

VILNIUS GEDIMINAS TECHNICAL UNIVERSITY

Jurgita ALCHIMOVIENĖ

**ASSESSING SUSTAINABLE  
REFURBISHMENT OF APARTMENT  
BUILDINGS IN URBAN  
NEIGHBOURHOODS**

**SUMMARY OF DOCTORAL DISSERTATION**

**TECHNOLOGICAL SCIENCES,  
CIVIL ENGINEERING (02T)**



LEIDYKLA  
Vilnius TECHNİKA 2012

Doctoral dissertation was prepared at Vilnius Gediminas Technical University in 2008–2012.

Scientific Supervisor

**Prof Dr Saulius RASLANAS** (Vilnius Gediminas Technical University, Technological Sciences, Civil Engineering – 02T).

**The dissertation is being defended at the Council of Scientific Field of Civil Engineering at Vilnius Gediminas Technical University:**

Chairman

**Prof Dr Povilas VAINIŪNAS** (Vilnius Gediminas Technical University, Technological Sciences, Civil Engineering – 02T).

Members:

**Dr Raimondas BLIŪDŽIUS** (Kaunas University of Technology, Technological Sciences, Civil Engineering – 02T),

**Prof Dr Marija BURINSKIENĖ** (Vilnius Gediminas Technical University, Technological Sciences, Civil Engineering – 02T),

**Prof Dr Birutė GALINIENĖ** (Vilnius University, Social Sciences, Economics – 04S),

**Dr Zenonas TURSKIS** (Vilnius Gediminas Technical University, Technological Sciences, Civil Engineering – 02T).

Opponents:

**Prof Dr Dalė DZEMYDIENĖ** (Mykolas Romeris University, Technological Sciences, Informatics Engineering – 07T),

**Prof Dr Habil Leonas USTINOVIČIUS** (Vilnius Gediminas Technical University, Technological Sciences, Civil Engineering – 02T).

The dissertation will be defended at the public meeting of the Council of Scientific Field of Civil Engineering in the Senate Hall of Vilnius Gediminas Technical University at 1 p. m. on 13 December 2012.

Address: Saulėtekio al. 11, LT-10223 Vilnius, Lithuania.

Tel.: +370 5 274 4952, +370 5 274 4956; fax +370 5 270 0112;

e-mail: doktor@vgtu.lt

The summary of the doctoral dissertation was distributed on 12 November 2012.

A copy of the doctoral dissertation is available for review at the Library of Vilnius Gediminas Technical University (Saulėtekio al. 14, LT-10223 Vilnius, Lithuania).

VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETAS

Jurgita ALCHIMOVIENĖ

DAUGIABUČIŲ NAMŲ MIESTŲ  
GYVENAMUOSIUOSE RAJONUOSE  
DARNAUS ATNAUJINIMO  
VERTINIMAS

DAKTARO DISERTACIJOS SANTRAUKA

TECHNOLOGIJOS MOKSLAI,  
STATYBOS INŽINERIJA (02T)



LEIDYKLA  
Vilnius TECHNIKA 2012

Disertacija rengta 2008–2012 metais Vilniaus Gedimino technikos universitete.  
Mokslinis vadovas

**prof. dr. Saulius RASLANAS** (Vilniaus Gedimino technikos universitetas, technologijos mokslai, statybos inžinerija – 02T).

**Disertacija ginama Vilniaus Gedimino technikos universiteto Statybos inžinerijos mokslo krypties taryboje:**

Pirmininkas

**prof. dr. Povilas VAINIŪNAS** (Vilniaus Gedimino technikos universitetas, technologijos mokslai, statybos inžinerija – 02T).

Nariai:

**dr. Raimondas BLIŪDŽIUS** (Kauno technologijos universitetas, technologijos mokslai, statybos inžinerija – 02T),

**prof. dr. Marija BURINSKIENĖ** (Vilniaus Gedimino technikos universitetas, technologijos mokslai, statybos inžinerija – 02T),

**prof. dr. Birutė GALINIENĖ** (Vilniaus universitetas, socialiniai mokslai, ekonomika – 04S),

**dr. Zenonas TURSKIS** (Vilniaus Gedimino technikos universitetas, technologijos mokslai, statybos inžinerija – 02T).

Oponentai:

**prof. dr. Dalė DZEMYDIENĖ** (Mykolo Romerio universitetas, technologijos mokslai, informatikos inžinerija – 07T),

**prof. habil. dr. Leonas USTINOVIČIUS** (Vilniaus Gedimino technikos universitetas, technologijos mokslai, statybos inžinerija – 02T).

Disertacija bus ginama viešame Statybos inžinerijos mokslo krypties tarybos posėdyje 2012 m. gruodžio 13 d. 13 val. Vilniaus Gedimino technikos universiteto senato posėdžių salėje.

Adresas: Saulėtekio al. 11, LT-10223 Vilnius, Lietuva.

Tel.: (8 5) 274 4952, (8 5) 274 4956; faksas (8 5) 270 0112;

el. paštas doktor@vgtu.lt

Disertacijos santrauka išsiuntinėta 2012 m. lapkričio 12 d.

Disertaciją galima peržiūrėti Vilniaus Gedimino technikos universiteto bibliotekoje (Saulėtekio al. 14, LT-10223 Vilnius, Lietuva).

VGTU leidyklos „Technika“ 2041-S mokslo literatūros knyga.

## **Introduction**

### ***Formulation of the Scientific Problem***

According to the data of the Directive of the EU, buildings in European countries consume more than 40 % of the EU energy. Energy saving measures considerably decrease energy consumption and the emission of greenhouse gas (GHG). Thus, the refurbishment of buildings has to follow the principles of sustainability and requires a comprehensive research. The effectiveness of refurbishing apartment buildings is usually determined by economic criteria without paying proper attention to sustainable refurbishment. The application of methods based on the principles of sustainable refurbishment would make the refurbishment of apartment buildings and their environment more effective. Usually, assess buildings from the perspective of environment protection. Therefore, the improvement of these methods by including economic and social aspects is essential to increasing the effectiveness of sustainable refurbishment of apartment buildings.

### ***Relevance of the Scientific Problem***

Comprehensive refurbishment of buildings built before 1993 and their environment is an increasingly important task not only for the owners but for investors and the state as well. Apartment buildings constitute the majority of these buildings and, therefore, their refurbishment is an important problem. In Lithuania, about 96 % of apartment buildings were built before 1993 and about 30 000 of these buildings require modernisation. They are inefficient, environmentally-unfriendly and their heating needs a great amount of energy, which, in turn, causes the emission of a significant amount of carbon dioxide and other greenhouse gases. Therefore, a comprehensive research is required to prepare and execute an effective refurbishment project of a building.

The application of sustainability rating methods would decrease the consumption of natural resources, climatic changes and the emission of CO<sub>2</sub> and improve the quality of life. However, these methods should be developed based on the conditions of a particular country.

The BREEAM building sustainability rating method was one of the first methods of its kind and is the basis for many modern rating methods. After analysing these methods, the BREEAM system was chosen as a basis. It was adapted to Lithuanian conditions and supplemented with criteria which are important for refurbishing apartment buildings in Lithuania. The application of this method would encourage to refurbish apartment buildings and their environment more effectively, as well as improve the environmental, economic and social conditions.

***The Research Object*** is a large-panel apartment building in an urban neighbourhood, its condition and environment as well as the refurbishment means, strategies, scenarios and the assessment of the effectiveness of its refurbishment.

***The Aim of the Thesis*** is to offer a method for rating the sustainable refurbishment of apartment buildings in urban neighbourhoods of Lithuania, aimed at increasing the effectiveness of modernizing residential apartment buildings.

### ***Tasks of the Thesis***

The following tasks should be performed to achieve the aim of the dissertation:

1. To perform a review of scientific literature on the topic of sustainable refurbishment of apartment buildings and to analyse the experience of foreign states in refurbishing urban neighbourhoods.
2. To analyse the current situation in Lithuanian territory planning in order to solve the problem of refurbishing urban neighbourhoods, to analyse the state of apartment buildings in Lithuania.
3. To create a strategy for refurbishing apartment buildings in urban neighbourhoods.
4. To review the most popular sustainable building rating systems and methods and to make their comparison.
5. To offer a method suitable for rating the sustainable refurbishment of apartment buildings in urban neighbourhoods of Lithuania based on the analysis of sustainable building rating systems.
6. To perform the assessment of the selected large-panel apartment building in the urban neighbourhood of Vilnius and its refurbishment project using BREEAM and the method offered by the author.

### ***Research Methodology***

The research in the dissertation is based on the scientific and other publications of Lithuanian and foreign authors, the experience of EU states in performing the refurbishment projects, statistical data on the Internet, encyclopaedic knowledge and other scientific and informational publications of Lithuanian and foreign institutions.

The method offered for the sustainable refurbishment of apartment buildings in Lithuania is the result of the analysis of sustainable building rating systems and methods, with its basis being the BREEAM method. Moreover, the method offered for refurbishing apartment buildings in urban neighbourhoods is based on the criteria, adapted to and characteristic of Lithuania.

### ***Scientific Novelty***

1. The problems of planning the refurbishment of urban neighbourhoods of Lithuania have been determined.
2. The strategies and scenarios based on them for refurbishing apartment buildings in urban neighbourhoods have been offered.
3. A method for rating the sustainable refurbishment of apartment buildings in urban neighbourhoods of Lithuania, based on the analysis of sustainable building rating systems, has been offered. In assessing the building it was also proposed to include the economic criteria, which are not taken into account when using sustainable building rating methods.
4. The proposed method was tested by assessing a residential apartment building before the refurbishment and its refurbishment project from the perspective of sustainability.

### ***Practical Value***

The results may be applied in making efficient decisions, concerning the refurbishment of apartment buildings in urban neighbourhoods, on the national level. The assessment of the refurbishment of apartment buildings from the perspective of sustainability is beneficial to all the parties involved in the refurbishment process. The knowledge gained after the assessment will help improve the quality of life, decrease the CO<sub>2</sub> emission, and, therefore, slow down the climatic changes and promote the rational use of national resources.

### ***Defended Propositions***

1. It is necessary to improve Lithuanian legislation, related to urban territory planning, to create a sustainable refurbishment system for urban neighbourhoods.
2. The strategies and the scenarios based on them have been offered for refurbishing the apartment buildings in urban neighbourhoods of Lithuania. These strategies and scenarios must be employed to achieve effective comprehensive refurbishment of apartment buildings and their environment.
3. A method for rating the sustainability of refurbishing buildings in urban neighbourhoods has been adapted to Lithuania. A decision support system (DNDAVSPS) for assessing the sustainable refurbishment of apartment buildings has been created using the proposed method. The system allows to determine the effectiveness of refurbishing apartment buildings from the perspective of sustainability.

4. Using the decision support system for assessing the sustainable refurbishment of apartment buildings (DNDAVSPS), the sustainability of refurbishing an apartment building can be assessed. Based on the results, a sustainability standard can be determined and awarded.

### ***The Scope of the Scientific Work***

The dissertation consists of the Introduction, four main chapters, the Conclusion, References and a list of the relevant works by the author, as well as 6 appendices. The length of the dissertation is 160 pages (without appendices). There are 14 numbered formulas, 14 figures and 38 tables. The number of references used is 168.

## **1. A review of apartment building refurbishment**

The first chapter presents the concepts of sustainable development and sustainable refurbishment of apartment buildings as well as the goals which should be accomplished by refurbishing apartment buildings and their environment in a sustainable way. Actual examples of sustainable refurbishment of urban neighbourhoods in several EU countries are given: two in Germany and one in Ireland. It is beneficial to Lithuania to be interested in and apply the experience gained by other states in completing successful projects. Comprehensive modernization of the neighbourhood has proved to be more effective in reducing energy consumption and climatic changes as well as improving the quality of life and increasing the market value.

The planning problems of refurbishing urban neighbourhoods of Lithuania, the state of apartment buildings and the problems of their living environment are also analysed.

The chapter also discusses the financing programmes and funds for refurbishing apartment buildings in Lithuania, which allow to receive funding for improving energy efficiency.

The strategies for refurbishing apartment buildings in urban neighbourhoods and the scenarios based on them have also been offered.

## **2. Sustainable building rating systems**

The chapter presents the most popular sustainable building rating methods and systems, which were created to decrease the negative environmental effect during the design, construction, refurbishment and/or the use of buildings (Table 1).



**Table 1.** Sustainable building rating systems, methods

Name of the System, Method	Year of Creation, Country
BREEAM (Building Research Establishment Environmental Assessment Method)	1990, UK
LEED (The Leadership in Energy and Environment Design)	1998, USA
BEAM Plus (HK-BEAM – Hong Kong building environmental assessment method)	1996, Hong Kong
GBTool (Green building challenge) currently, SBTool	1995, International
CASBEE (Comprehensive assessment system for building environmental efficiency)	2004, Japan
BEPAC (Building environmental performance assessment criteria)	1993, Canada
LiderA	2000/2005, Portugal
Green Star	2003, Australia
HQE (High Quality Environmental standard)	1992, France
Minergie	1994/1997, Switzerland
CEPAS (The Comprehensive Environmental Performance Assessment Scheme for Buildings)	2001, Hong Kong
Protocollo ITACA (Innovation and Transparency of the Contracts and Environmental Compatibility)	2005, Italy
DGNB (German Sustainable Building Council)	2007, Germany
TQB (Total Quality Building Assessment)	2002, Austria

However, the use of these methods varies from country to country because of climatic, cultural and other differences. Therefore, the most effective method has to be adapted to the conditions of a specific country, including regional technical and cultural features. The most popular methods, including BREEAM, LEED, etc. have become the basis of a multitude of recent methods. Thus, this chapter focusses on the analysis and comparison of sustainable building rating methods, BREEAM and LEED. The advantages and disadvantages of both methods are also given. BREEAM, LEED and other environmentally-friendly building rating methods are aimed at efficiently using energy and water, decreasing pollution and climatic changes, raising the quality of life in a building and achieving rational management and use of the available resources. However, the problems of environment protection and the financial aspects should be considered simultaneously and such methods do not perform a highly important financial assessment.

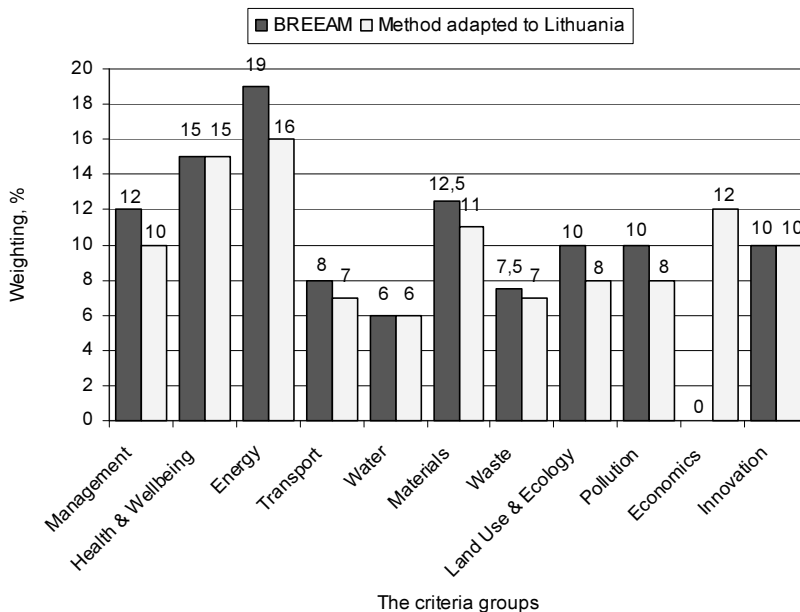
### 3. A method for rating the sustainable refurbishment of apartment buildings in urban neighbourhoods

The chapter presents the proposed method for rating the sustainable refurbishment of apartment buildings in the urban neighbourhoods of Lithuania, which is based on the BREEAM method. Since the assessment of energy efficiency, ecology and economics should be performed simultaneously, the first priority was to add a group of economic criteria to the criteria groups of the BREEAM method. Then, the new values for the significances of criteria groups were determined by the method of expert evaluation. The consistency of expert judgements was significant and, therefore, the obtained significance values of the criteria groups were used in the proposed method. According to the expert survey results, the group of economic assessment criteria was the third most important group (12 %), with the group of energy criteria being the most important (16 %) and the group of health and wellbeing criteria (15 %) – the second most important group. The least important group of criteria was the one associated with water (6 %). All groups of assessment criteria and the values of their significance are given in Table 2.

**Table 2.** The criteria groups of the modified BREEAM method and their significance

No	The criteria groups	Weighting, %
1.	Management	10
2.	Health & Wellbeing	15
3.	Energy	16
4.	Transport	7
5.	Water	6
6.	Materials	11
7.	Waste	7
8.	Land Use & Ecology	8
9.	Pollution	8
10.	Economics	12
		100
11.	Innovation	additional 10
Total		110

For the sake of comparison, the groups of assessment criteria and the values of their significances (in per cent), included in the BREEAM 2008 and the method adapted to Lithuania, are shown in Fig 1.



**Fig. 1.** The criteria groups of the BREEAM method and the method adapted to Lithuania and the significance of these groups

After including the group of economic criteria in the assessment and determining new values for the significances of criteria groups, the criteria are altered based on the conditions of Lithuania. Moreover, some criteria relevant to the country are added and the irrelevant ones are excluded. The assessment criteria used in the proposed method are presented in Table 3.

The assessment of the building is based on all the criteria presented in Table 3. Each criterion is given a particular number of credits if the considered apartment building or its refurbishment project satisfies the requirements raised to it. In the opposite case, the credits are not given. When a building has been evaluated, the obtained credits are expressed in per cent and summed up. Then, the rating (standard), representing a sustainable building, is assigned to the considered building, depending on its evaluation results in per cent (Table 4), i.e. if it meets the minimum requirements raised to such building.

**Table 3.** Criteria groups and their criteria for the method adapted to Lithuania

<p>Management:</p> <ul style="list-style-type: none"> <li>• Construction work control</li> <li>• Professional builders</li> <li>• Construction site impacts</li> <li>• Building user guide</li> <li>• Consulting</li> <li>• Security</li> </ul>	<p>Materials:</p> <ul style="list-style-type: none"> <li>• Environmental Impacts of materials</li> <li>• Reuse of existing building structures</li> <li>• The state of existing building structures</li> <li>• Insulation</li> <li>• Heat loss</li> <li>• Designing for robustness</li> <li>• Responsible sourcing of materials – finishing materials</li> </ul>
<p>Health &amp; Wellbeing:</p> <ul style="list-style-type: none"> <li>• Daylighting</li> <li>• View out</li> <li>• Privacy</li> <li>• High-frequency voltage – electric power transformer</li> <li>• Internal and external lighting levels</li> <li>• Natural ventilation</li> <li>• Indoor air quality</li> <li>• Volatile organic compounds</li> <li>• Thermal comfort</li> <li>• Local temperature control</li> <li>• Microbial contamination</li> <li>• External environment</li> <li>• Acoustic performance</li> </ul>	<p>Waste:</p> <ul style="list-style-type: none"> <li>• Construction site waste management</li> <li>• Recycled aggregates</li> <li>• Recyclable waste storage</li> <li>• Recycling – composting</li> </ul>
<p>Energy:</p> <ul style="list-style-type: none"> <li>• Reduction of CO<sub>2</sub> emissions</li> <li>• Accurate energy monitoring</li> <li>• External lighting</li> <li>• Low and zero carbon technologies</li> <li>• Energy efficient equipment</li> </ul>	<p>Land Use &amp; Ecology:</p> <ul style="list-style-type: none"> <li>• Site selection</li> <li>• Contaminated land</li> <li>• Ecological value of the site and protection of ecological features</li> <li>• Impact on the ecological value of the site</li> <li>• Enhancing site ecology</li> </ul>
<p>Transport:</p> <ul style="list-style-type: none"> <li>• Public transport</li> <li>• Infrastructure</li> <li>• Cyclist facilities</li> <li>• Pedestrian and cyclist safety</li> <li>• Car parking capacity</li> </ul>	<p>Pollution:</p> <ul style="list-style-type: none"> <li>• Refrigerant leaks</li> <li>• NO<sub>x</sub> emissions from the heating source</li> <li>• Flood risk</li> <li>• Minimising watercourse pollution</li> </ul>
<p>Water:</p> <ul style="list-style-type: none"> <li>• Water consumption</li> <li>• Water monitoring</li> <li>• Water leak detection</li> <li>• Water recycling</li> </ul>	<p>Economics:</p> <ul style="list-style-type: none"> <li>• Market value coefficient</li> <li>• Savings</li> <li>• State support</li> </ul> <p>Innovation:</p> <ul style="list-style-type: none"> <li>• Daylighting</li> <li>• Reduction of CO<sub>2</sub> emissions</li> <li>• Low and zero carbon technologies (renewable energy sources)</li> <li>• Water monitoring</li> <li>• Responsible sourcing of materials</li> <li>• Construction site waste management</li> <li>• Professional assessment</li> </ul>

**Table 4.** Assessment results

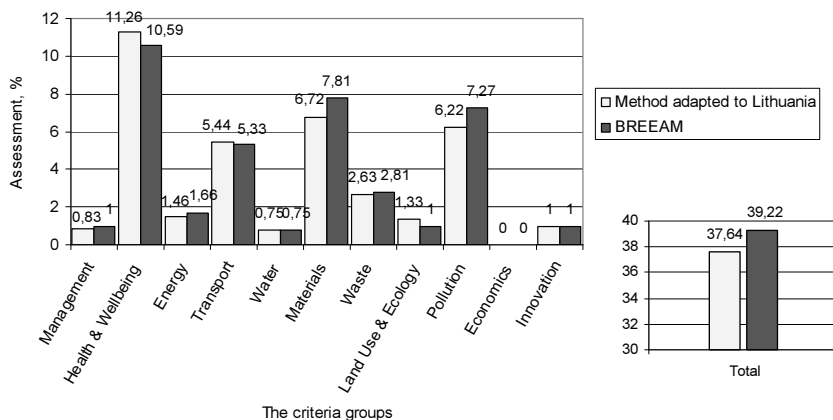
BREEAM rating	Score, %
Outstanding	$\geq 85$
Excellent	$\geq 70$
Very good	$\geq 50$
Good	$\geq 45$
Pass	$\geq 30$
Unclassified	$< 30$

The decision support system (DNDAVSPS), based on Microsoft Excel, was created for evaluating the sustainable refurbishment of apartment buildings and performing the calculations.

#### 4. The assessment of a large-panel apartment building in an urban neighbourhood of Vilnius

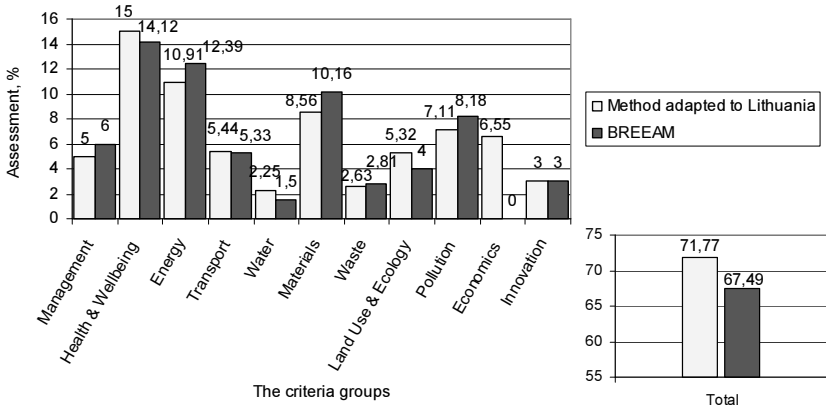
In this chapter, the sustainability of a real standard apartment building and its refurbishment project was evaluated, based on the method suggested by the author. For the sake of comparison, the considered apartment building was also assessed by the BREEAM method.

According to the evaluation results of the standard apartment building, obtained before the refurbishment by the BREEAM and the method adapted to Lithuania, the considered building could not meet even the minimum requirements (Fig 2).



**Fig. 2.** The results of rating the sustainability of the apartment building before the refurbishment using both methods, %

The value obtained in evaluating the apartment building refurbishment project based on BREEAM was equal to 67,49 %, while the evaluation by the method adapted to Lithuania gave 71,77 % (Fig 3).



**Fig. 3.** The results of rating the sustainable refurbishment project for the apartment building using both methods, %

The result yielded by the second method is better, corresponding to the rating ‘Excellent’, while the rating obtained by the BREEAM method, was ‘Very good’ because it lacked 2,51 % to be ‘Excellent’. The author of the dissertation considers that the evaluation based on the method adapted to Lithuania is more accurate and comprehensive since the significances of the criteria and their groups as well as the requirements for these criteria have been corrected for use in a particular country. Moreover, the economic evaluation, required for preparing a building refurbishment project, has been included and the assessment of the state of the main building structures, on which the building’s strength and safety strongly depend, has been made.

## General conclusions

1. The analysis of the research carried out all over the world shows that the lack of sustainable refurbishment of buildings and their environment is a globally important problem. A survey of the implemented sustainable refurbishment projects of various urban neighbourhoods in the EU member-states and the analysis of their successful practice and experience were made. This allowed the author to suggest the refurbishment strategies and scenarios based on them, which must be em-

ployed for effective comprehensive refurbishment of apartment buildings and their environment in urban neighbourhoods of Lithuania.

2. The analysis of territory planning regulations in Lithuania as well as science research reports on Lithuanian apartment buildings and their environment allowed the author to conclude that the majority of apartment buildings built before 1993 currently do not meet modern technical requirements. The infrastructure of urban neighbourhoods is poor. Moreover, when the need for refurbishing buildings and their environment is growing, it is difficult to perform planning of sustainable refurbishing of buildings and their environment in the absence of clearly defined general requirements.
3. Based on the survey of methods and systems used internationally for rating sustainable buildings, the BREEAM method was chosen as a basis for assessing the sustainability of Lithuanian apartment buildings. It was selected, based on the suitability of its assessment criteria, and the fact that there are different versions of the method for assessing different types of buildings. Furthermore, the BREEAM method is internationally recognized for its effectiveness and reliability.
4. The BREEAM and other similar methods do not evaluate the financial aspects of refurbishment, while the problems associated with environment protection and the financial aspects should be considered simultaneously. Therefore, it was suggested to include a group of economic evaluation criteria in the method adapted to Lithuania. The criteria of this group take into account the increased energy efficiency and the market price of a building.
5. The suggested method for rating the sustainability of the refurbished apartment buildings takes into account the conditions of Lithuania. Some criteria relevant to the country were altered or excluded and some new ones were added to the analysis. In particular, a new group of economic criteria was added and new values for the significance of each group of criteria were determined.
6. Based on the suggested method, a decision support system for evaluating the sustainable refurbishment of apartment buildings (DNDAVSPS) was created. The system allows to comprehensively evaluate and determine a sustainability standard of a building.
7. The developed system was tested by evaluating a standard apartment building before the refurbishment and its refurbishment project. The building did not satisfy even the minimum requirements before the refurbishment, while if refurbished according to the evaluated project, it can meet the sustainability standard 'Excellent'. Such a high result

from the perspective of sustainability indicates that the refurbished building consumes less energy, pollutes the environment to a lesser extent and provides a better quality of life for its inhabitants, i.e. the building was refurbished according to the principles of sustainability.

8. For the sake of comparison, the evaluation of the apartment building before refurbishment and its refurbishment project was made according to the BREEAM method. The evaluation based on the suggested method is more comprehensive because it includes a greater number of important criteria which were specifically adapted to Lithuania. Moreover, such evaluation is more effective because it embraces the economic aspects of a building and determines the condition of the main building structures, on which its longevity strongly depends.

### **List of published works on the topic of the dissertation In the reviewed scientific journals**

Raslanas, S.; Alchimovienė, J. 2012. Daugiabučių namų Lietuvoje atnaujinimo darnumo įvertinimas [Assessment the Sustainability of the Renovation of Multi-Apartment Buildings in Residential Areas], *Engineering Structures and Technologies* 4(4). ISSN 2029-8838. doi:10.3846/2029882X.2012.748259.

Raslanas, S.; Alchimovienė, J.; Banaitienė, N. 2011. Residential Areas with Apartment Houses: Analysis of the Condition of Buildings, Planning Issues, Renovation Strategies and Scenarios, *International Journal of Strategic Property Management* 15(2): 152–172. ISSN 1648-715X. (ISI Web of Science).

Ginevičius, T.; Kaklauskas, A.; Kazokaitis, P.; Alchimovienė, J. 2011. Recommender System for Real Estate Management, *Verslas: teorija ir praktika* 12(3): 258–267. ISSN 1648-0627. (ICONDA, Business Source Complete).

Alchimovienė, J.; Stasiukynas, A.; Gudienė, N. 2011. Daugiabučių gyvenamųjų namų būklės analizė [The Analysis of the State of Multi-Apartment Residential Houses], *Mokslas – Lietuvos ateitis* 3(2): 17–20. ISSN 2029-2341. (Index Copernicus).

Alchimovienė, J.; Gudienė, N. 2010. Teritorijų planavimo nuostatų analizė sprendžiant miestų gyvenamųjų rajonų (kvartalų) atnaujinimą [Analysis of Territory Planning Regulations Concerning Modernization of Residential Areas], *Mokslas – Lietuvos ateitis* 2(2): 5–10. ISSN 2029-2341. (Index Copernicus).

Ramanauskaitė, J. (Alchimovienė, J.) 2009. Daugiabučių namų kvartalų modernizavimo strategijų analizė [The Analysis of Renovation Strategies of Multi-Storey Apartment Houses in Residential Districts], *Mokslas – Lietuvos ateitis* 1(5): 98–102. ISSN 2029-2341. (Index Copernicus).



## **In the other editions**

Alchimovienė, J.; Raslanas, S. Sustainable Renovation and Evaluation of Blocks of Multi-apartment Houses, in *8th International Conference „Environmental Engineering” May 19–20, 2011, Vilnius, Lithuania 3*: 835–841. ISSN 2029-7106.

## **About the author**

Jurgita Alchimovienė was born on 25 August 1979 in Utena. In 2002, she was awarded the Bachelor's degree and, in 2004 – a Master's degree in Construction Engineering in Vilnius Gediminas Technical University. In 2008–2012, she was a doctoral student in Vilnius Gediminas Technical University. In 2011, she was internship at Tallinn Technical University (Estonia), in 2012 – to VIA University College in Horsens, Denmark. At present, she is the head of educational laboratory at the Department of Construction Technology and Management of Vilnius Gediminas Technical University.

## **DAUGIABUČIŲ NAMŲ MIESTŲ GYVENAMUOSIUOSE RAJONUOSE DARNAUS ATNAUJINIMO VERTINIMAS**

### ***Mokslo problemos formulavimas***

Europos direktyvos duomenimis, Europos valstybėse pastatai sunaudoja daugiau nei 40 % visos Europos Sąjungos (ES) energijos, iš jų daugiau nei pusę – gyvenamieji pastatai. Energijos taupymo priemonės labai sumažina suvartojamos energijos kiekį ir kartu šiltnamio efektą sukeliančių dujų kiekį, todėl atnaujinant pastatus būtina atlikti išsamų tyrimą ir vadovautis darnos principais. Daugiabučių namų atnaujinimo efektyvumas dažniausiai nustatomas remiantis ekonominiais kriterijais, nepakankamai dėmesio skiriant darniam atnaujinimui. Daugiabučių namų ir jų aplinkos atnaujinimo efektyvumą papildinti vertinimo metodų, pagrįstų darnaus atnaujinimo principais taikymas. Šie metodai pastatus dažniausiai vertina iš apinkosauginių pozicijų. Todėl tokių metodų patobulinimas ekonominiais ir socialiniais aspektais yra svarbus didinant pastatų darnaus atnaujinimo efektyvumą.

### ***Mokslo problemos aktualumas***

Kompleksinis pastatų, statytų iki 1993 m., ir jų aplinkos atnaujinimas yra vis didėjančios svarbos uždavinys ne tik savininkams ar investuotojams, bet ir valstybei. Didelę dalį visų pastatų sudaro daugiabučiai, todėl jų atnaujinimas yra aktuali problema. Lietuvoje apie 96 % daugiabučių pastatyti iki 1993 m., modernizavimo reikia apie 30 000 namų. Tokie daugiabučiai yra neekonomiški, neekologiški, jų šildymui suvartojama daug energijos, todėl išskiriamas didelis

kiekis anglies dvideginio bei kitų šiltnamio efektą sukeliančių dujų. Norint parengti efektyvų pastato atnaujinimo projektą ir jį įgyvendinti, reikia atlikti kompleksinį tyrimą.

Pastatų darnumo vertinimo sistemų ir metodų taikymas padėtų sumažinti gamtinių išteklių naudojimą, klimato kaitą, CO<sub>2</sub> emisiją, pagerintų gyvenimo kokybę. Tačiau metodai turi būti kuriami ir tobulinami atsižvelgiant į šalies sąlygas.

Pastatų darnumo vertinimo metodas BREEAM yra vienas pirmųjų, remiantis juo pasaulyje radosi daugelis kitų metodų. Išanalizavus šiuolaikinius vertinimo metodus, pagrindu buvo paimta BREEAM sistema, ji pritaikyta ir papildyta kriterijais, kurie aktualūs modernizuojant daugiabučius namus Lietuvoje. Šio metodo taikymas skatintų efektyviau vykdyti daugiabučių ir jų aplinkos atnaujinimą, gerinti ekologinę, ekonominę ir socialinę aplinką.

**Tyrimų objektas** – stambiaplokščiai daugiabučiai namai miesto gyvenamuosiuose rajonuose, jų būklė, aplinka, atnaujinimo priemonės, strategijos, scenarijai ir atnaujinimo efektyvumo vertinimas.

**Darbo tikslas** – pasiūlyti Lietuvos daugiabučių namų miestų gyvenamuosiuose rajonuose darnaus atnaujinimo vertinimo metodą, siekiant padidinti daugiabučių gyvenamųjų namų modernizavimo efektyvumą.

### ***Darbo uždaviniai***

Darbo tikslui pasiekti reikia spręsti šiuos uždavinius:

1. Atlikti daugiabučių namų darnaus atnaujinimo mokslinės literatūros apžvalgą, išanalizuoti miestų gyvenamųjų rajonų atnaujinimą užsienio šalyse.
2. Išanalizuoti Lietuvos teritorijų planavimo esamą situaciją, sprendžiant miestų gyvenamųjų rajonų (kvartalų) atnaujinimą, atlikti Lietuvos daugiabučių namų būklės mokslinių tyrimų analizę.
3. Sukurti daugiabučių gyvenamųjų rajonų modernizavimo strategiją.
4. Apžvelgti dažniausiai pasaulyje taikomas darnių pastatų vertinimo sistemas ir metodus, palyginti juos tarpusavyje.
5. Remiantis pastatų darnumo vertinimo metodų analize, pasiūlyti daugiabučių namų miestų gyvenamuosiuose kvartaluose darnaus atnaujinimo vertinimo metodą, pritaikytą Lietuvos sąlygoms.
6. Atlikti pasirinkto daugiabučio stambiaplokščio namo Vilniaus gyvenamajame kvartale ir jo atnaujinimo projekto įvertinimus pagal BREEAM ir pagal autorės siūlomą metodą.

### ***Mokslinis naujumas***

1. Nustatytos Lietuvos miestų gyvenamųjų rajonų ir kvartalų atnaujinimo planavimo problemos.
2. Pasiūlytos daugiabučių gyvenamųjų namų rajonų modernizavimo strategijos ir jomis grindžiami scenarijai.
3. Remiantis pastatų darnumo vertinimo sistemų analize, pasiūlytas daugiabučių namų miestų gyvenamuosiuose rajonuose atnaujinimo darnumo įvertinimo metodas pritaikytas Lietuvos sąlygoms. Vertinant pastatą pasiūlyta įtraukti ekonominius kriterijus, į kuriuos darnių pastatų vertinimo metodai neatsižvelgia.
4. Pasiūlytas metodas patikrintas, įvertinus daugiabutį gyvenamąjį namą prieš atnaujinimą ir jo atnaujinimo projektą darnos požiūriu.

### ***Tyrimų metodika***

Rengiant darbą remtasi Lietuvos ir užsienio šalių mokslinėmis ir kitomis publikacijomis, ES šalyse įgyvendintų atnaujinimo projektų patirtimi, statistiniais duomenimis internete, enciklopediniais žinytais bei kitais Lietuvos ir užsienio institucijų moksliniais ir informaciniais leidiniais.

Lietuvai naujai siūlomo daugiabučių namų atnaujinimo pagal darnos principus vertinimo metodika pagrįsta pastatų darnumo vertinimo sistemų lyginamąja analize. Siūlomas daugiabučių namų miestų gyvenamuosiuose rajonuose atnaujinimo vertinimo metodas grindžiamas kriterijais, pritaikytais Lietuvos sąlygoms.

### ***Praktinė vertė***

Darbo rezultatai gali būti taikomi priimant efektyvius daugiabučių namų miestų gyvenamuosiuose rajonuose atnaujinimo sprendimus. Daugiabučių namų modernizavimo įvertinimas darnumo požiūriu yra naudingas visoms suinteresuotoms atnaujinimo procese dalyvaujančioms grupėms. Taip prisidedama prie gyvenimo kokybės gerinimo, klimato kaitos stabdymo, gamtinių išteklių naudojimo ir CO<sub>2</sub> emisijos mažinimo.

### ***Ginamieji teiginiai***

1. Būtina sutvarkyti Lietuvos miestų teritorijų planavimo teisinę bazę, siekiant užtikrinti užstatytos aplinkos darnaus atnaujinimo sistemos sukūrimą.
2. Vadovaujantis pasiūlytomis daugiabučių gyvenamųjų namų rajonų Lietuvoje modernizavimo strategijomis ir jomis grindžiamais scenarijais, galima pasiekti efektyvesnio, kompleksinio daugiabučių namų ir jų aplinkos atnaujinimo.

3. Remianis daugiabučių namų miestų gyvenamuosiuose rajonuose atnaujinimo darnumo vertinimo metodu sukurta daugiabučių namų darnaus atnaujinimo vertinimo sprendimų paramos sistema (DNDAVSPS), galima efektyviau nustatyti daugiabučių namų atnaujinimą darnos požiūriu, nes įvertinami ir ekonominiai kriterijai.
4. Taikant daugiabučių namų darnaus atnaujinimo vertinimo sprendimų paramos sistemą (DNDAVSPS) galima įvertinti daugiabučio namo atnaujinimo darnumą ir pagal gautus įvertinimo rezultatus suteikti darnumo standartą.

### ***Darbo apimtis***

Disertaciją sudaro įvadas, keturi skyriai ir rezultatų apibendrinimas. Taip pat yra keturi priedai.

Darbo apimtis yra 160 puslapių, neskaitant priedų, tekste panaudota 14 numeruotų formulių, 14 paveikslų ir 38 lentelės. Rašant disertaciją buvo panaudoti 168 literatūros šaltiniai.

Pirmame skyriuje apžvelgiami moksliniai darbai, pateikiamos darnaus vystymosi ir darnaus daugiabučių atnaujinimo sampratos, apžvelgiami ES šalių miestų rajonai, kvartalai atnaujinti pagal darnos principus, analizuojamos Lietuvos miestų gyvenamųjų rajonų/kvartalų atnaujinimo planavimo problemos, daugiabučių namų būklė ir gyvenamosios aplinkos problemos, apžvelgiamos Lietuvos daugiabučių namų atnaujinimo finansavimo programos bei pasiūlytos daugiabučių gyvenamųjų namų rajonų modernizavimo strategijos ir jomis grindžiami scenarijai.

Antrame skyriuje pateikiamos ir aptariamos dažniausiai pasaulyje taikomos darnių pastatų vertinimo sistemos, metodai, plačiau išanalizuojami ir palyginami BREEAM ir LEED pastatų darnumo vertinimo metodai, nustatomi jų trūkumai ir pranašumai.

Trečiame skyriuje remiantis BREEAM metodika pasiūlomas Lietuvos daugiabučių namų miestų gyvenamuosiuose rajonuose darnaus atnaujinimo vertinimo metodas. Jis pritaikytas atsižvelgus į Lietuvos sąlygas, pakoregavus ir pakeitus šaliai neaktualius kriterijus, įtraukus ekonominių kriterijų grupę ir iš naujo nustatčius kriterijų grupių reikšmingumus. Remiantis pasiūlytu metodu sukurta daugiabučių namų darnaus atnaujinimo vertinimo sprendimų paramos sistema (DNDAVSPS).

Ketvirtame skyriuje autorės pasiūlytu metodu įvertinamas realaus tipinio daugiabučio namo ir jo atnaujinimo projekto darnumas. Palyginimui daugiabučio namo įvertintas ir pagal BREEAM metodą.

### ***Bendrosios išvados***

1. Pasaulinių tyrimų analizė parodė, kad darnaus pastatų ir jų aplinkos atnaujinimo stoka yra aktuali problema ne tik Lietuvoje, bet ir kitose šalyse. Apžvelgus ES šalyse įgyvendintus miestų rajonų ir kvartalų darnaus atnaujinimo projektus, remiantis jų patirtimi ir sėkmingais rezultatais, pasiūlytos daugiabučių namų rajonų Lietuvoje modernizavimo strategijos ir jomis grindžiami scenarijai, kuriais būtina vadovautis siekiant efektyvaus, kompleksinio daugiabučių namų ir jų aplinkos atnaujinimo.
2. Išanalizavus Lietuvos teritorijų planavimo normas, Lietuvos daugiabučių namų ir jų aplinkos mokslinių tyrimų ataskaitas, galima teigti, kad dauguma daugiabučių statytų iki 1993 m. šiuo metu neatitinka keliamų techninių reikalavimų, daugiabučių namų rajonų aplinkos infrastruktūra – skurdi, o augant būsto ir jo aplinkos atnaujinimo poreikiui, pastatų ir jų aplinkos darnaus atnaujinimo planavimą atlikti sudėtinga, nesant aiškių ir bendrų reikalavimų.
3. Remiantis atlikta pasaulyje taikomų darnių pastatų vertinimo metodų ir sistemų apžvalga Lietuvos daugiabučių namų darnumui vertinti, pagrindu pasirinktas darnių pastatų vertinimo metodas BREEAM. Šis metodas pasirinktas atsižvelgus į vertinamų kriterijų tinkamumą, taip pat jis turi skirtingas versijas įvairių tipų pastatams vertinti, o metodo veiksmingumas ir patikimumas pripažintas tarptautiniu mastu.
4. Nustatyta, kad BREEAM ir kiti panašūs metodai neapima finansinio vertinimo, o aplinkos apsaugos klausimai ir finansiniai aspektai turėtų būti sprendžiami tuo pat metu, todėl Lietuvai pasiūlytame metode įtraukta ekonominių kriterijų vertinimo grupė, kurios kriterijai įvertina pastato rinkos vertės padidėjimą ir suvartotos energijos sumažėjimą.
5. Pasiūlytas Lietuvos daugiabučių namų darnaus atnaujinimo vertinimo metodas pritaikytas atsižvelgus į šalies sąlygas, pakoreguoti ir pakeisti šaliai neaktualūs kriterijai. O į vertinimą įtraukus naują ekonominių kriterijų grupę buvo iš naujo nustatyti kriterijų grupių reikšmingumai.
6. Remiantis pasiūlytu metodu, sukurta daugiabučių namų darnaus atnaujinimo vertinimo sprendimų paramos sistema (DNDAVSPS), kuri leidžia kompleksiskai įvertinti ir nustatyti pastato darnumo standartą. Ši sistema patikrinta įvertinus tipinį daugiabutį namą iki atnaujinimo ir jo atnaujinimo projektą. Pagal gautus rezultatus nustatyta, kad pastatas iki atnaujinimo netenkina net minimalių reikalavimų, o pastatui, atnaujintam pagal įvertintą projektą, gali būti suteikiamas darnumo standartas „Puikus“. Tai labai aukštas įvertinimas darnos požiūriu, kuris parodo, kad sumažėjo atnaujinto pastato suvartojamos energijos kiekis,

aplinkos tarša, pagerėjo gyvenimo kokybė ir pastatas atnaujintas vadovaujantis darnos principais.

8. Palyginimui atliktas to paties daugiabučio iki atnaujinimo ir jo atnaujinimo projekto įvertinimas pagal BREEAM metodą. Įvertinimas, pagal pasiūlytą metodą yra kompleksiškesnis, nes apima daugiau aktualių ir svarbių kriterijų, kurie pritaikyti Lietuvos sąlygoms. Taip pat padidėja metodo naudingumas, nes atliekamas pastato ekonominis įvertinamas bei įvertinama laikančiųjų pastato konstrukcijų būklė, o tai labai svarbu pastato ilgaamžiškumui.

### **Trumpos žinios apie autorę**

Jurgita Alchimovienė gimė 1979 m. rugpjūčio 25 d. Utenoje.

2002 m. Vilniaus Gedimino technikos universitete įgijo statybos inžinerijos bakalauro laipsnį, 2004 m. – statybos inžinerijos magistro laipsnį. 2008–2012 m. – Vilniaus Gedimino technikos universiteto doktorantė. Doktorantūros studijų metu 2011 m. stažavosi Talino technikos universitete (Estijoje), 2012 m. – Horsensio universitetiniame koledže (Danijoje). Šiuo metu dirba Vilniaus Gedimino technikos universiteto Statybos technologijos ir vadybos katedros mokomosios laboratorijos vedėja.

**Jurgita ALCHIMOVIEŅĒ**

**ASSESSING SUSTAINABLE REFURBISHMENT OF APARTMENT BUILDINGS  
IN URBAN NEIGHBOURHOODS**

**Summary of Doctoral Dissertation  
Technological Sciences, Civil Engineering (02T)**

**Jurgita ALCHIMOVIEŅĒ**

**DAUGIABUČIŲ NAMŲ MIESTŲ GYVENAMUOSIUOSE RAJONUOSE  
DARNAUS ATNAUJINIMO VERTINIMAS**

**Daktaro disertacijos santrauka  
Technologijos mokslai, statybos inžinerija (02T)**

2012 11 12. 1,5 sp. l. Tiražas 70 egz.  
Vilniaus Gedimino technikos universiteto  
leidykla „Technika“,  
Saulėtekio al. 11, 10223 Vilnius,  
<http://leidykla.vgtu.lt>  
Spausdino UAB „Ciklonas“,  
J. Jasinskio g. 15, 01111 Vilnius