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PRINCIPLES OF REVITALISATION OF DERELICT RURAL BUILDINGS

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Abstract. The problem of Lithuanian derelict and mismanaged rural buildings that have a negative influence on the economy and environment of the country is analysed in the paper. Revitalisation of unused rural buildings is analysed in a context of sustainable development. Factors determining distribution and revitalisation perspectives of unused buildings were established by using methods of mathematical statistics. It was estimated that the peculiarities of territorial distribution are different in various zones of different development activity, also they differ according to the uses of buildings. Analytical review of sustainability indicator systems was performed. The model of indicator system for revitalisation of derelict rural buildings is proposed in the paper. This indicator system was worked out according to the common principles of sustainable development and to local peculiarities, explored by analysing territorial distribution of objects. It is possible to rate the priorities of building revitalisation alternatives by using the proposed model of the system with the help of multiple criteria decision-making methods. Due to incomplete and inconsistent information regarding sustainable development, the author suggests to use fuzzy set theory.

Keywords: derelict rural buildings, buildings revitalisation, sustainable development, sustainability indicators, fuzzy set theory.

1. Introduction

Rural property constitutes an important part of the economic potential in Lithuania. Buildings for farming and other items of rural infrastructure embrace a great part of this property. Most of these objects were built under socialist economic conditions. Political and economic changes were followed by an unsuccessful reorganisation of the agricultural sector in Lithuania. After the re-establishment of Lithuania's independence, the properties of collective and state farms have been privatised and people's farms, agricultural partnerships and other agricultural enterprises were established. However, most agricultural partnerships collapsed in a short time. The majority of agricultural buildings become private property, but they were not used and have almost been destroyed. Many rural properties, due to their large parameters, energy susceptibility, technological and economic depreciation, do not meet the contemporary production requirements. Small farmers are not capable of using or holding large complexes in a proper condition. Much investment is required for the purpose of using these objects. As the result, there are many derelict and mismanaged buildings in rural areas of Lithuania. These buildings are not used for any kind of activity and many of them are semi-destroyed. They negatively influence the environment and landscape, threatening people's safety, wasting the real estate while decaying irreversibly.

The problem of decline and deterioration of property is also relevant to other countries. Most countries have areas of land, within city environments or on a regional scale, that are deteriorating or deteriorated and that exhibit characteristics such as areas with a large proportion of empty industrial or commercial buildings, potentially derelict and based on a declining or vanishing industry. But the solution of the problem regarding rural property is new and has no analogies in the developed European countries. The scientific research is performed being conscious of an importance of Lithuanian rural buildings in the structure of the economic potential of the state and being aware of natural and social environmental damage.

The revival of Lithuanian rural property as a process of investment and production, substantiation of efficient financing method has been analysed in several scientific papers [1–3].

In this paper, a multiple sustainable development approach is used for finding rational development trends of derelict rural buildings and their surroundings because the analysed problem is complex, including various fields and requirements from many interested parties. The economic benefit of revitalisation of buildings is combined with the environmental potential as well as social interest.

This paper aims to carry out the structural analysis and the spatial distribution peculiarities of mismanaged Lithuanian rural buildings and to suggest principal trends for establishing revitalisation priorities of derelict property according to the general principles of sustainable development.

Methods of research: analytical review, structural analysis of factual material, mathematical statistical analysis.

2. Sustainable construction as a context of the research

Since 1987, when the World Commission on Environment and Development defined sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs', sustainable development has received significant attention of the global community at the international, national and local levels. To accomplish these tasks, a balance must be kept between growth, prosperity and the needs of economic as well as social development. The introduction of environmentally friendly products with a reduced consumption of natural resources, energy, and decreased emissions of pollutants is to be promoted. Accordingly, human and natural environmental considerations need to be regarded in the economic decision-making. Sustainable development continues to receive increasing international recognition and it has become a guiding principle for the global society at the start of the new millenium. Consequently, it is clear that the various activities of the construction sector have to be regarded and analysed as a sustainable development.

Sustainability has become an important issue mainly in countries where construction is in decline [4]. The prevention of urban decline and urban sprawl is a concern expressed by most countries. In the Western and Eastern European countries conservation of open space and safeguarding the structure of rural settlements is a major problem. This concern was consolidated by two main challenges and future trends to construction industry thrown down by Kohler [5] and Rees [6], namely that countries must reduce the environmental impact of their built environment tenfold by 2040 and that they must stop constructing additional new buildings, instead to improving their existing stock. These worldwide attitudes amplify the importance of redevelopment of derelict buildings in rural areas of Lithuania.

Rational use of derelict buildings is analysed from the aspect of sustainable development for the reason mentioned above and depending on local peculiarities of a ground of the explored phenomenon and subsequence of a possible decision. No priorities are given to the economic benefits of revitalisation. Great attention is paid to social and natural environmental potential, because within the system of collective farms deteriorating and rapidly forming private farms, not only agricultural production but also the entire life of the rural population changed in essence. Many rural people are unemployed due to a rapid and not very successful reorganization of the agricultural sector, during the transition period. A lot of social and cultural properties have also been damaged. This phenomenon exacerbates the social and moral crisis of the rural population in our country. Also, the territories of these buildings are not ecologically stable due to weak environmental legislation in the socialist years. Devastated objects are ruining the landscape and negatively influencing the environment. The proper and sustainable management of these buildings and their territories could help decrease the rural, social and economic crisis as well as prevent the environment and landscape degradation. Moreover, sustainable development is greatly appreciated while planning the distribution and use of various national, local funds and financial funds of the European Union.

There are several possible ways of arranging mismanaged buildings and their territories. It is necessary to set new ecologically motivated priorities in areas where huge anthropogenic intervention was made. Buildings that are less depreciated should be renovated and used for proper purposes, especially since in the European Union and in other countries attention to urban renovation is given as opposed to the development of new sites. Revitalisation variants should be selected according to technical conditions, social interests and environmental possibilities.

Buildings with great depreciation and those not fit for renovation must be dismantled instead of falling into decay or simple demolition. Dismantling instead of demolition helps separating different building materials and reusing and recycling materials for superior utilization options [7]. Recovering and reusing building materials can partially reduce the environmental impacts of the construction industry by decreasing the volume of construction and demolition wastes, conserve natural primary resource stocks and landfill space and generate a new source of building materials that are less energy and resource intensive [7–9].

The development policy and priorities must be based on reliable scientific information and knowledge. The solution from the aspect of sustainable development could be formalised with the help of sustainability indicators. Indicators are parameters or values that provide information about a phenomenon. The importance of indicators is their significance beyond the direct associations of the parameter and its value. The benefits of indicators include the ability to gain enough formalised and quantifiable data of a sense of the performance of a system [10]. Consequently a model of an indicator system was worked out according to the common principles of sustainable development, for local conditions and to the peculiarities of a problem. For that purpose, sustainable development indicator systems as developed by science and government institutions in Europe and other world countries and theoretical recommendations are analysed here. There are very wide and varied systems of indicators that have been developed internationally and by local authorities. This review embraces a wide range of SD concepts from government and non-governmental organisations, industry and research. In the past 20 years many environment assessment methods as well as sets of criteria of sustainable urban development have been formulated. These include, among others: the World Resources Institute [11], the World Conservation Union-IUCN [12], the UN Commission on Sustainable Development [13], the World Bank [14], etc [15–18]. A fair amount of initiative has been aimed at developing sector indicators for agriculture, transport and energy. But there is no universal indicator system that can be used in every situation. At a detailed level, local constraints, specific features and national priorities have to be taken into account. A unique indicator set should be developed for the best achievement of the desired goals in any given situation.

In order to manage derelict buildings, firstly the existing situation needs to be explored according to the procedure of defining the indicator sets [19]. Therefore scientific research of the present state has been completed in this paper. Observations of these buildings' territorial distribution and their peculiarities were made in the context of the conception of the country's economic, social and ecological sustainable development. Economic and social factors determining the distribution peculiarities of unused buildings and their environment were established by using methods of mathematical statistics. An approach of multiple statistical analysis for recognition of significant factors for sustainable development strategies is also appropriate and used in research [20].

Depending on building distributions and established distinctions and the sustainable development indicator systems and theoretical recommendations that were analysed, the model of indicator system was proposed and based on these findings. Also, it is possible to realise such a model with the help of multi-criteria decision-making tools.

3. Situation of derelict rural buildings and their spatial distribution

According to data from the Lithuanian State Territorial Planning and Construction Inspectorate, also from Lithuanian Institute of Agrarian Economics and data on the carried out questionnaire by previous researchers, there are nearly 6300 derelict buildings and nearly 1100 mismanaged buildings in the countryside, that is 7400 unexploited objects in total.

Generalised findings of investigated property on the base of mentioned data have been carried out. The place of unused rural buildings in the total structure of Lithuanian real estate is presented in Table 1.

According to classification of rural property in conformity with Soviet catalogues of former kolkhoz buildings and using previous research, held by S. Lunkevičius *et al* [1], it was established that Lithuanian rural property dominated by farming buildings (Table 2).

Table 1. Building area of derelict and mismanaged rural property

Factor	Value
Total building area in the territory of Lithuania, *ha*	185 098 ha
Building area of unexploited rural buildings, *ha*	962 ha
Building area of other real estate, *ha*	184 136 ha
Building area of unexploited rural buildings in proportion to building area of other real estate, %	0,52 %
Density of unexploited rural buildings (average number of buildings situated in 1 000 ha area of farming land), *units / 1000 ha*	1,88

Table 2. Distribution of derelict rural property according to its usage

Purpose of use	A part of property
Industrial buildings	83 %
Social buildings	2 %
Dwelling houses	1 %
Other buildings	14 %

In the whole structure of Lithuanian real estate dwelling houses constitute the largest part of buildings, namely 75 %. Industrial buildings include 6 % of total stock of buildings. This fact expresses the importance of redevelopment of rural buildings. Deteriorated farming buildings amount to even 3 % of total stock of Lithuanian industrial buildings. It is a national asset of the Republic of Lithuania and it must be protected and effectively used.

It is important to find out how many rural buildings are fit for reconstruction subject to their depreciation. It is considered that only objects with depreciation no higher than 30 % are suitable for repair and future use. S. Lunkevičius *et al* estimated that some 60 % of buildings became of poor state since 1991 [1]. They have already decayed or are quickly decaying and are not proper for reconstruction.

According to data from the Lithuanian State Territorial Planning and Construction Inspectorate, there are some 70 % of derelict and mismanaged Lithuanian rural buildings of poor state that need to be demolished. Some 30 % of rural buildings are suitable for repair. It is important to choose the most effective strategy of revival of these objects. The strategy ought to be based not only on physical characteristics of the object, but also on regional peculiarities, on environmental performance, on the requirements of local community, and generally on the principles of sustainable development.

Determination of the number and the building area of desolated objects designated for demolition is important when estimating their environmental impact (Table 3).

Table 3. The number and the building area of objects to be demolished

Factor	Derelict rural buildings	Buildings suitable for future use	Buildings for demolition
The number of objects, *units*	7401	2105	5296
Percent of objects, %	100 %	28 %	72 %
Area of building objects, *ha*	962 ha	269 ha	693 ha

Forasmuch as reuse and recycling of building materials is important requirement for sustainable construction, quantity of building materials and their decomposition was estimated (Table 4). The estimation is based on data from the Lithuanian State Territorial Planning and Construction Inspectorate, also from Lithuanian Institute of Agrarian Economics and from the research of S. Lunkevičius *et al* [1]. It is estimated that the scrap quantity of buildings to be demolished is about 2870 thousands of cubic meters.

Table 4. Decomposition of rural buildings to be demolished

Material	Quantity, %
Bricks, reinforced concrete, asbestos	65 %
Wood	20 %
Metals	10 %
Other material	5 %

In order to rationally manage objects to be redeveloped, the relationship between derelict and mismanaged rural buildings and socio-economic conditions was analysed and spatial distribution tendencies of buildings in various regions of Lithuania was also established. In this paper, peculiarities of territorial distribution of derelict and mismanaged rural buildings in Lithuania and factors influencing them were analysed by mathematical statistics methods. As a dependant variable in correlation, a number of derelict and mismanaged buildings in 1000 ha of territory in an administrative region were used for this research. As independent (factorial) variables, the authors have used: farming land productivity grade, farming land percent rented by farming communities, parameters of life quality, population activity indices, indices of farming and corn agriculture territorial concentration in 1990 and 1997.

The data is grouped into three regions according to the concept of the country's spatial development [21]. This concept is based on tendencies in the industrialisation of the country's economy, influences from the internal and external markets, the processes of the internal economy of the country, the economic, social, environmental quality, the system of settlements as well as on the inertia of the country's development. Lithuania's territory is divided into three main types of areas: areas of active development, areas of regressing development and 'buffer' areas. The largest amount of facilities held and the greatest variety of activity and maximum internal as well as foreign investment is characteristic of the areas of active development. The main industries, science, culture and facilities centres and major highways are located in these territories, in contradistinction to areas of regressing development. Areas of active development cover main cities and zones of their influence. The economic base of areas of regressing development is composed of agriculture, forestry and recreation. They cover the north–eastern and southern parts of Lithuania. 'Buffer' areas take the middle place according to the character of activity, geographical and environmental situation and singularities of the local population. They are situated in territories of a slight influence of largest cities, farther from them. These differences must be taken into consideration when finding the most rational ways of derelict buildings management. The priorities of disposal should differ according to local singularities of intention of finding a sustainable solution and meeting the environmental, social and economic needs and restrictions.

Sets of derelict and mismanaged agricultural industrial buildings and rural buildings of other functions (housing and facilities) have also been analysed in the research.

Several correlation matrices according to regional peculiarities and the use of buildings have been calculated and statistical connections estimated [22]:

$$[R]=[r]=\frac{1}{n-1}[Q]^T[Q], \tag{1}$$

where $[R]$ is the correlation matrix, is the correlation coefficient, n is the number of members of the set (number of objects), $[Q]$ is the normalised matrix of primary data consisting of n series and $(m+1)$ columns, where m is number of factors. The centralised and the normalised matrix of primary data is derived from the initial matrix [22]

$$[V]=\begin{bmatrix} y_1 & x_{11} & \cdots & x_{m1} \\ y_2 & x_{12} & \cdots & x_{m2} \\ \vdots & \vdots & \vdots & \vdots \\ y_n & x_{1n} & \cdots & x_{mn} \end{bmatrix}, \quad (2)$$

where $y_i, i=1,2,...,n$ is the value of comparative density of derelict and mismanaged buildings (measured in units / 1000 ha), $x_{ij}, i=1,2,...,n; j=1,2,...,m$ is the value of economic, social and environmental factors, i is the number of members in the set of buildings used in the analysis, j is the number of economic, social and environmental factors applied in the mathematical statistical analysis.

The centralised and the normalised matrix of primary data [22]

$$[\mathbf{Q}]=\begin{bmatrix} y'_1 & x'_{11} & \cdots & x'_{m1} \\ y'_2 & x'_{12} & \cdots & x'_{m2} \\ \vdots & \vdots & \vdots & \vdots \\ y'_n & x'_{1n} & \cdots & x'_{mn} \end{bmatrix}, \quad (3)$$

where

$$y'_i = \frac{y_i - y}{\sigma(y)}, \quad (4)$$

$$x'_{ji} = \frac{x_{j_i} - x_i}{\sigma(x_j)}, \quad (5)$$

$$y = \frac{\sum_{i=1}^{n} y_i}{n}, \quad (6)$$

$$x_i = \frac{\sum_{j=1}^{n} x_{j_i}}{n}, \quad (7)$$

$$\sigma(y)=\sqrt{\frac{\sum_{i=1}^{n}(y_i - y)^2}{n-1}}, \quad (8)$$

$$\sigma(x_j)=\sqrt{\frac{\sum_{i=1}^{n}\left(x_{j_i} - x_j\right)^2}{n-1}}. \quad (9)$$

The empirical value of calculated correlation coefficient is [22]

$$\sigma(r_{ij}) \approx \frac{1-r_{ij}^2}{\sqrt{n}}. \quad (10)$$

The confidence interval of calculated correlation coefficient with the credibility $p=1-q=0{,}95$ [22]:

$$r_{ij} - t_q\sigma(r_{ij}) \le r_{ij} \le r_{ij} + t_q\sigma(r_{ij}), \quad (11)$$

where t_q is the root of the Student's distribution with $(n-2)$ degrees of freedom and with the credibility p. The correlation coefficient is statistically significant in case of zero value gets into the confidence.

Correlation matrixes are compared and have the purpose of proving that their structure is statistically different. The statistics M is counted in order to compare matrixes [22]:

$$M = \left[\left(\sum_{i=1}^{n} n_i\right) - k\right] \ln\,[R] - \sum_{i=1}^{k}\left[(n_i - 1)\ln\,[R]_i\right], \quad (12)$$

where n_i is the number of members of the set, k is the number of matrixes compared, $i=1,2,...,k$; $[R]_i$ is determinants of the compared matrixes, $[R]$ is the determinant of generalised and integrated matrix. The determinant of generalised and integrated matrix

$$[R] = \sum_{i=1}^{k} \frac{n_i - 1}{\sum_{i=1}^{k} n_i - k}\,[R]_i. \quad (13)$$

Compared matrices are not identical when $M > \chi^2_{l,q}$, where χ^2 – a radical of Pirson's distribution, when l is a degree of freedom and q is a level of credibility. A degree of freedom is $l = 1\ 2(k-1)m\,(m+1)$.

The statistics counted $M = 43{,}9$. With the credibility $p = 1 - q = 0{,}95$, $\chi^2_{l,q} = 43{,}7$. That indicates the fact that correlation structure of unused buildings in areas of active development, regressing development and 'buffer' territories are different to the credibility $p = 0{,}95$. The difference of the correlation structure of agricultural industrial buildings and buildings of other uses (housing and facilities) was proved analogically.

Some conclusions can be drawn concerning the results of this analysis. It is estimated that a correlation between derelict and mismanaged rural buildings and the regional concentration of economic, social and agricultural indices are different in zones of active and regressing development and in 'buffer' areas. Mostly statistically significant relations between mismanaged buildings and socio-economic factors in various zones of development activity are presented in Figs 1, 2 and 3.

In areas of active development, the distribution peculiarities are influenced mostly by the population activity indices and life quality parameters. Trendlines of the type of moving average are presented (Fig 1).

In areas of regressing development, indices of farming territorial concentration are statistically most significant (Fig 2). 'Buffer' areas take an intermediate place according to their concept as well as to the results of the correlation analysis [23, 24] (Fig 3).

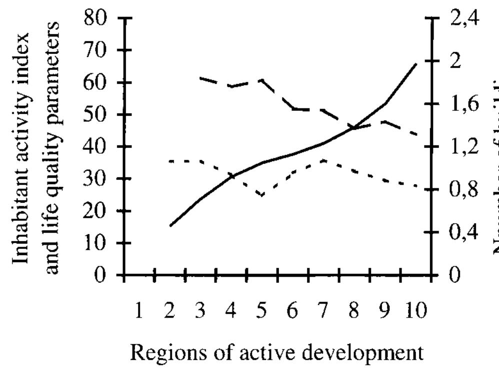

Fig 1. Connection between mismanaged buildings, the inhabitant activity index and life quality parameters in areas of active development:

is the trendline of density of buildings,
is the trendline of inhabitant activity index,
is the trendline of life quality parameters.

1 ... 10 – Šiauliai, Klaipėda, Panevėžys, Mažeikiai, Kėdainiai, Vilnius, Akmenė, Trakai, Kretinga and Jonava regions.

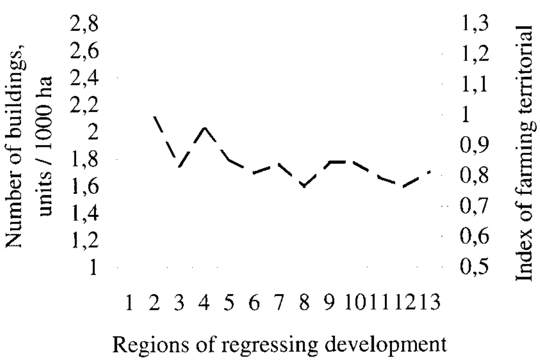

Fig 2. Connection between mismanaged buildings and index of farming territorial concentration in areas of regressing development:

is the trendline of density of buildings,
is the trendline of index of farming territorial concentration.

1 ... 13 – Biržai, Švenčionys, Molėtai, Utena, Varėna, Alytus, Zarasai, Ukmergė, Kupiškis, Lazdijai, Šalčininkai, Ignalina and Rokiškis regions.

These connections are reverse. This point can be explained by the fact that stronger collective farms existed in districts with better agricultural conditions. Such farms were less deteriorated and more farming communities were founded here. These communities use buildings for farming and for their agricultural activities. Thus there are less derelict and mismanaged buildings in these regions. Many of the analysed buildings are private property, but they are not used and almost destroyed, because small farmers are not capable of using large complexes and maintaining them in proper conditions.

Analysis of mismanaged buildings used for farming showed that the distribution peculiarities of dependant

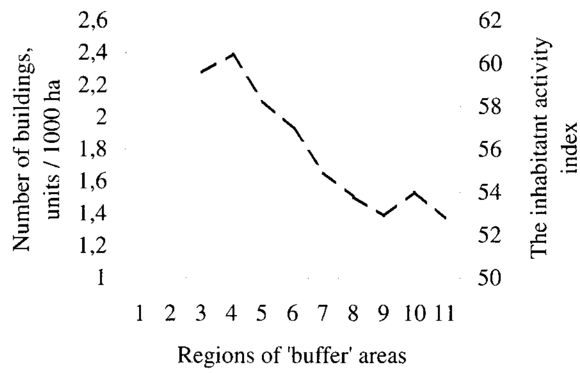

Fig 3. Connection between mismanaged buildings and the inhabitant activity index in 'buffer' areas:

is the trendline of density of buildings,
is the trendline of inhabitant activity index.

1 ... 11 – Šakiai, Kelmė, Telšiai, Šilalė, Prienai, Pasvalys, Vilkaviškis, Raseiniai, Radviliškis, Marijampolė and Tauragė regions.

variables are influenced mostly by indices of farming territorial concentration, farming land productivity and farming land percents that are rented by farming communities. Distribution peculiarities of mismanaged buildings of other uses in rural areas are mostly influenced by the population's activity indices and life quality parameters [24, 25]. There are many renovated buildings used for commercial purposes or manufacture in areas of higher activity or those with a higher life quality.

4. The principal model for establishing the rational use priorities of derelict buildings

The model of indicator system for the rational use of derelict buildings is designed according to the research of a situation in transition and the analytical review of literature on sustainability development indicators. In the research, sustainability indicators are used not for understanding sustainability like in most analysed systems presented in scientific publications. They are used for decision-making, because decisions supporting, conflict solving and the involved stakeholders are also possible purposes for the use of sustainability indicators [26].

Classification of the indicators according to the typology was analysed. The model of indicator system for management of derelict rural buildings was designed on the ground of Pressure - State - Response [18] and Driving-forces – Pressure – State – Impact – Response indicator models. These models have tended to be used most often for identification and reporting on environmental indicators [27]. If other aspects are included, they become valuable tools for assessing all aspects of sustainable development. When considering the specific features of an analysed problem, namely sustainable revitalisation of derelict and mismanaged rural buildings in Lithuania, three typology groups are proposed, ie *Existing State*, *Development Possibilities* and the *Impact*.

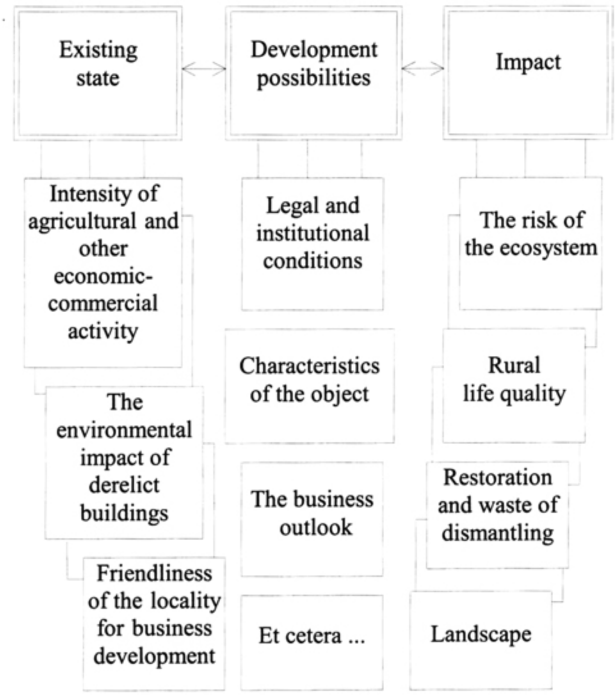

Fig 4. Model of the indicator system of derelict rural buildings rational use

Sustainable development requires systems information. The total system is made up of a large number of component systems. Each of the systems proposed by the authors' typology group consists of several subsystems and constitute the whole system. Some of the main subsystems are shown in Fig 4. These subsystems describe various components of sustainability that are chosen according to the singularity of the problem. It is possible to change some of the component systems depending on the aim and circumstances of the research. While solving the problem of derelict buildings arrangement and rational use, component systems involve the environmental impact of derelict, renovated or dismantled buildings, the economic benefits and changes in the local population's quality of life after implementing the restoration variants and the business outlook.

In the next stage, it is necessary to define indicators that can provide essential and reliable information about component systems and the total system. All proposed subsystems consist of a number of indicators selected from existent and approved sustainability indicator systems and adapted to local singularities and peculiarities of the problem and are based on previous statistical research. For example, reuse benefit could be expressed by several indicators, which are measured by average composite scores, namely style and design qualities, character of buildings, appropriate location, relative costs against newly built. Reuse benefit could be expressed by start-up/implementation constraints, access limitations to disused buildings, external image, inflexible design, provision of services, planning constraints indicator [28].

Indicators are quantitative in order to realise the model with the help of multi-criteria decision-making methods. The advantages of using multi-criteria decision-making methods for similar tasks are obvious and motivated by several scientific publications. In order to achieve the objective of development proposals that are more sustainable, it is necessary to explore the current situation, to identify a range of possible policies and to select an optimum for the situation under consideration. In all these cases there is a need for scientific methods and techniques [29]. Decision problems of the sustainable development type are conflicting by nature. A set of multiple goals and objectives needs to be considered simultaneously. Different stakeholders with their interests and values interacting with each other make the decision-making process much more complicated. Therefore multi-criteria techniques seem to be an appropriate tool [30]. It can assure sustainability of the total system and the solution objectivity and is based on mathematical methods.

To decide upon a mathematical theory to model sustainable rural building redevelopment, the type of uncertainty related to sustainable development must be considered. The type of uncertainty due to incomplete and inconsistent information is known as fuzzy uncertainty [31]. Fuzzy set theory has long been valued when working with imprecise data and when solving multiple-objective decision-making problems, eg in deriving integrated decisions for agricultural sustainability [32], in modelling decisions related to housing sustainability [30] and economic-ecological evaluation [33]. The analogous method based on sustainability indicators information could be adapted for establishing rural building redevelopment priorities.

According to fuzzy set theory [31, 34], the fuzzy set of objectives is $\mathbf{O}_j$ The attainment of the objectives is measured by a set of sustainability indicators:

$$\mathbf{O}_j = \{o_j \mid j = 1, 2, \dots m\}. \tag{14}$$

A set of alternatives of decisions:

$$\mathbf{X}_j = \{x_j \; j = 1, 2, \dots n\}. \tag{15}$$

The sustainability objectives can include economics, environmental, futurity, social and other objectives. The attainment of objective j by an alternative of a decision i is expressed as the degree of membership of the function $\mu_{o_j}(x_i)$. The decision is the intersection of all fuzzy objectives using the 'and' logic. The optimal alternative is defined as a decision achieving the highest degree of membership in $\mathbf{A}$, which is denoted by:

$$\mathbf{A} = \mathbf{O}_1^{w_1} \cap \mathbf{O}_2^{w_2} \cap \dots \mathbf{O}_m^{w_m}, \tag{16}$$

where w_j is weighting indicating the relative importance of objective j,

$$\mathbf{A} = \left\{ \left(x_i, \min_j \left(\mu_{O_j}(x_i) \right)^{w_j} \right) i = 1,2 \dots n; j = 1,2, \dots m \right\}. \tag{17}$$

Established spatial distribution peculiarities of derelict rural buildings in Lithuania demonstrated that the same solution is inexpedient for the whole country territory. The results of statistical analysis and the concept of the country's spatial development, presented in the Master Plan of the territory of Lithuania where areas of active development have been planned, outlined the possible differences of buildings restoration. One ought to make renovations and use buildings not for farming in the areas of active development. In other localities these buildings can be effectively used for farming purposes and there are less possibilities of changing their functions successfully. But the quantities of agricultural production are not increasing in Lithuania. Thus damaged and not useful farming objects ought to be dismantled or renovated and adapted for other activities according to local possibilities.

Appropriate statistical indices were calculated (1), (2) and it was proved that the structure of correlation matrixes was statistically different. This scientific argument confirms the assumption that the model ought to be adapted to local social, economical and environmental conditions.

For the reasons mentioned above, several decision-making matrices were composed. They consist of uniform subsystems that describe rural buildings revitalisation alternatives from the aspect of sustainable development, while values of criterion vary in different analysed areas and depend on restoration variants of derelict buildings and their environment. Also, the use of weighted decision-making is preferable. The determination of weights of criterion allows one to distinguish the importance of the indicators. Different weights of indicators can be set in various evaluation matrixes according to the existing singularities and the development possibilities that were established in previous research. The mentioned features enable one to adapt the proposed model for other goals, concerning construction and location problems. One can carry out objective and sustainable solutions on the base of described principles. It is possible to use the model not only in Lithuania but also in other countries.

5. Conclusions

1. According to the assessment of existent situation, derelict and mismanaged rural buildings make a considerable amount of total building stock in Lithuania. It is important to solve the question of their rational revitalisation.

2. Derelict and mismanaged rural buildings cause a negative influence on the economy and on the natural as well as social environment of the country. Consequently, revitalisation of unused rural buildings must be analysed in a context of sustainable development.

3. Revitalisation of rural property includes restoration, redevelopment and/or dismantling of buildings. The research indicated that the priority of revitalisation alternatives of buildings and their territories depends on local features and peculiarities of the object. The same solution is inexpedient for application to any object and within the whole territory of a country.

4. Economical and social factors determining distribution and revitalisation perspectives of unused buildings were established by using methods of mathematical statistics. It was estimated that the peculiarities of derelict and mismanaged rural buildings territorial distribution are statistically different in various zones of development activity as presented in the conception of Lithuania's spatial development and they differ according to the purpose of buildings.

5. The model of indicator system for a rational use of derelict buildings from the aspect of sustainable development was proposed. It reflects European trends of sustainability, existing experiences in a field of indicator development and peculiarities of the problem.

6. The priorities of building revitalisation alternatives can be established by realising the proposed indicator model with the help of multi-criteria decision-making techniques. Considering uncertainty due to incomplete and inconsistent information related to sustainable development, fuzzy set theory was suggested in solving problem of rational revitalisation of derelict and mismanaged rural buildings.

7. Established principal trends of derelict buildings revitalisation and proposed model of sustainability indicator system can be adapted for other goals, concerning construction and location problems not only in Lithuania but also in other countries.

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