MODEL OF ECONOMIC JUSTIFICATION OF CONSTRUCTIONS' RENOVATION

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Abstract
In the life cycle of constructions we often cope with the problem if it is economic justificated to renovate certain construction. On the market we meet growing problem of older constructions which are more and more neglected and unkept. This is the consequence of high number of new apartments and other constructions. General crisis has also an influence on negligence and has forced owners of constructions to economize and consequently at negligence of older constructions what brings to diladaptation. This will also happen to new constructions because owners act too less responsible or economic, therefore the reason of diladaptation is the lack of knowledge of owners. They do not know how to take care of constructions and how to maintain them regularly and when to sanitate them. By originating the damages are often connected high cost which means that the issue of preventing diladaptation is important not only from the view of security and aesthetic but also from the view of national economies and sustainable development.

Keywords: Renovation, sanitation of buildings, maintenance of buildings, physical deterioration, functional obsolescence, economic obsolescence.

INTRODUCTION

Around the world the awareness of regular maintaining and renovation objects as the right and only way for preserving the value of buildings has been expanded more and more. However there is still not enough large emphasis at the field of planning basis and modernization of building in accordance with technical development and requirements of modern user, which would ensure not only preservation but also decrease of fixed property's value. Only with maintaining we ensure following exploitational ability of buildings, where we have to execute renovations on the basis of previous assessment of the reason for damage's origin and condition of damaged objects. For each object separately the costs, risks and advantages of renovation or substitutional building have to be deliberated. Built constructions as fixed property represent an important issue of national wealth of society or country. The aim of each country is that fixed properties keep their functional ability as long

as possible, which is possible to achieve only with appropriate relationship to fixed property and good managing with them. We have more and more neglected buildings all around the world which are at the edge of destruction and on the edge of suitability of pillar construction. At that kind of buildings the owners still do not know how to decide right or is it worth to renovate that building or to build the substitutional building. Thus it will be indirectly able for the owners by the help of this model how to decide in this case. The model does not include only economic decision but also includes all the others criteria which influent on this decision. Thus we are developing multicriteria decisive model of economic justification of renovation or substitutional building. By the help of that model it will be possible to decide about economic justification of renovation or substitutional building on the basis of criteria of physical deterioration, functional obsolescence and economic obsolescence and profitability. We consider profitability at buildings of business activities while we do not consider profitability at public buildings, because profitability of that kind of buildings is indirect. Pšunder and Torkar (2006) define mentioned criteria as.

- Physical deterioration: we understand it as reducing of value, caused because of condition deterioration as consequence of use.
- Functional obsolescence: it means reducing of buildings value because of bad construction, structure or materials, which can cause reduced usefulness of fixed property.
- Economic obsolescence is reducing of fixed property's value because of factors which origin from environment. These can e changes in standardization, legislation, infrastructure or environment town plan.

Model does not deal with objects which are written in register of cultural inheritance, which means that certain architectural changes are allowed only on the basis of very well-founded reasons and on the basis of essential studies by which existing possibilities have to be checked. Basic guidance at regular maintaining and investing maintaining work on the building of cultural inheritance is keeping of genuineness – authenticy. Thus we have to renovate that kind of buildings not regarding on costs which origin during renovation.

Thus we will enter mentioned criteria: physical deterioration, functional obsolescence and economic obsolescence and profitability into real problem by the help of methods of multicriteria deciding of economic justification of economic justification or substitutional building. Real examples of saluting with multicriteria deciding have been practically different form case to case, after which the deciding methods have been developed and then launched as methods for individual categorization of deciding problem.

Thus we are developing multicriteria decisive model by which we will be able to estimate economic efficiency of renovation or substitutional building. It is the definition of time term in the buildings' life time until when it is still justified to renovate or sanitate considering higher profitability or benefit which will be brought by substitutional building with its activity.

THEORETICAL BASIS

Many scientific fields and disciplines like philosophy, psychology, economy, mathematics and even more specified fields as decisive theory and decisive analyze have been occupied with problems of deciding (Bohanec and Rajkovič, 1995). Especially important question is how to help to the one who is taking decision to take qualitative

decision on the easiest and the most systematically organized way. Decisive situations where we estimate variants only by one characteristic are very rare. Usually we take decisions on the basis of different views on variants, and then we speak about multicriteria deciding (Bohanec and Rajkovič, 1988).

Multicriteria deciding is acknowledged and widely used method which supports decisive paradigm and is used on different fields of study (Bell et al, 2003). The origins of multicriteria deciding go back in the middle of the 20. century, when Koomans represented concept of non-dominant vector in 1951 and when Kuhn and Tucker represented optimal conditions for existence of non-dominant solutions (Pomerol and Babrba-Romero, 2000). Decisive moment for development of multicriteria deciding was in 1972 when the first international conference on multicriteria deciding was organized at Columbian university in South Carolina. Multicriteria deciding was there defined as independent scientific field (Pomerol and Babrba-Romero, 2000). Since then many scientific subscriptions have been published.

At multicriteria deciding we cope with more or less difficult decisions of choice among different variants where we are not able to create final decision of choosing the best variant without use of methodological accession.

Requirements at choice of the best product are for example the lowest price, the longest time of use, the strongest materials, the least influence on environment, the easiest use etc. We know out of practice and experiences that we can not fulfill all the requirements because usually these are opposite to each other. It is necessary to make compromise and choose one variant among many of them that suits to requirement or criteria the most. (Omladič, 2002). It is necessary to use methodology which makes possible the interactive optimization on the basis of many criteria.

Methodology of multicriteria deciding is based on the fact that there are many factor which influent on the choice of solutions, for achievement of final aim are not all the same important. Decisive problem is divided on smaller sub-problems on the first level, these can be further divided on even smaller sub-sub-problems-that means sub-problem on the first level and so on until the satisfaction of wideness and deepness of decisive scheme (Bohanec and Zupan, 2004). Thus we get decisive scheme. Wideness and deepness of decisive scheme are dependent of extensiveness and pretentiousness of problem with which we cope.

The essence of the multicriteria deciding method is that we divide the decisive problem on smaller sub-problems and treat them separately (Koprivšek and Oblak, 1997). At that method we divide decisive problem on levels (we make hierarchy) namely that on the highest level is the main aim or decisive problem and under it are criteria or sub-problems which can be set and divided on optional number of levels, hierarchically the lowest are alternative decisions or variants (Zadnik, 2000).

The basic question which appears at multicriteria deciding is how to find the appropriate profitability's function. Neuman (1953) and Chankong and Haimer (1983) cited by Rajkovič and Bohanec (1988) quote that is has to be ensured the existence and monotony of that function in accordance with measure theory. Rajkovič and Bohanec further ascertain that appropriate sentences ensure sufficiency for existence and monotony of profitability function. We call these conditions of sufficiency axioms.

Defining the profitability function by the help of axioms' checking is named axiomatic accession. Rajkovič and Bohanec (1988) quote that most of theorists acknowledge axiomatic access as the only right access at taking decisions. Practical men reproach difficulties to this access at checking of axioms and in certain situation not being practical. Therefore we often meet in praxis the direct access where person taking decision defines the function of profitability by his own judgments on the basis of his experiences and beliefs. It is possible that are direct and axiomatic access combined, which can be seen in practice. Here

we have direct identification of decisive knowledge which can be axiomatic grounded if it is possible (Rajkovič and Bohanec, 1988).

There exist many methods for support of multicriteria deciding. Individual methods are appropriate for simple decisive methods with small number of criteria and alternatives, again other are designed for the most difficult problems.

At developing of multicriteria model we resulted from model which was developed by Vaniers and co-authors (2006), which is decisive model for managing with fond of buildings.
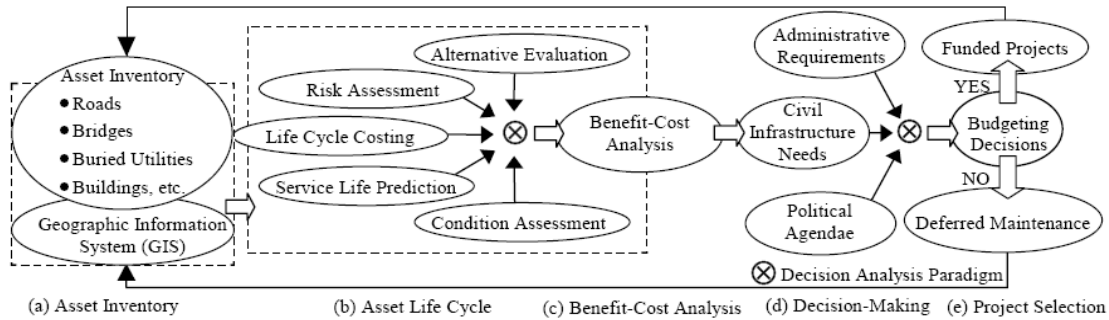
Picture 1: Proposed framework for decision making. (Vanier and Lounis 2006)

It is the framework which was firstly designed for definition of building which needs certain interventions the most. Model is based on the relation of invested sources and profit which is got because of them and what can be defined by the help of analyze of costs and profit. In the complex of that analyze we consider momentary condition of buildings, their remaining life time, complete life costs and all potential risks connected with individual building. We have to analyze all the alternatives or variants which are available.

CONCEPT OF PROBLEM

Value of the building decreases because of deterioration's and obsolescence's kind which were listed above. As a rule first appears physical deterioration, then with time appear also functional and economic obsolescence. Thus we have formulated mathematically the value of building or fixed property after the certain time as (Kovačec, Pšunder, Soršak, 2010):

$$V(t) = V_i - dP_{HY} - dF_{UN} - dE \tag{1}$$

Where is:

$V(t)$ – value of fixed property after the certain time;
V_i – initial value of fixed property;
dP_{HY} – extent of physical deterioration for which the value of fixed property is reduced;
dF_{UN} – extent of functional obsolescence for which the value of fixed property is reduced;
dE – extend of economic obsolescence for which the value of fixed property is reduced.

On the Picture 2 it is the chart where is represented that in the cases when we cure physical deterioration or functional obsolescence we can exceed initial value of the building or fixed property by enough high input. Regarding to cost of curing, the economic obsolescence (Pšunder, Torkar, 2007) is incurable. Here is necessary to ask a question how high can be the

inputs at the physical deterioration and functional obsolescence that it is not economic to build the substitutional building. Thus we are looking for time limit in the buildings' life time until it is justificated to renovate or sanitate buildings regarding to higher profitability which will be brought by new building and its activity.
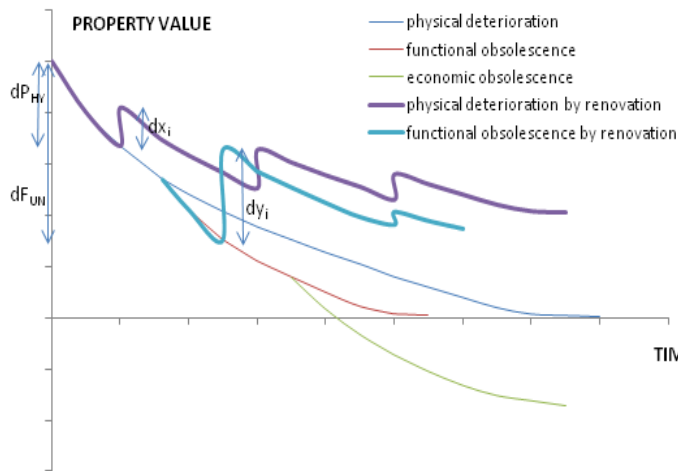
Picture 2: Value of the building at "the recovering" of deterioration and obsolescence.

Thus we have formulated "Eq. (1)" as:

$$V(t) = V_I - \sum_{i=1}^{n}(dP_{HYi} - dx_i) - \sum_{i=1}^{n}(dF_{UNi} - dy_i)$$

(2)

Where is:
dxi – extend of inputs in the "recuperation" of physical deterioration;
dyi – extend of inputs in the "recuperation" of functional obsolescence.

On the basis of above equations 1 and 2 we have dervated following equation, which will be the basis for multicriteria decisive model for building's renovation described in the following chapter.

The condition of economic justification of renovation of non-economic buildings, these are public buildings, is formulated as:

$$V(t_{after\ renovation}) > V(t_{OB}) + C_{renovation}$$
(3)

Value of building before and after the renovation can be defined with method of comparable sales. Conditions of economic justification of business buildings' renovation, these are buildings which bring benefits, are formulated as:

$$V(t_{after\ renovation}) > V(t_{OB}) + C_{renovation} + benefits$$
(4)

MULTICRITERIA DECISIVE MODEL

Suggested multicriteria decisive model is based on represented theoretical points of departures in previous chapters and with combination of individual methods. It involves single criterion techniques, as well as multiple criteria techniques including, weighted mean.

At chosen multicriteria decisive model we treat one building. In the first stage we choose a building and try to study throughout the condition of it as it is represented on the Picture 3. Then we define possibilities of building's renovation in variants. After that we define renovation's costs of individual variants. Then we estimate the value of existing building and profitability of it in case of business building. We also define values of sub-criteria of existing building which are basis for further estimation. We choose the team of professionals and fixed property's estimators from build profession and who estimate and value fixed property after value international standards – MSOV (2007). Estimators and professionals estimate values of fixed property after purchase-value way which is based on the principle of Whitmer (Encyclopedia of Investments, 1990) that deliberate investigator for estimated fixed property is not prepared to pay more than costs of building equal fixed property amount, which has to be considered in our multicriteria decisive model because we are looking for economic justification of renovation or substitutional building. After defining the value of the building we start with multicriteria deciding. Here we use the team of professionals and fixed properties' estimators from construction profession, which estimate criteria represented in able 3 after preference measure scale with interval 0-10. Lower limit suits to expressive bad or undesired value of parameter, the upper one the most ideal and desired. Thus 10 mean ideal, the best, the most desired value, 0 the worst, undesired value. Thus the most important criterion gets weight 10 while are weights of remaining criteria defined relatively in the relation to the most important criteria. When the team of professionals finishes with the estimation with Delphi method we define estimations' unity of different professionals and we use achieved estimations for continuation of deciding.

After definition of estimation we start working on profitability's function. We define it after method of value's defining. The advantage of this method is that it is simple because we need to define only smaller number of preference in general. Thus we take as the example the sub-criteria of remaining life-time, where we make:

Class	To less	little	satisfying	appropriate
Interval of largeness (years)	0-25	25-50	50-75	75-100
profitability	0	0,50	0,75	1,00

Table 1: Defining of profitability

We define profitability also for others sub-criteria on the same way.

After defining the estimation we start with count of profitability which is made after following equation:

$$Profitability = \frac{Estimation}{Common\ estimation}$$
(5)

For estimation we take the estimation of individual main criterion (Table1), while we take common estimation of individual main criterion for common estimation. After definition we make scheme of criteria, Picture 4, where we divide main criteria by percentage in the way to add together estimations of sub-criteria and then we multiply this estimation with the sum of all estimations, thus:
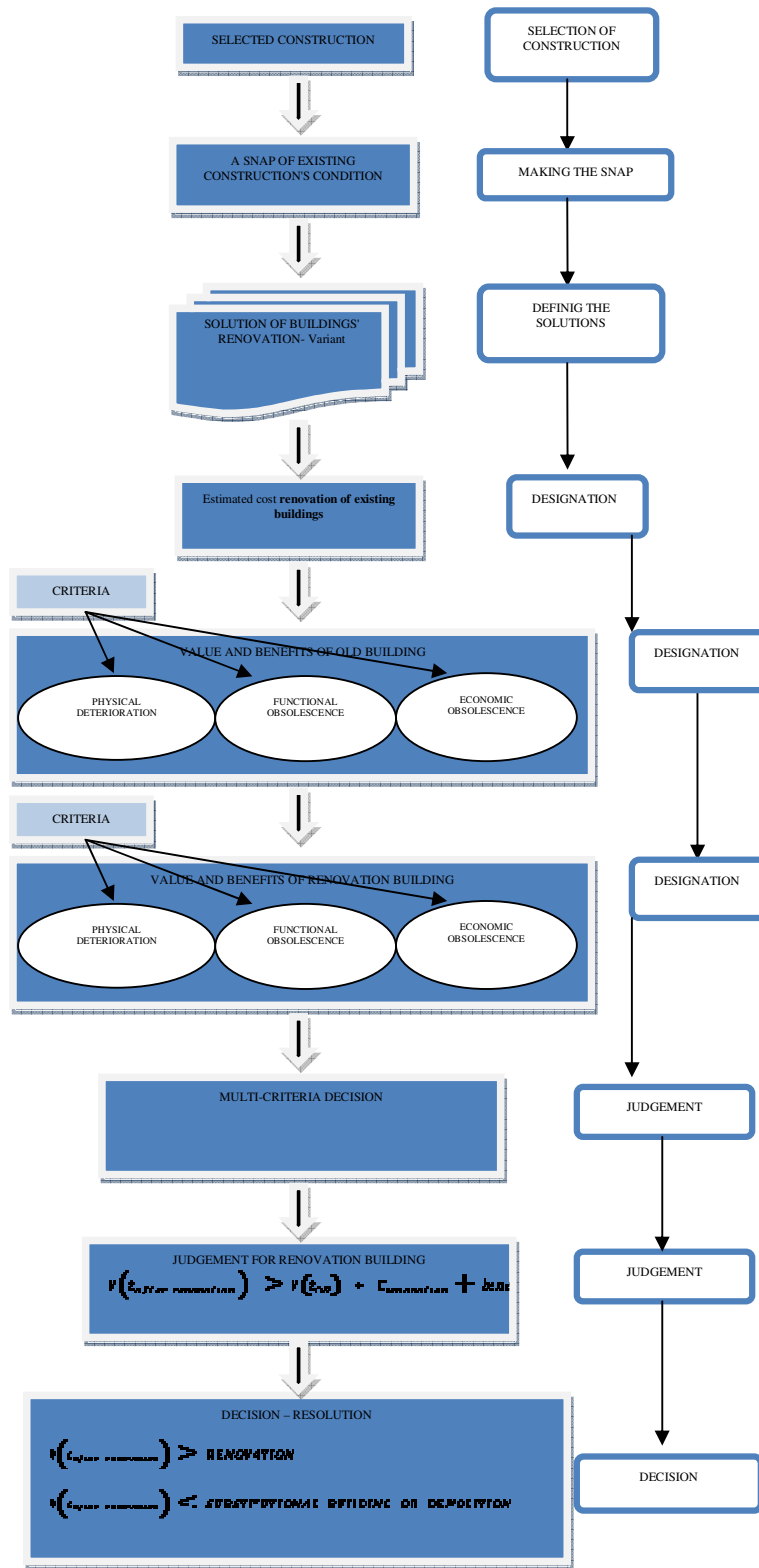
$$k = \frac{\sum estimation\ of\ sub-criterion}{\sum estimation\ of\ criteria} * 100\%$$
(6)

Where is:
k – Main criterion

The same division expressed by percentage we make also for sub-criteria.

Picture 3: Multicriteria decisive model of economic justification of the building.

CRITERIA		Renovation of the building Variant 1			...	Renovation of the building Varianta n		
Main criteria (k)	Sub-criteria (k_p)	Estimation (o_{p1})	Estimation together	Benefit (k_{r1})		Estimation (o_{pi})	Estimation together	Benefit (k_{ri})
PHYSICAL DETERIORATION (X_1)	Quality of the buildig (y_1)							
	Remaining life time (y_2)							
FUNCTIONAL OBSLOLESCENCE (X_2)	Construction's condition (y_3)							
	Condition of built materials (y_4)							
	Cost of maintainance (y_5)							
	Energetic efficiency (y_6)							
	Cost of heating (y_7)							
ECONOMICAL OBSOLESCENCE (X_3)	Location (y_8)							
PROFITABILITY (X_4)	Profit (y_9)							
BUILDING'S VALUE (X_5)	Value of the buildig after market method (y_{10})							
VALUE								

Table 2: Multicriteria deciding
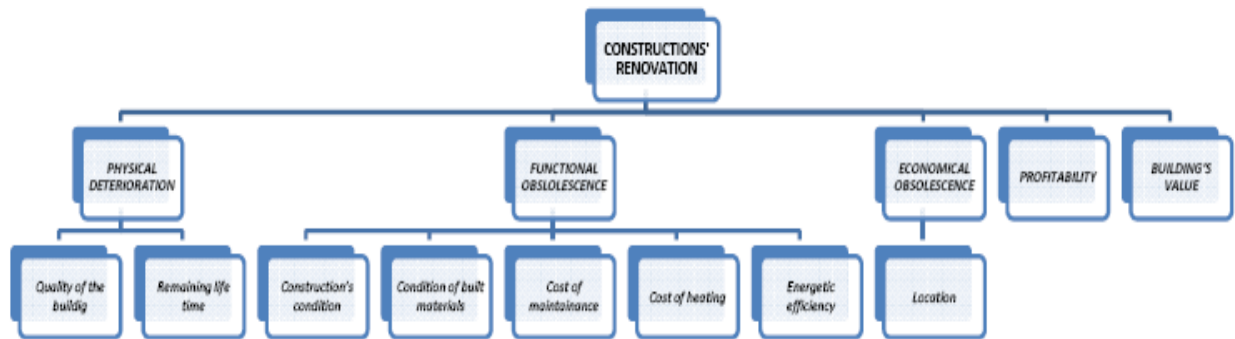
Picture 4: Scheme of criteria for evaluation.

After division expressed by percentage we count profitability of main criteria after equation:

$$k_{pr}X1 = (k_L(p(y1)) * k_L'r1(y1)) + k_L(p(y2)) * k_L(r1(y2)))/100$$
(7)

$$k_{pr}X2 = (k_L p(y3) * k_{pr}1(y3) + k_L p(y4) * k_{pr}1(y4) + k_L p(y5) * k_{pr}1(y5) + k_L p(y6) * k_{pr}1(y6) + k_L(p(y7))$$
)/100 (8)

$$k_{pr}X3 = (k_L p(y8) * k_{pr}1(y8))/100$$
(9)

$$k_{pr}X4 = (k_L p(y9) * k_{pr}1(y9))/100$$
(10)

$$k_{pr}X5 = (k_L p(y10) * k_{pr}1(y10))/100$$
(11)

After that we count final profitability of variant of building's renovation 1 after equation:

$$k_{pr}1 = (k_L X1 * k_{pr}X1 + k_L X2 * k_{pr}X2 + k_L X3 * k_{pr}X3 + k_{X4} * k_{rX4} + k_{X5} * k_{rX5})/100$$
(12)

Equation is valid for each variant of building's renovation. After definition of profitability for individual variant we choose variant with higher value of profitability. After that we check chosen variant of building's renovation after equation 3 or 4, it depends if the building is business or non-business. On so far as we get higher value of renovation after equations 3 or 4 then the decision about renovation is right, in case that it is lower then the decision about renovation is not appropriate, however we can decide for substitutional building or demolition and selling the land.

EXAMPLE

Represented model has been tried in company Gradbeno podjetje Ptuj d.o.o. on many cases and we have got successful results and confirmation of use the chosen model. The test of the model will be show on one of the examples.
Quoted equations have been tested on the real building Color Medvode in Slovenia. Building is abandoned factory which was bought by Slovenian company. This company rents this factor which is old and necessary of renovation or substitutional building. Thus the company could enlarge its rental and use of building with renovation. In this way we will make comparison between two variants of renovation of mentioned buildings, which have been prepared by architecture biro.

Picture 4: Factory Color Medvode.

CRITERIA		Renovation of the building Variant 1			Renovation of the building Varianta 2		
Main criteria (k)	Sub-criteria (kₚ)	Estimation (oₚ₁)	Estimation together	Benefit (k_{r1})	Estimation (oₚ₂)	Estimation together	Benefit (k_{r2})
PHYSICAL DETERIORATION (X₁)	Quality of the buildig (y₁)	5	11	0,50	6	12	0,60
	Remaining life time (y₂)	6		0,50	6		0,75
FUNCTIONAL OBSLOLESCENCE (X₂)	Construction's condition (y₃)	5	28	0,75	5	32	0,75
	Condition of built materials (y₄)	5		0,75	5		0,75
	Cost of maintainance (y₅)	5		0,50	7		0,50
	Energetic efficiency (y₆)	6		0,50	7		0,75
	Cost of heating (y₇)	7		0,50	8		0,50
ECONOMICAL OBSOLESCENCE (X₃)	Location (y₈)	5	5	1	5	5	1
PROFITABILITY (X₄)	Profit (y₉)	9	9	0,75	10	10	1
BUILDING'S VALUE (X₅)	Value of the buildig after market method (y₁₀)	10	10	0,90	9	9	0,80
VALUE		63		**0,625**	68		**0,641**

Table 3: The example of Color Medvode.

Variant 1:

$$k_{tr}X1 = (45 * 0{,}50 + 55 * 0{,}50)/100 = 0{,}500$$

$$k_{tr}X2 = (18 * 0{,}75 + 18 * 0{,}75 - 18 * 0{,}50 + 21 * 0{,}50 + 0{,}25 * 0{,}50)/100 = 0{,}466$$

$k_0 rX3 = (100 * 1\ )/100 = 1$

$k_{rX4} = (100 * 0,75)/100 = 0,75$

$k_{rX4} = (100 * 1)/100 = 0,90$

$k_0 r1 = (17,46 * 0,500 + 44,44 * 0,466 + 7,93 * 1\ + 14,28 * 0,75\ + 15,87 * 0,90\ )/100 = 0,623$

Variant 2:

$k_0 rX1 = (50 * 0,60 + 50 * 0,75\ )/100 = 0,675$

$k_0 rX2 = (15 * 0,75 + 15 * 0,75 + 22 * 0,50 + 22 * 0,75 + 25 * 0,50\ )/100 = 0,625$

$k_0 rX3 = (100 * 1\ )/100 = 1$

$k_{rX4} = (100 * 1)/100 = 1$

$k_{rX4} - (100 * 0,8)/100 = 0,8$

$k_0 r1 = (17,64 * 0,675 + 47,05 * 0,625 + 7,35 * 1\ + 14,70 * 1\ + 13,23 * 0,8\ )/100 = 0,739$

The results show that variant 2 is better than variant 1. That's why we check variant 2 after equations 3 and 4, so it depends if the building is business or non-business. Because in this case we have business building we check with equation 4, where the building has also fulfilled the condition.

CONCLUDING REMARKS

By help of multi-criteria decisive model it is possible to decide in which time limit of building's lifetime is it reasonable and economic justified to take a decision not to maintain or to improve sanitary conditions, but to demolish and construct new building or substitutional building regarding the criteria, therefore physical deterioration, functional and economic obsolescence in connection with the value of the object and profitability or benefit. Discussed model was tested in company Gradbeno podjetje Ptuj d.o.o. which deals with construction of all kinds of buildings. In the paper are represented only short abstracts of model. We will develop this model in the future that will regard business and non-business buildings in details and at the same time define the possibility of economic judgments of renovation and substitutional construction of buildings.

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