.200	0.700	0.001	0.001	0.270	0.300	0.500	0.100	0.700		0.520
2	11.830	9.000	16.430	23.580	241.860	85.220	71.370	28.900	15.500	1.730	6.200	0.300	0.100	0.100	0.500		0.304

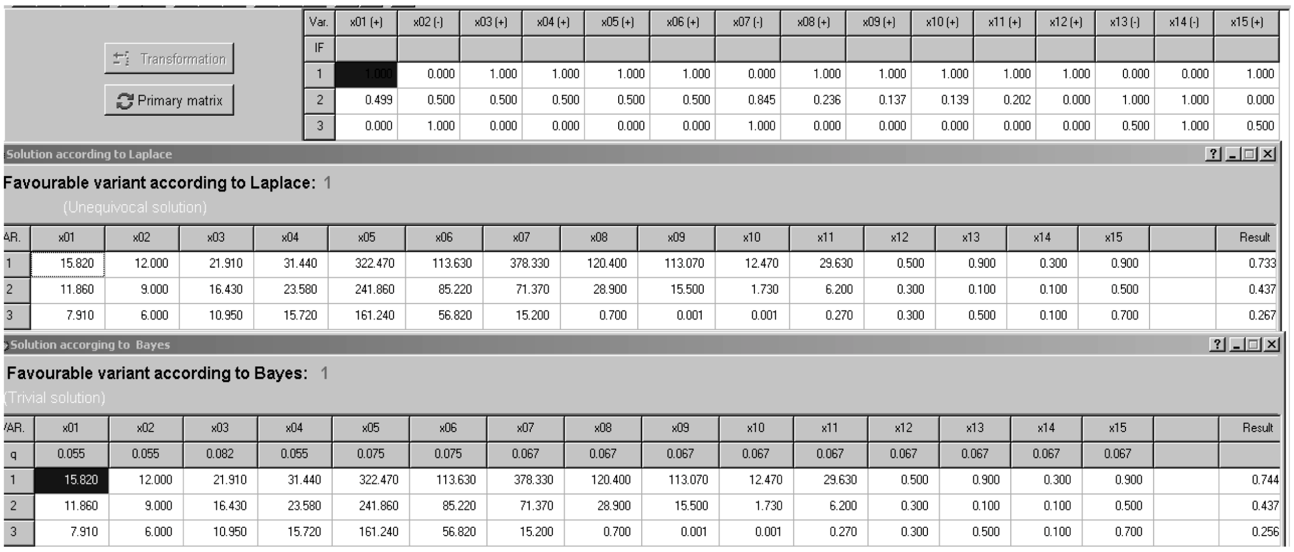
Solution according to Bayes

Favourable variant according to Bayes: 1

(Trivial solution)

VAR.	x01	x02	x03	x04	x05	x06	x07	x08	x09	x10	x11	x12	x13	x14	x15		Result
q	0.055	0.055	0.082	0.055	0.075	0.075	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067		
1	11.860	9.000	16.430	23.580	341.860	85.220	378.330	120.400	113.070	12.470	29.630	0.500	0.900	0.300	0.900		0.532
3	15.820	12.000	21.910	31.440	322.470	113.630	15.200	0.700	0.001	0.001	0.270	0.300	0.500	0.100	0.700		0.528
2	11.830	9.000	16.430	23.580	241.860	85.220	71.370	28.900	15.500	1.730	6.200	0.300	0.100	0.100	0.500		0.293

Fig 5. Calculation outputs when maintaining the existing economic state of a region in 'buffer' area



Transformation

Primary matrix

Var.	x01 (+)	x02 (-)	x03 (+)	x04 (+)	x05 (+)	x06 (+)	x07 (-)	x08 (+)	x09 (+)	x10 (+)	x11 (+)	x12 (+)	x13 (-)	x14 (-)	x15 (+)
IF															
1	1.000	0.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000	1.000
2	0.499	0.500	0.500	0.500	0.500	0.500	0.845	0.236	0.137	0.139	0.202	0.000	1.000	1.000	0.000
3	0.000	1.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.500	1.000	0.500

Solution according to Laplace

Favourable variant according to Laplace: 1

(Unequivocal solution)

AR.	x01	x02	x03	x04	x05	x06	x07	x08	x09	x10	x11	x12	x13	x14	x15		Result
1	15.820	12.000	21.910	31.440	322.470	113.630	378.330	120.400	113.070	12.470	29.630	0.500	0.900	0.300	0.900		0.733
2	11.860	9.000	16.430	23.580	241.860	85.220	71.370	28.900	15.500	1.730	6.200	0.300	0.100	0.100	0.500		0.437
3	7.910	6.000	10.950	15.720	161.240	56.820	15.200	0.700	0.001	0.001	0.270	0.300	0.500	0.100	0.700		0.267

Solution accorging to Bayes

Favourable variant according to Bayes: 1

(Trivial solution)

VAR.	x01	x02	x03	x04	x05	x06	x07	x08	x09	x10	x11	x12	x13	x14	x15		Result
q	0.055	0.055	0.082	0.055	0.075	0.075	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067		
1	15.820	12.000	21.910	31.440	322.470	113.630	378.330	120.400	113.070	12.470	29.630	0.500	0.900	0.300	0.900		0.744
2	11.860	9.000	16.430	23.580	241.860	85.220	71.370	28.900	15.500	1.730	6.200	0.300	0.100	0.100	0.500		0.437
3	7.910	6.000	10.950	15.720	161.240	56.820	15.200	0.700	0.001	0.001	0.270	0.300	0.500	0.100	0.700		0.256

Fig 6. Calculation outputs when harmonizing regional development in 'buffer' area

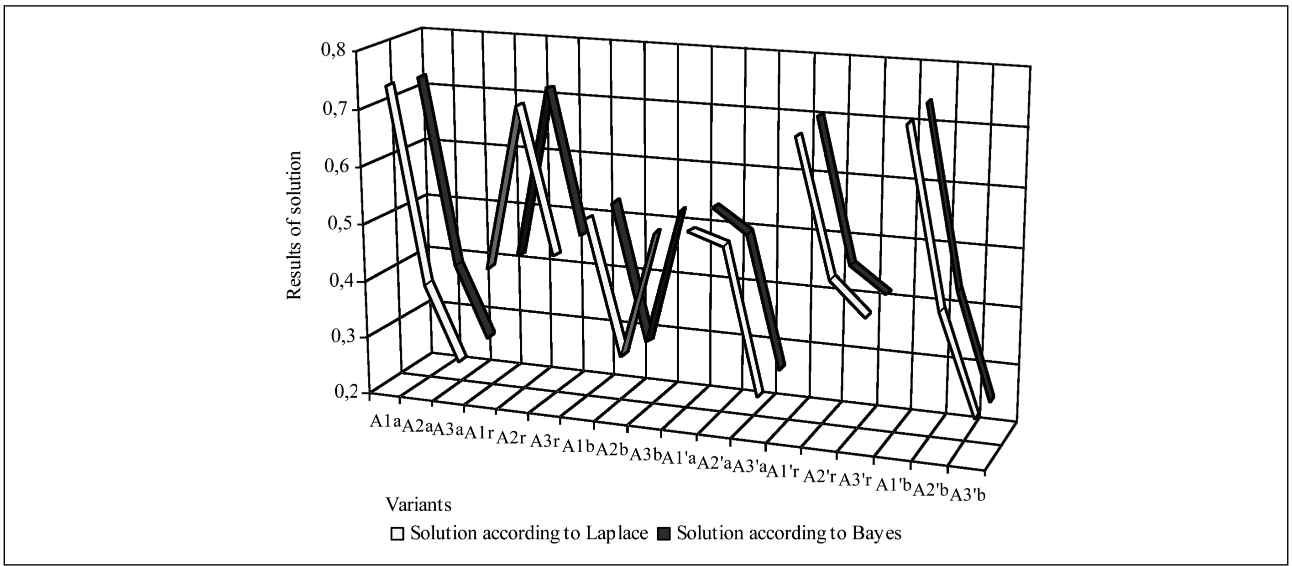


Fig 7. Comparison of calculation outputs according to Bayes and Laplace, where A_1, A_2 and A_3 – renewal alternatives of buildings when maintaining the existing economic state of a region, A'_1, A'_2 and A'_3 – renewal alternatives of buildings when harmonizing of regional development, *a* – area of active development, *r* – area of regressing development, *b* – 'buffer' area

regressing development A_2 has a great priority when maintaining the existing economic state of a region, while A_1 and A_3 can be considered as equal (Fig 7: A_{1r} – A_{3r}). On the contrary, in 'buffer' area the priority is given to A_1 and A_3 when maintaining the existing economic state of a region (Fig 7: A_{1b} – A_{3b}). Whereas, when harmonizing regional development, A_1 (reconstruction of rural buildings and adapting them for production or commercial activities) is the most favourable in 'buffer' and regressing areas.

5. Conclusions

1. The case study has proved that the applied methods of the Game Theory were effective in a real life situation and could be successfully applied to solving similar optimization problems in business or industry that involve great uncertainty.

2. Bayes's and Laplace's rules were applied for searching rational renewal variants of derelict buildings in Lithuanian rural areas. The analysis indicated that there were little differences in calculation outputs between the used methods despite the described peculiarities of the rules. The results were consistent enough to prepare some scientific recommendations for a sustainable redevelopment of derelict buildings.

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STATYBOS OBJEKTŲ ATNAUJINIMO UŽDAVINIŲ MODELIAVIMAS, TAIKANT LOŠIMŲ TEORIJOS METODUS

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Santrauka

Nagrinėjamas statybos objektų atnaujinimo uždavinių modeliavimas, taikant lošimų teorijos metodus. Racionalūs statybos valdymo variantai parenkami įvairiomis sąlygomis, kurios aprašomos efektyvumo rodikliais. Dažnai sprendimus tenka priimti visiško neapibrėžtumo sąlygomis, kai nežinomos išorinių sąlygų tikimybės. Šiame straipsnyje autoriai analizuoja racionalių apleistų pastatų atnaujinimo variantų parinkimą darnaus vystymosi požiūriu. Darnaus vystymosi sąvoka susijusi su informacijos trūkumu ir neapibrėžtumu. Potencialius sprendimo variantus apibūdinantys rodikliai yra diskretūs, tačiau nežinomi jų pasiskirstymo dėsniai bei kitimo ribos. Todėl nagrinėjamam uždaviniui spręsti pritaikyti lošimų teorijos metodai. Suformuluotos galimos apleistų bei nenaudojamų statinių Lietuvos kaimo vietovėse sutvarkymo alternatyvos. Pagrindinių darnaus vystymosi posistemių konfliktui spręsti ir racionaliam pastatų tvarkymo sprendiniui rasti taikytos Bayeso ir Laplaceo taisyklės. Taikant Bayeso taisyklę, įvertinamas santykinis rodiklių reikšmingumas, o, skaičiuojant pagal Laplaceo taisyklę, imama, jog visi rodikliai sprendimą priimantiems asmenims yra vienodai svarbūs. Atlikti skaičiavimai parenkant racionalius variantus atskiruose šalies regionuose bei taikant skirtingas plėtros strategijas, suformuluotas šalies teritorijos bendrajame plane. Pateiktos rekomendacijos, kaip būtų racionalu sutvarkyti apleistus pastatus. Gauti rezultatai patvirtino lošimų teorijos metodų tinkamumą efektyviai taikyti sprendžiant kitus panašaus pobūdžio uždavinius.

Reikšminiai žodžiai: statybos objektų atnaujinimas, sprendimų priėmimas, lošimų teorija, Bayeso taisyklė, Laplaceo taisyklė.

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