

REFURBISHMENT URGENCY INDICATORS OF RESIDENTIAL BUILDINGS

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Methodology and criteria, which help to estimate the urgency of intervention taking into account the degradation and natural obsolescence processes of building materials and elements in housing sector, has been proposed in the paper. The evaluation of refurbishment urgency is divided into two levels:

Level one – urgency of intervention priority at the level of the building element – building element treated as part of structure or installation (for example elements described in Epiqr method)

Level two – urgency of intervention at the level of the macroelement (set of building's elements, group of Epiqr elements) and at the level of the building.

As the result of deterioration urgency for building the numerical value of UIB (urgency indicator for building) is estimated. The value of UIB is between 0 and 1. The lower value of the UIB means that the building is more deteriorated and needs more urgent renovation.

Keywords: asset management, building surveying, housing, refurbishment.

INTRODUCTION

The best practice of real property management is to take the right decision of refurbishment range at the best moment. Owners or administrators of a large number of residential buildings have to decide how and where at first to invest the limited resources. The majority of methods of assessment the technical state of building elements or their deterioration state usually appear to be a different “time methods” (Thierry, Zalewski 1982) which take time as only one parameter. These methods give usually the percentage of building deterioration (Arendarski 1978), though the values for many buildings give no information of real refurbishment needs. Other, multi-criteria methods which apply fuzzy set theory or neural network (Urbański, Waszczyszyn 2002) require large set of homogenous buildings to teach the network or find the dominant factors. None of these methods may be applied to compare buildings at different age and give no proper indication of building's “weak” places. Proposed method of indicators calculation takes into account different criteria i.e. age of building, state of deterioration and costs of renovation and may be applied for all types of residential buildings.

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RANGE OF INTERVENTION URGENCY

Evaluation of the range of intervention urgency depends on the current needs of a building owner or administrator. The problem of formulation methods and criteria, which allow to estimate the intervention urgency, taking into account the degradation and natural obsolescence processes of building materials and elements, has been divided into two levels:

Level one – urgency of intervention at the level of the building part or element,

Level two – urgency of intervention at the level of the macroelement (group of elements) and at the level of the building.

LEVEL ONE - ELEMENTS OF THE BUILDING

Evaluation of the urgency of intervention priority at the level of the building's element gives an opportunity to mark and choose the elements which are highly deteriorated. The evaluation should be done while the diagnosis of building deterioration state is performed. It is possible to choose different parts of the building and treat them as element. The division of a building into elements used in EPIQR software (Genre, Flourentzou, Faist 1998) has been applied in this paper.

The factors used for estimation the priority of intervention urgency at the level of the element are as follows :

deterioration state of the element – codes of degradation,

element age/lifespan ratio,

quality standard of the building.

Input data

Epiqr elements and degradation codes

According to the EPIQR method (Flourentzos, Droutsa, Wittchen 2000), 50 elements of the residential building have been chosen. Types of elements -see Table 1 usually represent the most popular ways of element creation. The state of deterioration is described in the same way as in the EPIQR method – choosing one of the degradation codes – “a”, “b”, “c” or “d”.

Table 1: Code “m” description – chosen building's elements

Element No, Name	Type of element	Description of Element Critical Deterioration State CODE “M”
5 balconies	5-1 5-2	Visible bars of armature of the reinforced concrete plates. Advanced corrosion of steel bearing elements. Inefficient system of water outflow. Elements of balustrade and handrails unstable, they move, threat of overturning.
22 internal electrical installation	22-1	Frequent fuse switch off. Electric breakdown on steel meter boxes, other metal parts or walls. Uncovered (out of insulation) electric wires, fear of electric shock. Lack or damaged lighting fittings, switches or sockets.

<p>39 windows</p>	<p>39-1</p>	<p>Broken window panes. Window hinges and locks damaged or not functional. Difficult closing and opening. Rainy water comes through the windows into the rooms.</p>
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To each of the degradation code corresponds the range of necessary works, which are necessary to perform in purpose to restore the element to the the degradation code “a” again. If one of the element does not exist in the building or is skipped, will no longer be taken into account in further analysis. Additional degradation code - critical code “m” (from eMergency) and a new description of critical state of the building’s elements have been proposed. Example of of element critical deterioration state description for two choosen elements are presented in Table 1.

The description takes into account the degradation of the physical state of the building’s element, technical and functional depreciacion. In some cases the description is similar to the state of the element which corresponds to the Epiqr’s “d” code, in other cases shows the current state may be dangerous for occupants or passing-by pedestrians. Some cases shows extreme situations, which may vary in different countries due to the national and regional regulations, inhabitant habits etc.

Element age/lifespan ratio

Element age and element average lifespan is estimated in years.

There are two kinds of values which may be taken into account in conjunction with the rest of the input factors:

- Case 1 - value of the ratio is less then 1 – means that the age of element is lower then predicted average lifespan,
- Case 2 - value of the ratio is equal or higher then 1 – means that the age of the element is close to its lifespan ora the element is even older then predicted average lifespan,

Quality standard of the building

Three kinds of building quality have been introduced:

- high quality building,
- medium quality building,
- low quality building.

Two kinds of the factor values are taken into account in conjunction with the rest of the input factors:

- Case 1 - high quality building (element)
- Case 2 - medium or low quality building (element).

Output – building’s element priority of intervention

As the result of deterioration urgency, three kinds of priorities have been indicated according to the Epiqr propositions:

- priority 1 - very urgent necessity of intervention, - red light
- priority 2 - intervention needed in close future, - yellow light
- priority 3 - intervention can be made at better moment or intervention is not necessary - green light

Considering the input factors, the following cases have been formulated as a result of different combinations of the input factors – see Table 2.

The influence of element's quality and age is not important when the deterioration state of element is marked as "m". In other cases all three factors affect the value of priority of intervention.

Table 2: Estimation of priority of intervention value

Case No	Element Degradation Code	Element Age/Lifespan ratio value	Quality standard of the building	Priority of intervention
1	m	≥ 1	High quality	1
2	m	≥ 1	Medium or low quality	1
3	m	< 1	High quality	1
4	m	< 1	Medium or low quality	1
5	d	≥ 1	High quality	1
6	d	≥ 1	Medium or low quality	1
7	d	< 1	High quality	1
8	d	< 1	Medium or low quality	2
9	c	≥ 1	High quality	1
10	c	≥ 1	Medium or low quality	2
11	c	< 1	High quality	2
12	c	< 1	Medium or low quality	2
13	b	≥ 1	High quality	2
14	b	≥ 1	Medium or low quality	3
15	b	< 1	High quality	3
16	b	< 1	Medium or low quality	3
17	a	≥ 1	High quality	3
18	a	≥ 1	Medium or low quality	3
19	a	< 1	High quality	3
20	a	< 1	Medium or low quality	3

LEVEL TWO - NUMERICAL INDICATORS FOR BUILDING AND MACRO-ELEMENT

The intervention urgency evaluation at the level of the building and of the level of the macroelement is proposed as estimation and comparison of the numerical values of the following two indicators :

UIB – urgency indicator of the building,

UIM - urgency indicator of the macro-element.

Macro-element definition

Macro-element may be described as a set or aggregation of building's elements. To show the methodology of calculation the indicator value for group of building's elements, the macro-element definition developed within the elaboration regarding EPIQR Plus checklist for residential building and European project – Investimmo, has been applied.

There are six macro-elements which consist of the different numbers of Epiqr elements. The name of macro-elements are as follows:

Macro-element 01A - Facades

Macro-element 01B - Roof

Macro-element 01C - Common spaces

Macro-element 01D - Sanitary premisses and installations

Macro-element 01E - Appartments

Macro-element 01F - Technical installations

Example of macro-element aggregation is presented at Table 3.

Table 3: Examples of Macro-elements

Macro-element No	Element name	EPIQR's element No
01A	External wall finish	element 03
	Facade decorations	element 04
	Windows	element 39
	Shutters and solar protection	element 40
	External doors	element 15
	Basement windows	element 16
	External wall thermal insulation	element 06
	Facade scaffoldings, site installations	element 50
	Balconies and galleries	element 05
	Structure slab walls	element 02
01F	Surroundings	element 01
	Electrical power supply	element 21
	Heating central production plant	element 11
	Sanitary hot water production	element 36
	Heating distribution network	element 12
	Oil storage	element 10
	Water connection and metering	element 13
Gas connection to the city network	element 13	

Factors influencing the UIB and UIM values

The procedure of UIB value estimation takes into account three factors :

Factor 1- Epiqr elements and degradation codes

Standard Epiqr codes “a”, “b”, “c” “d” and additional code “m” which describes critical state of element deterioration are applied.

Factor 2 - Value of the ratio which is calculated as the cost of element renovation from the current deterioration state divided by the cost of renovation from the code “d” for the most expensive element, what means that the current cost of element renovation is divided by the maximal cost of renovation (corresponding “d” code) choosen from all existing and not skipped building elements.

Factor 3 - Element age/lifespan ratio

Element age and element average lifespan is estimated in years. The value of the ratio may vary from 0 (new building) to the value close to 1 (which means that the age of the element riched predicted average lifespan of the element), but values greater then 1 are also allowable.

Procedure of UIB and UIM calculation

The principle of the method is based on the assumption, that each of the building element is evaluated according to the criteria which take into account presented factors.

One element may potentially gain 3 points, 1 point from each criterion. The score of the element is calculated in a different way for each criterion.

Generally, the score of element decreases due to the deterioration processes, increasing age of the element and higher cost of renovation.

Description of criteria

CRITERION 1 – State of deterioration

As the initial data standard Epiqr's deterioration codes and additional "critical code" is taken. Weights are associated with deterioration codes as follows:

Element deterioration "a" - weight 0,1

Element deterioration "b" - weight 0,3

Element deterioration "c" - weight 0,5

Element deterioration "d" - weight 0,7

Element deterioration "m" - weight 0,9

If any of the elements which means element not existing or skipped, weight value is taken as 0. In this case these elements will not be counted.

The score of the element in this criterion is calculated as "*1 minus weight value*".

Possible values of the element score at that criterion are: 0,9; 0,7; 0,5; 0,3; 0,1.

CRITERION 2 – Cost of renovation

Cost of element renovation which is estimated according to the Epiqr's method which corresponds with deterioration codes, is taken as initial data.

Values at the column G- table 1 represent the ratio of present cost of renovation divided by the maximum value of the renovation costs for code "d", chosen from all existing and not skipped elements – this value is estimated from the Epiqr scenario – all elements in code "d".

The score of the element in this criterion is calculated as "*1 minus ratio value*".

Possible values of the element score at that criterion may vary between 0 and 1 .

When the element is not existing or is skipped the score is not taken into account.

CRITERION 3 – Age of element

Age of the element which is estimated in years by the user, which usually is the same for most of building elements as building age, is taken as initial data. Values represent the ratio of the present element age divided by the average lifespan of the element.

The score of the element in this criterion is calculated as "*1 minus ratio value*".

Possible values of the element score at that criterion usually vary between 0 and 1 , but negative values are also permissible in that criterion. Negative element score means, that the element is older then its predicted average lifespan.

When the element is not existing or is skipped the score is not taken into account.

Output – UIB numerical value

As the result of deterioration urgency for building the numerical value of UIB is estimated. The value is calculated as a total score for all existing and not skipped elements divided by the total possible score for all elements.

The value of UIB is between 0 and 1.

The lower value of the UIB means that the building is more deteriorated and needs more urgent intervention.

Output – UIM numerical value

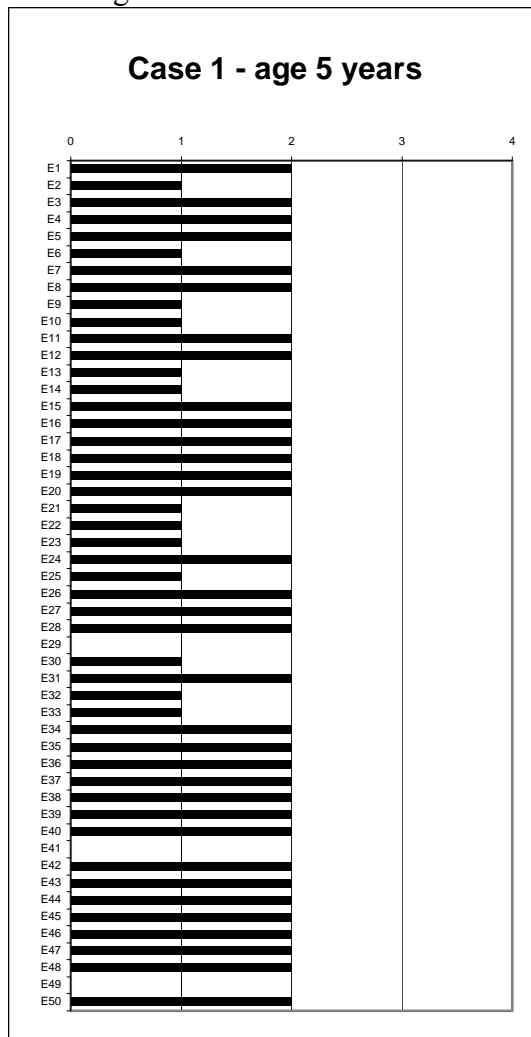
As the result of deterioration urgency for macroelement the numerical value of UIM is estimated. The value is calculated as a total score for all existing and not skipped elements inside macroelement divided by the total possible score for all elements inside macro-element. If one of the element inside macro-element doesn't exist or is skipped, this element is not taken into account in the estimation of UIM value. The value of UIM is between 0 and 1. The lower value of the UIBM indicator means that the building macro-element is more deteriorated and needs more urgent intervention.

EXAMPLES

To illustrate the range and area of changes of UIM and UIB indicators the following cases have been analysed:

- **case 1** - apartment building, 5 years old, technical state – good,
- **case 2** - apartment building, 27 years old, technical state – good,
- **case 3** - apartment building, 27 years old, technical state – medium,
- **case 4** - apartment building, 50 years old, technical state – medium/bad,
- **case 5** - apartment building, 82 years old, technical state – bad.

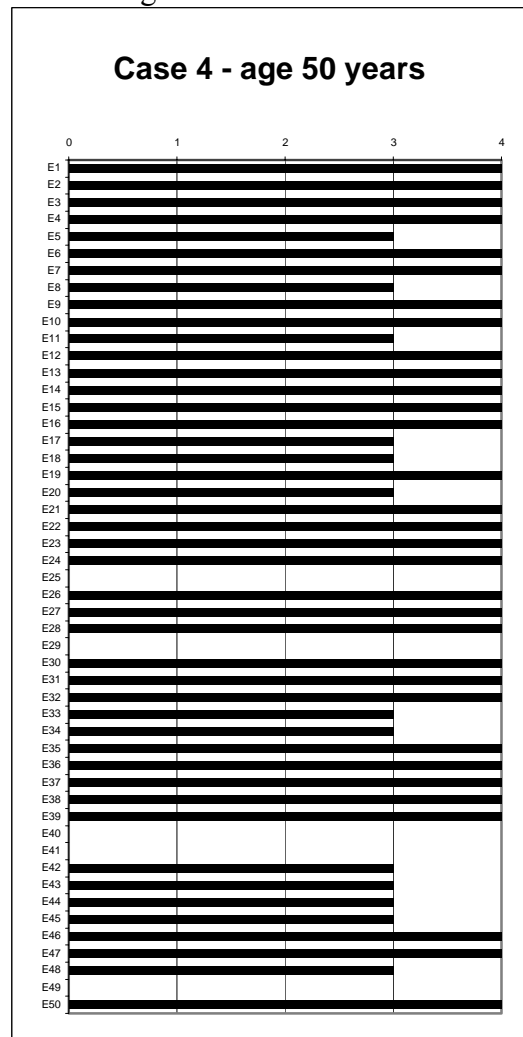
Fig.1



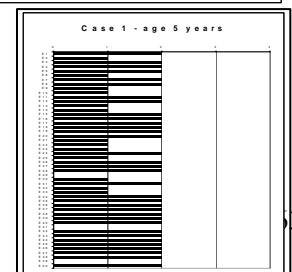
UIB=0,874

Macro-element	UIM
01A	0,885
01B	0,895
01C	0,902
01D	0,874
01E	0,822
01F	0,808

Fig 2.



UIB=0,459



The values of indicators UIB and UIM, as well as the illustration of deterioration state of the building's elements (50 elements accord. EPIQR methodology) are presented at Fig.1 and Fig 2.

The x-axis on the diagrams shows the range of element deterioration. The numbers 1-4 on the x-axis corresponds to the Epiqr's degradation codes a,b,c,d. The values of UIB indicators are shown under the diagrams. The results of urgency indicators for macroelements UIM are presented in tables under the diagrams. The values of UIB and UIM indicators for more deteriorated and older building (case 4) are close to 50% lower than for new and not deteriorated building (case1).

Presented on Fig 1. and Fig.2 tables with the results of UIM indicators for macroelements give the information which types (groups) of elements are more deteriorated and which need more detailed diagnosis. On the Fig.2 the macro-element 01F – technical installations has the lowest UIM value (0,337) and is much lower than the UIM value for macro-element 01C.

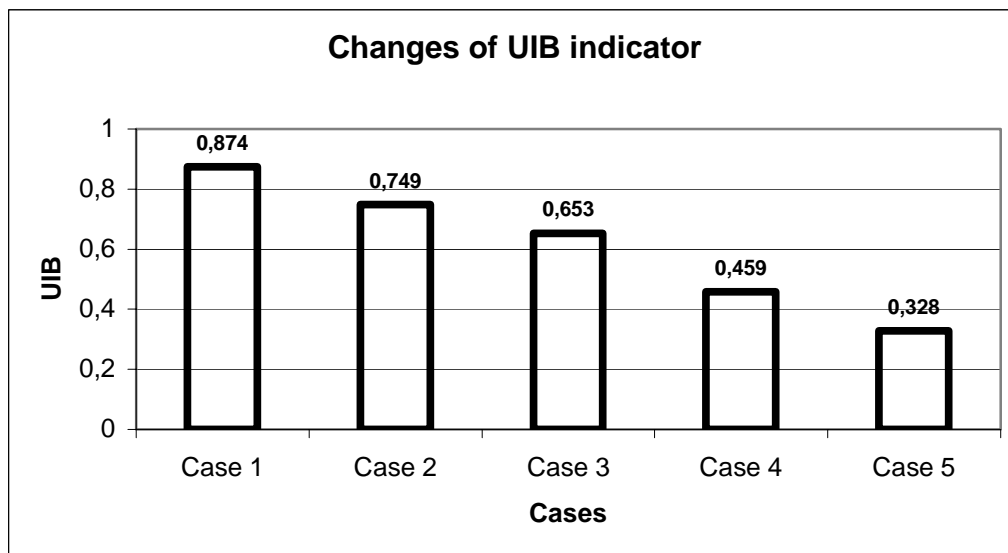


Fig.3

The values of indicators UIB for different 5 buildings (case 1-5) are presented at Fig.3. The values of UIB indicators decrease due to the age of building and more deteriorated elements. It is possible to compare the UIB values for quite different buildings and similar buildings (the same type and dimensions) and choose the one which needs more urgent renovation.

CONCLUSIONS

Commonly used methods (Thierry, Zalewski 1982) of building or its element deterioration state assessment do not offer the possibility of building's refurbishment needs comparison, also in time. The standard, percentage value of building's deterioration give no detailed information of building technical state, in real. These values can not be compared for different buildings. Proposed and described methodology of estimation and calculation of the urgency indicators for residential buildings is flexible. Different classification of macro-elements or groups may be applied. The approach gives the opportunity to compare the same buildings in time

and different buildings at the same moment. It is possible to give automatically the element of the building its priority of refurbishment intervention as a result of building's deterioration diagnosis. Introduction of UIB and UIM indicators makes easy to compare different buildings or their parts (macroelements or groups) in time and choose the range and right moment for renovation activity. The method takes into account not only technical aspects but also cost of renovation.

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