



8th  
International  
Academic  
Conference on  
Places and  
Technologies

---

**PROCEEDINGS**

---

EDITORS

**Aleksandra Djukić  
Aleksandra Krstić-Furundžić  
Eva Vaništa Lazarević  
Milena Vukmirović**

# Keeping up with technologies to imagine and build together sustainable, inclusive, and beautiful cities

**PLACES AND  
TECHNOLOGIES**  
2023

DIGITAL  
PUBLICATION

EDITORS

**8th International Academic  
Conference on Places and Technologies**  
Belgrade, 19-21 October 2023

Proceedings  
DOI: [https://doi.org/10.18485/arh\\_pt.2024.8](https://doi.org/10.18485/arh_pt.2024.8)

**Aleksandra Djukić  
Aleksandra Krstić-Furundžić  
Eva Vaništa Lazarević  
Milena Vukmirović**

PUBLISHER

**University of Belgrade  
Faculty of Architecture**

FOR PUBLISHER

**Vladimir Lojanica**

DESIGN

**Vladimir Kovač**

TECHNICAL SUPPORT

**Jelena Marić  
Nikola Mitrović  
Ana Šabanović**

CIRCULATION

**50 copies**

PLACE AND DATE

**Belgrade, April 2024**

ISBN 978-86-7924-343-0

**PLACES AND  
+TECHNOLOGIES** <sup>23</sup>



PLACES  
AND  
TECHNO  
LOGIES  
2023

F+23

# CONTENT

## COMMITTEES

12 SCIENTIFIC COMMITTEE; ORGANIZING COMMITTEE; TECHNICAL COMMITTEE

## KEYNOTES

16 EMBRACING THE PRINCIPLES OF CIRCULAR ECONOMY FOR SUSTAINABLE BUILT ENVIRONMENTS: NEW TRENDS, APPROACHES AND CHALLENGES

\_ **Katerina Tsikaloudaki**

17 GREEN URBAN RENEWAL STRATEGIES IN THE CONTEXT OF ZERO NET LAND TAKE

\_ **Ivana Katurić**

## SPATIAL PLANNING

19 EXPLORING SPATIAL HETEROGENEITY OF URBAN HEAT ISLAND THROUGH BUILT ENVIRONMENT MORPHOLOGY

\_ **Han Liang Lin \_ Li-Ting Chung \_ Chi Feng Lai**

26 ANALYSIS OF SUCCESSFUL WASTE MANAGEMENT IN LARGE CITIES - THE EXAMPLE OF TOKYO

\_ **Marko Simić \_ Ivan Garić \_ Vladimir Vučenov \_ Dragoljub Sekulović**

34 THE SKOPJE CONTACT ZONE – A KEY TO A SUSTAINABLE FUTURE OF THE CITY

\_ **Ana Lukic Korobar \_ Lidija Trpenoska Simonovic**

## URBAN PLANNING

44 THE EIBENTHAL INITIATIVE: AN INFORMAL MODEL FOR SUSTAINABLE DEVELOPMENT

\_ **Ştefana Bădescu \_ Ana Branea \_ Mihai Danciu**

52 SHRINKING AND NON-GLOBAL CITIES: SIMILARITIES AND DIFFERENCES

\_ **Branislav Antičić**

60 PARTICIPATORY DESIGN FOR SUSTAINABILITY

\_ **Jernej Markelj \_ Aleksandar Petrovski \_ Jan Kazak**

68 COLLABORATIVE APPROACH FOR INTEGRATING NATURAL AND CULTURAL HERITAGE FOR SUSTAINABLE URBAN DEVELOPMENT: THE CASE OF ACTION PLAN FOR SOMBOR WITHIN DANURB+

\_ **Danijela Milovanović Rodić \_ Ana Šabanović \_ Branislav Antičić \_ Aleksandra Đukić**

75 PRESENTATION OF EXISTING METHODS BASED ON MULTI AGENT SYSTEMS WITH THE PURPOSE OF ROAD PLANNING

\_ **Julijan Jurak \_ Krešimir Osman \_ Matija Sikirić \_ Ljupko Šimunović**

83 POST-INDUSTRIAL TERRITORY DEVELOPMENT UNDER AN ARCHITECTURAL AND URBAN DEVELOPMENT PROJECT AS ILLUSTRATED BY THE VOLGOGRAD TRACTOR PLANT

\_ **Dmitrii Klimov**

- 92 REVITALIZATION OF RURAL AREAS ON REGIONAL LEVEL AS A DRIVER FOR ECOLOGICAL TRANSITION AND SUSTAINABLE DEVELOPMENT IN SERBIA  
\_ **Milica Igić** \_ **Milena Dinić Branković** \_ **Jelena Đekić** \_ **Mihailo Mitković** \_ **Milica Ljubenočić**
- 102 THE CONSEQUENCES OF CENTRALIZED DEVELOPMENT OF TOURIST INFRASTRUCTURE: THE EXAMPLE OF BUDVA PROMENADE  
\_ **Milena Bismiljak** \_ **Eva Vaništa Lazarević** \_ **Jelena Marić**
- 110 SMART CITY CRITERIA  
\_ **Dashnor Kadiri** \_ **Morana Pap** \_ **Bojan Baletić**
- 117 GOING GREEN-LESS: A MORPHOLOGICAL AND FUNCTIONAL STUDY OF DECREASING GREEN PUBLIC SPACES IN NOVI BEOGRAD, SERBIA  
\_ **Ivan Filipović** \_ **Kosta Stojanović**
- 125 MEDIATIC APPROACH TO URBAN SPACE: A COMPREHENSIVE DISPLAY PERSPECTIVE  
\_ **Zhao Lei** \_ **Wang Tie**
- 135 RECLAIMING THE OLD INTO THE NEW CITY CONCEPT: REVISITING THE "NEIGHBOURHOOD UNIT" CONCEPT AND ITS RELEVANCE FOR THE 15-MINUTE CITY MODEL - A CASE STUDY OF "DOMCHE" IN SKOPJE  
\_ **Elena Andonova** \_ **Jasmina Siljanoska**
- 143 DIGITAL NOMADS AS ENGINES FOR RURAL REVITALIZATION: THE DEVELOPMENT STRATEGY OF PÉCSDEVECSER, HUNGARY  
\_ **Noémi Kókai** \_ **Donát Rétfalvi**
- 150 STUDY ON THE CONSTRUCTION MODE OF NATIONAL PARK FROM THE PERSPECTIVE OF YANGTZE RIVER CIVILIZATION INHERITANCE: CHU JINAN CITY SITE NATIONAL HERITAGE PARK  
\_ **Bálint Bachmann** \_ **Chen Kun**
- 156 VERTICALITY OF CADASTRAL PLOT: MULTIPURPOSE FUNCTION IN SPACE  
\_ **Marko Milosavljević** \_ **Dejan S. Đorđević** \_ **Zlatko Stojmenović**
- 164 APPROACH TO THE CARTOGRAPHY OF GRANADA WITH ECOSYSTEM APPROACH: FOUNDATIONAL TRAIT, URBAN FABRIC, GREEN INFRASTRUCTURE AND HABITABILITY  
\_ **Juan Luis Rivas-Navarro** \_ **Belén Bravo-Rodríguez** \_ **Elisa Larisa Negoita**
- 172 FACTORS OF INTEGRATION AND SOCIAL COHESION OF URBAN FACILITIES IN THE NORTHERN AND SOUTHERN PERIPHERIES OF GRANADA  
\_ **Belén Bravo-Rodríguez** \_ **Juan Luis Rivas-Navarro** \_ **Cecilia Hita-Alonso** \_ **Pilar Martos-Fernández**
- 180 GEODATA AND GIS AS A DECISION-MAKING SUPPORT INSTRUMENT IN HEALTHY CITY GOVERNANCE  
\_ **Ksenija Lalović** \_ **Ratka Čolić** \_ **Veljko Dmitrović** \_ **Rastko Čugaj**
- 190 GREEN SPACE DEVELOPMENT MONITORING FOR THE SMART CITY: A NOVEL AI BASED METHODOLOGY FOR THE ASSESSMENT OF URBAN GREEN  
\_ **Christina Petschnigg** \_ **Alexander Pamler** \_ **Daniel Pfeiffer** \_ **Harald Urban** \_ **Guenter Koren** \_ **Torsten Ullrich**
- 198 ELEMENTS OF THE GEODESIGN FRAMEWORK AS A TOOL FOR GREEN INFRASTRUCTURE PLANNING ON A LANDSCAPE SCALE  
\_ **Boris Radić** \_ **Suzana Gavrilović** \_ **Sinisa Polovina**
- 207 COMPUTATIONAL MODELLING AND SIMULATIONS - THE FUTURE OF PREDICTING GROWTH AND DEVELOPMENT OF SUSTAINABLE CITIES  
\_ **Dijana P. Furundžić** \_ **Nikola Z. Furundžić** \_ **Aleksandra Krstić-Furundžić**
- 212 URBAN TRANSPORT INFRASTRUCTURE AND SUSTAINABLE MOBILITY  
\_ **Božidar S. Furundžić** \_ **Daniilo S. Furundžić**

## URBAN DESIGN

- 221 TENSIONS OF URBAN DEVELOPMENT IN POST-SOCIALIST CITIES: THE CASE STUDY OF COMMUNITY – BASED INITIATIVE FOR PRESERVATION AND TRANSFORMATION OF OPEN PUBLIC SPACE IN BANJA LUKA  
\_ Ana Špirić \_ Aleksandra Đukić
- 230 THE OBJECTS BUILT OUTSIDE AN URBAN CONTEXT AS A PROBLEM IN FURTHER URBAN PLANNING AND ARCHITECTURAL DESIGN  
\_ Velimir Stojanović
- 238 STUDY ON UPDATING STRATEGIES OF TRANSFORMING FROM AN OLD INDUSTRIAL ESTATE TO AN INDUSTRIAL HERITAGE COMMUNITY  
\_ Jie Tan \_ Hutter Akos
- 246 SHAPING RESIDENTIAL OPEN SPACE IN URBAN DENSIFICATION: GUIDING THE PROCESS TO PRESERVE ENVIRONMENTAL QUALITY AND HEALTHY LIFESTYLES IN NIŠ, SERBIA  
\_ Milena Dinić Branković \_ Milica Igić \_ Mihailo Mitković \_ Jelena Đekić
- 256 THE HISTORICAL PROCESSES OF TRANSFORMATION OF THE SPACE THROUGH URBAN DESIGN COMPETITIONS: THE CASE STUDY OF INDEPENDENCE SQUARE IN PODGORICA  
\_ Nemanja Milićević \_ Ema Alihodžić Jašarović \_ Eva Vaništa Lazarević \_ Jelena Marić
- 267 THE FUTURE PROSPECTS OF THE RESIDENTIAL TOWERS IN THE MACEDONIAN CITIES  
\_ Marija Petrova
- 277 POSSIBLE USES OF INTERACTION DESIGN TO SUPPORT PARTICIPATORY PROCESSES IN PUBLIC SPACE AND PRE-TESTS BASED ON VISUAL ATTENTION  
\_ Araf Öykü Türken \_ Cenk Hamamcıoğlu
- 287 INFORMAL LOW-RISE HOUSING IN THE SUBURBAN CONTEXT AS A PATTERN FOR THE NEW NEIGHBOURHOODS: THE CASE OF CITY OF TETOVO, NORTH MACEDONIA  
\_ Vlera Tachi
- 295 LIVING LAB, TECHNOLOGICAL SIMULATION  
\_ Aleksandra Kondraciuk
- 304 VIRTUAL REALITY FOR IMPROVING WALKABILITY  
\_ Stefan van der Spek \_ Marijke Koene \_ Cor Wagenaar  
\_ Sijmen A. Reijneveld \_ Jolanda Tuinstra \_ Manda Broekhuis
- 312 MORE-THAN-HUMAN DESIGN PRACTICE: REVIEW OF APPROACHES IN MAPPING SUBJECTIVE PARAMETERS OF PEDESTRIAN EXPERIENCES  
\_ Nikola Mitrović

## ARCHITECTURAL DESIGN

- 320 THE COMPLEXITIES AND CONTRADICTIONS OF SUSTAINABLE DESIGN AESTHETICS  
\_ Ana Kisjan \_ Dubravko Aleksić \_ Tijana Vujičić
- 325 HYBRID SPACES, HYBRID PLACES IN THE ARCHITECTURE OF THE OFFICE BUILDING  
\_ Ana Vračević \_ Dina Stober

## ARCHITECTURAL TECHNOLOGIES

- 334 THE IMPROVEMENT OF THE NEW OFFICE BUILDINGS' ADAPTABILITY: GENERAL RECOMMENDATIONS  
\_ Damjana Nedeljković \_ Tatjana Jurenić \_ Aleksandra Čabarkapa

- 340 REFURBISHMENT OF THE EXISTING MULTI-FAMILY HOUSING STOCK FROM THE PERIOD OF POST-WAR MASS CONSTRUCTION: SPATIAL AND ENERGY BENEFITS  
\_ Ljiljana Đukanović \_ Bojana Lević
- 348 MATERIAL EFFICIENCY: PATTERN DESIGN TECHNIQUES FOR 3D PRINTED RIB-STIFFENED FLOOR SYSTEMS  
\_ Maša Žujović \_ Radojko Obradović \_ Jelena Milošević
- 356 POSSIBILITIES OF STAGED RENOVATION OF REINFORCED CONCRETE FACADES OF MULTI-FAMILY BUILDINGS IN THE CENTRAL ZONE OF NEW BELGRADE  
\_ Nikola Macut \_ Tijana Žišić \_ Jelena Ivanović-Šekularac
- 364 RECONSTRUCTION OF THE HERITAGE BUILDING OF THE ŽIČA MONASTERY FOR THE PURPOSE OF SUSTAINABILITY  
\_ Nenad Šekularac \_ Jelena Ivanović-Šekularac \_ Nikola Macut \_ Tijana Žišić
- 371 KNAUFTERM3D – SOFTWARE FOR MODELLING AND CALCULATION OF BUILDINGS ENERGY EFFICIENCY PROPERTIES  
\_ Aleksandar Rajčić
- 379 COMMON BIM USES: EXPERIENCE-BASED RESEARCH  
\_ Motasem Altamimi \_ Márk Balázs Zagorác \_ Miklós Halada
- 387 THE IMPORTANCE OF SUSTAINABLE TIMBER CONSTRUCTION IN ACHIEVING LOW CARBON FOOTPRINT BUILDINGS  
\_ Peter Markus
- 393 ON THE EVALUATION OF THE IMPACT OF CLIMATE CHANGE ON THE ENERGY PERFORMANCE OF PREFABRICATED AND CONVENTIONAL BUILDINGS  
\_ Stella Tsoka \_ Katerina Tsikaloudaki \_ Theodoros Theodosiou \_ Kondylia Velikou
- 400 NEW TECHNOLOGIES IN ARCHITECTURAL HERITAGE PRESENTATION: ISSUES OF AUTHENTICITY  
\_ Jovana Tošić
- 407 ENERGY SAVINGS POTENTIAL IN MODULAR ENVELOPE RENOVATIONS OF PREFABRICATED RESIDENTIAL BUILDINGS IN BOSNIA-HERZEGOVINA AND SERBIA  
\_ Darija Gajić \_ Budimir Sudimac \_ Aleksandar Rajčić \_ Slobodan Peulić \_ Jelena Rašović
- 416 CAPABILITIES AND CHALLENGES IN BUILDING RENOVATION: APPLYING THE SUSTAINABILITY PRINCIPLES IN AN OFFICE BUILDING IN THESSALONIKI, GREECE  
\_ Katerina Tsikaloudaki \_ Katerina Karanafti \_ Theodoros Theodosiou \_ Konstantinos Laskos \_ Stella Tsoka
- 424 THE IMPORTANCE OF DAYLIGHT-SAVING TIME FOR ENERGY SAVINGS IN BELGRADE LATITUDE AND CLIMATE  
\_ Marija Grujić \_ Nikola Knežević
- 432 FACADE PANEL PARAMETRISATION IN THE MODERNIST HERITAGE OF NEW BELGRADE: A MULTIPLE-CASE STUDY  
\_ Djordje Mitrović

## ARCHITECTURAL EDUCATION

- 441 SHAPING A BETTER FUTURE: CONTEXTUAL LEARNING AND TEACHING OF STRUCTURAL DESIGN IN THE PROCESS OF ARCHITECTURAL EDUCATION  
\_ Aleksandra Nenadović \_ Jelena Milošević
- 449 SUSTAINABLE FLUIDITY IN AESTHETICAL PERSPECTIVES OF CONTEMPORARY ARCHITECTURE: POST-INDUSTRIAL DEVELOPMENT OF DANUBE'S WATERFRONT IN BELGRADE  
\_ Bojana Jerković-Babović

- 456 TOWARD THE IDEAS OF THE NEW EUROPEAN BAUHAUS: THE APPLICATION OF THE DIGITAL TOOLS IN THE UNIVERSITY CURRICULA  
\_ Vladimir Mihajlov \_ Aleksandra Stupar \_ Ivan Simic
- 465 LEED IN ACADEMIC ARCHITECTURAL EDUCATION  
\_ Nataša Čuković Ignjatović \_ Dušan Ignjatović
- 472 CREATIVE EDUCATION: NEW APPROACHES AND TRANSFORMATION OF TEACHING METHODOLOGY FOR INSPIRING STUDENTS  
\_ Eva Vaništa Lazarević \_ Jelena Marić \_ Milena Vukmirović
- 482 WORKCAMP IN HIGHER EDUCATION IN URBANISM: EXPERIENCE FROM DANURB+ BUILDING CAMP FOR STUDENTS IN GOLUBAC, SERBIA  
\_ Milorad Obradović \_ Aleksandra Djukić \_ Jelena Marić \_ Branislav Antonić \_ Nikola Mitrović

### **CLOSE DOMAINS TO PLACES AND TECHNOLOGIES**

- 490 NEW GENERATIVE AND AI DESIGN METHODS FOR TRANSPORTATION SYSTEMS AND URBAN MOBILITY DESIGN, PLANNING, OPERATION, AND ANALYSIS: CONTRIBUTION TO URBAN COMPUTING THEORY AND METHODOLOGY  
\_ Dragana Ćirić
- 504 TENSILE MEMBRANE STRUCTURES IN PUBLIC SPACES / CASE STUDY  
\_ Aleksandar Vučur \_ Isidora Zimović \_ Nebojša Stanošević
- 512 URBAN AIR MOBILITY DEVELOPMENT IN WESTERN BALKAN (WB6) REGIONAL PARTNERS  
\_ Olja Čokorilo \_ Anja Stamenić \_ Lidija Tomić
- 519 SOCIAL PERCEPTION AND ACCEPTANCE OF GEOTHERMAL SYSTEMS  
\_ Aleksandar Petrovski
- 526 URBAN INTERFACE DESIGN STRATEGIES BASED ON THE ADAPTABILITY OF 5G MILLIMETRE WAVE MOBILE COMMUNICATION  
\_ Hu Tianyu \_ Gabriella Medvegy \_ Ágnes Borsos \_ Wang Tie
- 539 A HUMAN SOCIETY NEEDS HUMAN PLACES  
\_ Pieter de Haan
- 550 FOSTERING INNOVATION: UNIVERSITY-INDUSTRY COLLABORATION NETWORKS IN ARCHITECTURAL RESEARCH  
\_ Milijana Živković \_ Eva Vaništa Lazarević \_ Jelena Marić \_ Jelena Milošević
- 558 ARTIFICIAL INTELLIGENCE APPLIED TO CULTURAL HERITAGE AND SUSTAINABILITY: A PORTUGUESE CASE STUDY  
\_ Janaina Cardoso de Mello \_ Gabriel Ko Freitag e Silva \_ Gyamarco Pereira Nascimento Secci
- 566 EVALUATING THE RELEVANCE OF COMPUTATIONAL DESIGN IN ARCHITECTURE AS A VIABLE RESPONSE TO THE AFFORDABLE HOUSING CHALLENGE  
\_ David Ojo \_ Gabriella Medvegy \_ Ágnes Borsos
- 573 BELGRADE UNIVERSITY ENDOWMENTS LEASE MANAGEMENT  
\_ Danilo S. Furundžić \_ Nemanja Šipetić

### **8TH CONFERENCE OF INTERDISCIPLINARY RESEARCH ON REAL ESTATE - CIRRE 2023**

- 582 THE ROLE OF PUBLIC SPACE IN SHAPING THE QUALITY OF LIFE FOR OLDER RESIDENTS: THE CASE OF SLOVENIA  
\_ Ajda Šeme \_ Richard Sendi \_ Maša Filipovič Hrast \_ Boštjan Kerbler



- 597 COMPARISON OF THE QUALITY OF LIFE IN HOUSING ESTATES FROM SOCIALIST AND POST-SOCIALIST ERA: THE CASE OF SLOVENIA  
\_ **Boštjan Kerbler** \_ **Ajda Šeme** \_ **Richard Sendi**
- 611 METHOD FOR 3D NEIGHBORHOOD MODEL CREATION IN CITYGML STANDARD AS BASIS FOR URBAN SIMULATION TOOLS  
\_ **Galina Voitenko** \_ **Hannes Harter** \_ **Niki Gaitani**
- 623 APPLICATION OF BLOCKCHAIN TECHNOLOGY IN ENERGY TRADING  
\_ **Asha Chathurini Wijethilake Haputhanthirige** \_ **Champika Liyanage** \_ **Ruchira Yapa** \_ **Susantha Udagedara**
- 635 PLANNING VISION AND THE SERVICE OF SPATIAL PLANNING  
\_ **Ivan Stanić**
- 641 TOLERANCE TO URBAN WINDOW VIEWS IN REGARD TO VARIOUS VARIABLES  
\_ **Živa Kristl** \_ **Ajda Fošner** \_ **Martina Zbašnik-Senegačnik**
- 648 THE ARCHITECTURE OF PUBLIC BUILDINGS AS TRANSFORMATIVE MODEL TO WARDS SUSTAINABILITY  
\_ **Mihajlo Zinoski** \_ **Jana Brsakoska** \_ **Kire Stavrov**
- 654 HIGHER PRICES, SMALLER SPACES: CORRELATION BETWEEN APARTMENT PRICES AND ARCHITECTURAL PRACTICES IN SKOPJE  
\_ **Mihajlo Zinoski** \_ **Vebi Fazliu** \_ **Valmir Dalipi**
- 662 FROM CLASSICAL MANAGEMENT TO URBAN HERITAGE FACILITY MANAGEMENT: MOBILITY AND ACCESSIBILITY IN URBAN HERITAGE AREAS  
\_ **Bintang Noor Prabowo**
- 673 CITIZENS' INVOLVEMENT IN THE DESIGN PROCESS OF PUBLIC SPACES: THE CASE OF ELGESETER STREET IN TRONDHEIM, NORWAY  
\_ **Clémence Magnière** \_ **Mahgol Afshari**
- 685 THE SCIENCE OF PLAY: CONFESSIONS OF AN ENGINEER EXPLORING SCIENCE AND TECHNOLOGY STUDIES. AN STS ANALYSIS OF SERIOUS GAMES AND CO-PRODUCTION  
\_ **Coline Senior**
- 693 SEMI-STRUCTURED INTERVIEWS AS THE FOUNDATION FOR INTERDISCIPLINARY RESEARCH ABOUT THE BUILT ENVIRONMENT, HEALTH, AND HAPPINESS  
\_ **Elham Andalib**
- 704 PREVIEW INCREASED INVESTMENTS AND DIFFERENTIATION IN HEALTH CARE REAL ESTATE  
\_ **Jan Veuger**
- 716 REDUX: IMPACT, TRENDS AND DEVELOPMENTS IN SOCIAL REAL ESTATE  
\_ **Jan Veuger**
- 723 USING CITIZEN PARTICIPATION METHODS TO IDENTIFY STRATEGIES FOR INCREASED ACTIVE MOBILITY - CASE ELGESETER STREET OF TRONDHEIM  
\_ **Mahgol Afshari** \_ **Alenka Temeljotov-Salaj** \_ **Agnar Johansen**
- 735 COWORKING SPACES - IS IT JUST A BUZZWORD, OR DOES IT HAVE POTENTIAL?  
\_ **Margareth Berstad**
- 747 IDENTIFICATION OF POTENTIAL IMPACTS OF CLIMATE CHANGE AND THE ADAPTATION OPTIONS IN LOW-COST STRATA RESIDENTIAL BUILDING IN MALAYSIA  
\_ **Mustafa Omar**
- 758 NEED FOR CREATIVE COMPETENCIES IN ENGINEERING EDUCATION  
\_ **Olav Torp** \_ **Elham Andalib** \_ **Alenka Temeljotov Salaj**

# COMMITTEES

## SCIENTIFIC COMMITTEE

### **Dr Laura Aelenei**

National Energy and Geology Laboratory (LNEG), Lisbon, Portugal

### **Dr Bachmann Bálint**

University of Pécs Faculty of Engineering and Information Technology, Institute of Architecture, Pécs, Hungary

### **Dr Benko Melinda**

Budapest University of Technology and Economics, Budapest, Hungary

### **Dr Brandão Alves Fernando**

FEUP Porto, Portugal

### **Dr Ana-Maria Branea**

Faculty of Architecture, Polytechnic University of Timisoara, Romania

### **Dr Christine Chaloupka-Risser**

University lecturer in Traffic Psychology, Vienna, Austria

### **Dr Milena Dinić Branković**

University of Nis, Faculty of Architecture and Civil Engineering, Serbia

### **Rector Dr Đokić Vladan**

Rector of University of Belgrade, Belgrade, Serbia

### **Dr Doytchinov Grygor**

Institute for Urban Design, Technical University of Graz, Austria

### **Dr Aleksandra Đukić**

Faculty of Architecture, Belgrade, Serbia

### **Dr Daria Gajić**

University of Banja Luka - Faculty of Architecture and Civil Engineering, Banja Luka, Republic of Srpska, Bosnia and Herzegovina

### **Dr Bob Giddings**

Northumbria University Faculty of Engineering and Environment, Newcastle, United Kingdom

### **Dr Cenk Hamamcioğlu**

Faculty of Architecture, Department of City and Regional Planning, Yıldız Technical University - Istanbul, Turkey

### **Dr Jelena Ivanović Šekularac**

University of Belgrade Faculty of Architecture, Belgrade, Serbia

### **Arch. Milena Ivkovic**

Founder of Placemaking Western Balkans, Serbia and Nederland

### **Dr Aleksandra Krstić-Furundžić**

University of Belgrade Faculty of Architecture, Belgrade, Serbia

### **Dr Jugoslav Joković**

Faculty of Electronic Engineering, University of Niš, Serbia

### **Dean Vladimir Lojanica**

University of Belgrade - Faculty of Architecture, Belgrade, Serbia

### **Dr Piotr Lorens**

Faculty of Architecture, Gdansk University of Technology, Gdansk, Poland

### **Dean Dr Ognen Marina**

Faculty of Architecture, Ss. Cyril and Methodius University Skopje, North Macedonia

### **Dr Lucia Marticigh**

University RomaTre, Faculty of Architecture, Rome, Italy

### **Dr Martinelli Nicola**

DICAR of Polytechnic of Bari, Bari Italy

### **Dean Dr Garbiella Medvegy**

Faculty of Engineering and Information Technology, University of Pécs, Hungary

**Arch. Ljubomir Mišćević**

University of Zagreb – Faculty of Architecture,  
Zagreb, Croatia

**Dr Miloš Mladenović**

Aalto University, Finland

**Dr Florian Nepravishta**

Universiteti Politeknik i Tiranës, Albania

**Dr Juan Luis Rivas Navarro**

University of Granada Department of Urban and Regional  
Planning, Granada, Spain

**Dr Svetislav Popović**

Faculty of Architecture Podgorica, Montenegro University,  
Podgorica, Montenegro

**Dr Boris Radic**

University of Belgrade Faculty of Forestry, Belgrade, Serbia

**Dr Darko Reba**

Faculty of Technical Science, University of Novi Sad, Serbia

**Dr Ralf Risser**

FACTUM, Vienna, Austria

**Dr Lina Seduikyte**

Kaunas University of Technology, Faculty of Civil Engineering and  
Architecture, Kaunas, Lithuania

**Dr Svetlana Stanarevic**

University of Belgrade Faculty of Security, Serbia

**Dr Ljupko Šimunović**

University of Zagreb Faculty of Transport and Traffic Sciences,  
Zagreb, Croatia

**Dr Olja Čokorilo**

University of Belgrade Faculty of Transport and Traffic Sciences,  
Belgrade, Serbia

**Dr Miroslava Raspopovic Milic**

Metropolitain University - Faculty of Information technologies,  
Belgrade, Serbia

**Dr Francesco Rotondo**

Università Politecnica delle Marche, Italy

**Dr Alenka Temeljotov Salaj**

Norwegian University of Science and Technology Department of  
Civil and Environmental Engineering, Norway

**Dr Katerina Tsikaloudaki**

Aristotle University of Thessaloniki Faculty of Engineering

**Dr Theodoros Theodosiou**

Aristotle University of Thessaloniki, Greece

**Manfred Schrenk**

Chairman of CORP - Competence Center for Urban and Regional  
Planning, Vienna, Austria

**Dr Stefan van der Spek**

TU Delft, Delft, Nederland

**Dr Aleksandra Stupar**

University of Belgrade Faculty of Architecture, Belgrade, Serbia

**Dr Eva Vanista Lazarevic**

University of Belgrade Faculty of Architecture, Belgrade, Serbia

**Dr Milena Vukmirović**

University of Belgrade - Faculty of Forestry, Belgrade, Serbia

**Dr Tijana Vujičić**

University of Banjaluka Faculty of Architecture, Civil Engineering  
and Geodesy, Bosnia and Herzegovina

**Dr Bora Yerliyurt**

Faculty of Architecture, Department of City and Regional  
Planning, Yıldız Technical University - Istanbul, Turkey

**Dr Filipović Dejan**

University of Belgrade, Faculty of Geography, Belgrade, Serbia

**Dr Nepravishta Florian**

Polytechnic University of Tirana, Faculty of Architecture and  
Urbanism, Tirana, Albania

**Dr Čokorilo Olja**

University of Belgrade Faculty of Transport and Traffic Sciences,  
Belgrade, Serbia

**ORGANIZING COMMITTEE**

## FOUNDING MEMBERS OF THE ORGANIZING COMMITTEE

**Dr Aleksandra Djukić**

Conference Director, University of Belgrade, Faculty of  
Architecture, Belgrade, Serbia

**Dr Aleksandra Krstić-Furundžić**

Head of Publishing, University of Belgrade, Faculty of  
Architecture, Belgrade, Serbia

**Dr Eva Vaništa Lazarević**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Milena Vukmirović**

Conference Program Director, University of Belgrade, Faculty of  
Forestry, Belgrade, Serbia

## ASSOCIATED MEMBERS OF THE ORGANIZING COMMITTEE

**Dr Jelena Marić**

Conference Executive Coordinator, University of Belgrade, Faculty  
of Architecture, Belgrade, Serbia

**Dr Suzana Gavrilović**

University of Belgrade Faculty of Forestry, Belgrade, Serbia

**TECHNICAL COMMITTEE****Dr Vladimir Kovač**

Technical Committee Member, University of Belgrade, Faculty of  
Architecture, Belgrade, Serbia

**Nikola Mitrović**

Technical Committee Member, University of Belgrade, Faculty of  
Architecture, Belgrade, Serbia

**Ana Šabanović**

Technical Committee Member, University of Belgrade, Faculty of  
Architecture, Belgrade, Serbia

## **REFURBISHMENT OF THE EXISTING MULTI-FAMILY HOUSING STOCK FROM THE PERIOD OF POST-WAR MASS CONSTRUCTION: SPATIAL AND ENERGY BENEFITS**

DOI: [https://doi.org/10.18485/arh\\_pt.2024.8.ch40](https://doi.org/10.18485/arh_pt.2024.8.ch40)

### **\_ Ljiljana Đukanović**

PhD, Associate Professor, Department of Architectural Technologies, Faculty of Architecture, University of Belgrade, Serbia, [djuli@arh.bg.ac.rs](mailto:djuli@arh.bg.ac.rs)

### **\_ Bojana Lević**

PhD student, Teaching Assistant, Department of Architectural Technologies, Faculty of Architecture, University of Belgrade, Serbia, [bojana.levic@arh.bg.ac.rs](mailto:bojana.levic@arh.bg.ac.rs)

### **ABSTRACT**

The most represented multi-family housing stock within the cities of Serbia was built in the period from 1946 to 1970. 25% of the total multi-family stock of Serbia consists of buildings built in that period. This multi-family housing stock is at the centre of discussion due to its energy, functional and spatial-organisational obsolescence. Designed with the aim of providing apartments for as many people as possible in the short term, these buildings are characterised by small apartments, outdated and rigid spatial organisation, inadequate dimensioning of spatial units and small window openings on the facades. In addition, these buildings have a high energy consumption for heating. The subject of the research includes the analysis of the application of complex and integrated refurbishment by adding exoskeleton to existing multi-family buildings in order to achieve high energy efficiency of buildings and increase the space of residential units, as well as improve vertical communications of buildings. The exoskeleton represents a spatial structure that is added to the existing building with the aim of spatial-functional and energy improvement. The paper will present various possibilities for the position of the exoskeleton on the envelope of the existing building, based on which it can be determined which spatial-organisational and functional characteristics of the existing building are being improved. Based on the predetermined typology of residential multi-family buildings, a classification of possible positions of the exoskeleton on the envelope of each type of multi-family building will be made. The goal of the research is to review the advantages and limitations of exoskeleton application in different types of multi-family residential buildings and to determine the possibilities of improving the spatial-organisational, functional and energy performance of existing multi-family buildings by applying complex and integrated refurbishment using exoskeleton.

**KEYWORDS** \_ *Multi-family housing stock, refurbishment, exoskeletons, energy efficiency, spatial comfort*

## INTRODUCTION

The energy renovation of the existing building stock is becoming a current topic in Europe. The renovation of the existing housing stock is a key factor in the task set by the European Commission for the period up to 2050 because the share of existing buildings is much higher than that of newly designed ones in the total building stock of the European Union. Many renovation strategies are based on energy-saving measures, such as retrofitting existing buildings to improve the building's thermal envelope and implementing efficient heating, ventilation, and air conditioning systems (European Commission, 2020).

Multi-family residential buildings built in the period from 1946 to 1970 make up one-quarter of the total multi-family stock in Serbia (Jovanović et al., 2013). Most of these buildings are characterized by high energy consumption for heating due to the poor thermal performance of the building envelope. Created according to the design regulations valid at that time, according to today's user requirements, they have major spatial and organizational deficiencies, such as small apartments, outdated and inflexible spatial organization, and small windows. The absence of elevators in many multi-family buildings from that period also reduces their comfort of use. The subject of the research includes the application of refurbishment methodology by adding an exoskeleton, as a constructive-functional element, to existing multi-family buildings with the primary goal of achieving high energy efficiency of buildings with remodelling and modernization of residential units, and improving vertical building communications. The paper shows the different uses of the exoskeleton and the positions of the exoskeleton on selected types of multi-family residential buildings in Serbia. The goal of the research is to review the advantages and limitations of exoskeleton application in different types of multi-family residential buildings and to determine the possibilities of improving the spatial-organizational, functional and energy performance of existing multi-family buildings by applying complex and integrated refurbishment using exoskeleton.

## STRATEGY OF VOLUMETRIC ADDITION TO AN EXISTING BUILDING

For the refurbishment of buildings, it is important to apply the principle of adaptability. The concept of sustainable buildings requires an adaptive, integrated renovation in order to improve the existing buildings from multiple aspects, simultaneously. One such approach is the strategy for adding a so-called exoskeleton as a spatial-functional prosthesis to the existing building. This method represents a three-dimensional reconstruction of the existing building, which consists of volumetric additions that provide a structural, energy, and functional upgrade. This method can be performed if there is a possibility of extending the facade or upgrading the existing roof (Guidolin, 2018).

The approach to renovating existing buildings by adding new structures has significant functional advantages that set it apart as one of the more significant approaches to the complex renovation of buildings. This refers to the possibility of adding missing functional elements to an existing building, such as elevators, fire escapes, or balconies, which can greatly improve its spatio-functional quality, as well as the comfort of its users. The exoskeleton system enables functional upgrades and an overall reorganization of a building's spatial structure, with improvements on many levels (Guidolin, 2018).

## RESEARCH METHODOLOGY

The research methodology includes several analyses. First, the study examines the types of multi-family housing constructed after World War II, as well as their spatial organization and functional characteristics. Then, an existing multi-family free-standing building is chosen for the research, and its spatial organization and functional characteristics are analyzed. The energy performance of the selected building is evaluated using the Knaufterm software<sup>1</sup>. Next, the energy improvement

<sup>1</sup> Knaufterm is the commercial software that is the most used calculation tool for calculating energy performance and determining the energy class of a building in Serbia.

achieved by applying the volumetric addition is analyzed. Finally, the advantages and limitations of applying the volumetric addition strategy to the existing building to improve its energy performance are determined.

### **MULTI-FAMILY HOUSING STOCK BUILT IN THE PERIOD FROM 1946 TO 1970 IN SERBIA**

Of the total stock of multi-family residential buildings in the Republic of Serbia, 24.81% were built in the period from 1946 to 1970 (Jovanović et al., 2013). This period is characterized by intensive housing construction, the dynamic growth of cities, the development of new settlements, and block construction.

The classification of multi-family buildings according to architectural-urban planning parameters and building characteristics includes the following types:

- A 5-storey free-standing building, on a separate plot, does not border neighboring buildings on any side,
- A 5-storey free-standing building consisting of two or more identical units with the separate entrances, in an open city block,
- A 5-storey building in a row, within a series of different buildings in a closed city block, borders neighboring buildings on one or two sides,
- A high-rise free-standing building with more than 10 storeys, on a separate plot, does not border neighboring buildings on any side (Jovanović et al., 2013).

The buildings built in this period have common characteristics; the architectural form of the buildings was compact and geometrically regular, the facade was simple, and the windows were small. The buildings were built in a traditional way, in a massive construction system, with brick as the dominant material. Similarities are also noticeable in the spatial organization: the kitchen includes a dining space, and there is no separate dining room. The central position of the entrance to the building, the position of the staircase, the absence of an elevator, and the interior and exterior finishes are also consistent in these types of buildings and represent their common characteristics. Such similarities between the types, which do not exist in any other period, derive primarily from the post-war housing policy, which aimed to provide the minimum housing space in the shortest possible time for a large number of people using known constructive systems and traditional building techniques (Jovanović et al., 2013). Rational solutions, common to all buildings, are the result of regulations for residential construction that aimed to define the minimum dimensional and technical standards. The regulation regarding thermal protection emerged only in the late 1960s (Official Gazette of SFRJ 45/67, 1967). Buildings from this period do not have an adequate solution for thermal conductivity from today's perspective of thermal requirements. However, the simple, cubic forms and relatively simple materialization of the building envelope make them extremely suitable for energy renovation because significant improvements can be achieved with relatively simple measures (Jovanović et al., 2013).

### **VARIOUS ASPECTS OF THE COMPLEX AND INTEGRATED REFURBISHMENT OF A BUILDING USING THE STRATEGY FOR VOLUMETRIC ADDITION**

The sustainable renovation goal is to improve living conditions in existing multi-family residential buildings and achieve high energy efficiency. Various parameters affect the heating energy calculation: the building envelope, the ratio of the volume of a building to the area of the building envelope, the total usable heated area, and a building's compactness (Ministry of Environmental Protection, Government of the Republic of Serbia, 2011). Volumetric additions to the facades of a building would increase the total usable surface of a building and its volume. As the area of the building envelope would increase by a smaller percentage in relation to the increase in volume, that would increase the possibility of achieving greater energy savings.

As the application of volumetric additions to the facades of a building increases its useful living space, apartments of minimal dimensions and outdated and rigid spatial organization, typical for the post-war multi-family housing stock, could be improved. A volumetric addition to an open space enables the creation of balconies and loggias that do not exist on these buildings. The functional characteristics of the building, such as vertical communications, can be improved by applying volumetric additions. A volumetric addition on the roof of a building increases its useful living space (Fig. 1). An increase in the number of storeys of a building is possible if the static calculations show that a building is suitable for such an intervention.

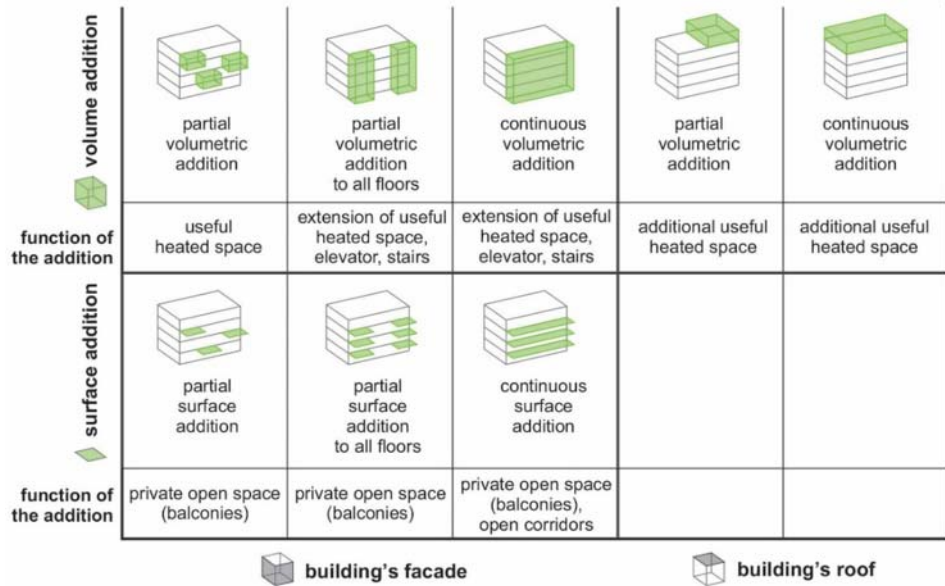


Figure 1: Variants of volumetric addition to an existing building (Image by authors)

## STRATEGY OF VOLUME ADDITION TO DIFFERENT TYPES OF MULTI-FAMILY HOUSING BUILDINGS

The strategy for adding volumetric extensions to facades and on a roof of an existing building in a complex and integrated renovation depends on a building type, structural strength (of all described building types), and the construction site size and accessibility.

As *free-standing buildings* were built in an open city block, there is sufficient surrounding space that is necessary for this renovation approach. Regarding *free-standing buildings consisting of two or more identical units*, it is not possible to apply this strategy to dilatation spaces and walls between them. On such buildings, there is a possibility of volumetric addition to the side facades of its end units. As these buildings were also built in an open city block, there is free space around them. In the case of *buildings in a row in a closed city block*, two facades are free, but in general, as these buildings were built on the regulation line, extension on the street facade is not allowed. Interventions to increase the volume of such a building are possible on the courtyard façade. Depending on the structural strength of such a building, an extension on the roof is possible (Fig. 2). High-rise, free-standing buildings with more than 10 storeys were not taken into consideration because their percentage share in the total multi-family housing stock in Serbia is small.

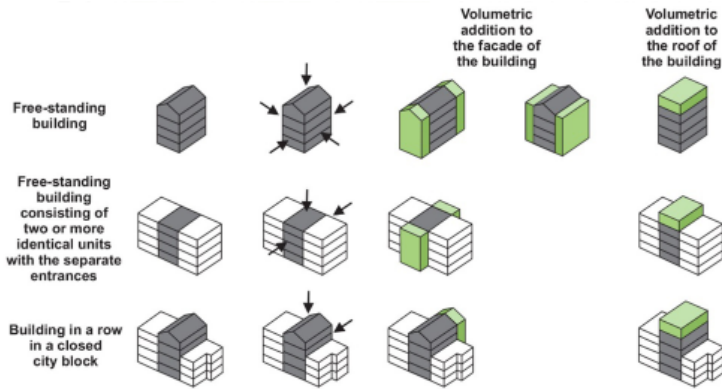


Figure 2: Possible directions of volumetric addition according to types of multi-family residential buildings (Image by authors)

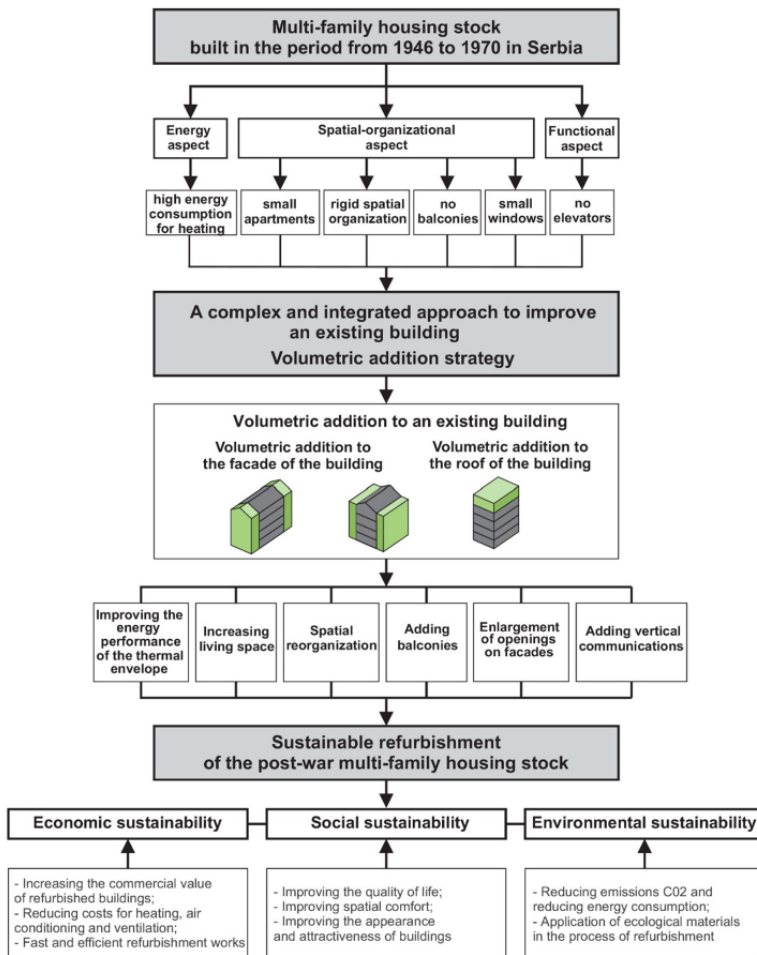
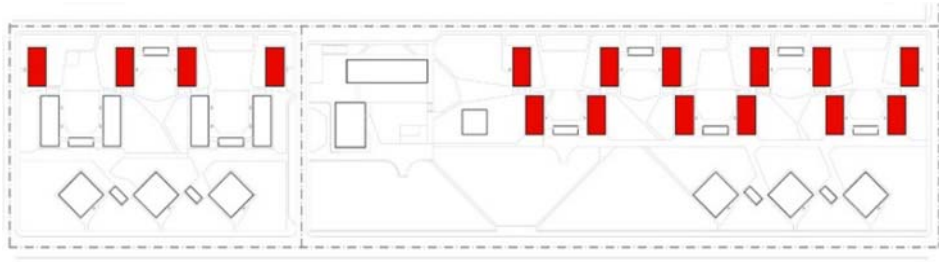


Figure 3: The research methodology (Image by authors)



## THE SELECTED MULTI-FAMILY RESIDENTIAL FREE-STANDING BUILDING

The selected free-standing multi-family residential building is located in New Belgrade and was built in 1961. Within an open city block, 16 identical residential buildings were built, each with 20 apartments. By multiplying one typical building in the city block, a total of 320 apartments were obtained (Fig. 4).



**Figure 4:** Grouping of 16 identical multi-family residential buildings (Image by authors)

The multi-family residential building form is a rectangular prism. The building has a basement and five original storeys. The basement of the building is used as storage space, and all other floors are for residential purposes.

On all the floors, the spatial arrangement of four apartments, two smaller with a usable area of 50,81 m<sup>2</sup>, and two bigger with a usable area of 56,13 m<sup>2</sup>, is repeated. The apartments are grouped around a centrally located staircase. Both types of apartments contain an entrance hallway, a bathroom, a kitchen, a living room, and two bedrooms. The only difference is that larger apartments also have a separate dining area. The building does not have balconies or loggias. (Fig. 5).



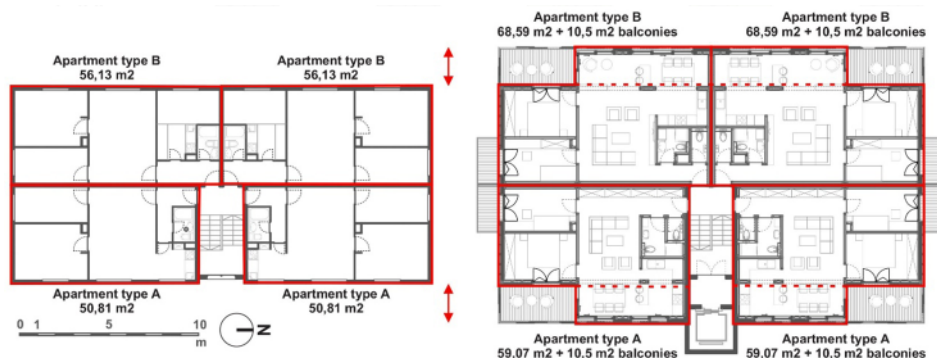
**Figure 5:** a) Typical floor plan; b) side façade; c) longitudinal facade of the selected multifamily housing building

The heated area includes the apartments on all floors, while the stairwell and basement are not heated. The heating system is based on electric energy. None of the positions of the building envelope meet the criteria from the Regulation on Energy Efficiency of Buildings for maximum values of the heat transfer coefficient. Based on this important finding, the selected building is a good example for research on the building's envelope to achieve better energy results. It is noticeable that some tenants have independently implemented certain energy improvements, but the study will consider the original condition of the existing building without subsequent interventions.

Based on the KnaufTerm calculation, the building belongs to the F energy efficiency class, which is one of the lowest on the scale of energy efficiency classes for residential buildings. It can be concluded that it would be extremely desirable to carry out energy efficiency renovation to reduce the total energy for heating and, therefore, improve the energy efficiency class.

### ENERGY EFFICIENCY/SPATIAL/FUNCTIONAL RETROFIT OF THE EXISTING BUILDING WITH VOLUMETRIC ADDITIONS






The research represents the complex and integral refurbishment of the existing building by proposing volumetric additions on longitudinal facades, which would increase the usable living space of residential units; the addition of loggias, from a spatial and organizational aspect; and the addition of an elevator, from a functional point of view (Fig. 6).



**Figure 6:** Spatial organization of apartments in the existing state of the building (left) and spatial organization of apartments through energy efficiency/spatial/functional retrofit of the existing building with volumetric additions (right) (Image by authors)

The solution envisages adding an elevator to the building to enable and facilitate vertical communication for its users and to make the building accessible to people with disabilities, the elderly, and families with small children. This intervention directly increases the users’ comfort and the market value of the building. The solution also envisages increasing the useful living space of all residential units by adding volumes to the longitudinal facades, thus enabling the extension of the apartments on both sides. By increasing the useful space, a better organization of all housing units, greater comfort, and the possibility of reorganizing rooms in each housing unit would be possible (Fig. 6).

The conceptual solution proposes the continuous volumetric addition on the roof of the building. The spatial organization of the upgraded floor would be the same as the typical floor.

| Type of the building   | Existing state of the building  | Volumetric addition / surface addition   | Function of a volumetric addition  | Project improvement of the building  |
|------------------------|---|--|------------------------------------|--|
| free-standing building | <br>number of floors: 5<br>number of apartments: 20<br>total heating surface: 1091,70 m <sup>2</sup><br>heating surface of apartments: 50 m <sup>2</sup> , 56 m <sup>2</sup><br>energy class: <b>F</b> |  partial volume addition to all floors  | useful heated space, elevator      | <br>number of floors: 7<br>number of apartments: 28<br>total heating surface: 1589,37 m <sup>2</sup><br>heating surface of apartments: 56 m <sup>2</sup> , 69 m <sup>2</sup><br>energy class: <b>B</b> |
|                        |   |  partial surface addition to all floors | balconies                          |  |
|                        |   |  continuous volume addition             | useful heated space (2 new floors) |  |

**Figure 7:** A comparative analysis of the energy efficiency/spatial/functional aspects of the existing state and a complex and integral refurbishment of the existing residential multi-family building (Image by authors)

Based on the interventions in all positions of the building envelope and by adding new positions in the building envelope, significant results were achieved in terms of reducing heat losses and the energy required for heating. Based on the KnaufTerm calculation, this variant of improvement of the building belongs to the B energy efficiency class.

## CONCLUSIONS

Considering that it is a very complex type of renovation that requires interventions on the entire building envelope, it can be concluded that this renovation strategy is suitable for free-standing buildings as well as free-standing buildings consisting of two or more identical units because these buildings are mostly placed in open city blocks and have facades that can be easily approached. This strategy is not easily applicable to a row of buildings within a city block due to space limitations, walls next to neighboring buildings, street facades that are placed on the regulation line, and courtyard facades that are inaccessible in closed city blocks. Further research and static calculations of the stability of the existing buildings are needed to verify whether this kind of intervention is feasible. This strategy represents a hypothetical intervention that raises numerous questions of feasibility in practice. The problems accompanying complex and integrated refurbishment would be the duration of the works and the accommodation of tenants in the meantime, the issue of ownership relations, and the consent of the housing community for such works to be carried out. Complex and integrated refurbishment that includes energy efficiency improvement and spatial expansion with the improvement of functions can be recognized as an adaptable method for future uses from the perspective of the resistance and adaptability of the already built context. On an urban scale, this method of retrofit can be introduced as a strategic approach for improving the energy efficiency of existing buildings.

## REFERENCES

- European Commission. 2019. A European Green Deal. Accessed April 21, 2023. [https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal\\_en](https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en)
- European Commission. 2020. A Renovation Wave for Europe – greening our buildings, creating jobs, improving lives. COM (2020) 662. Accessed April 21, 2023. [https://ec.europa.eu/commission/presscorner/detail/en/IP\\_20\\_1835](https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1835)
- EUR-Lex. 2018. EU Directive 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency. Official Journal of the European Union, L156/75-91. Accessed April 21, 2023. <http://data.europa.eu/eli/dir/2018/844/oj>
- Guidolin, Francesca. 2018. "Adaptive Socio-Technical Devices - Social Inclusion as a Rehabilitation Tool." *Sustainable and Resilient Building Design, Approaches, Methods and Tools*: 229-247. TU Delft Open.
- Jovanović Popović, Milica, Ignjatović, Dušan, Radivojević, Ana, Rajčić, Aleksandar, Đukanović, Ljiljana, Čuković Ignjatović, Nataša, Nedić, Miloš. 2013. *Atlas of multi-family buildings in Serbia*. Faculty of Architecture, University of Belgrade.
- Jovanović Popović, Milica, Ignjatović, Dušan, Radivojević, Ana, Rajčić, Aleksandar, Đukanović, Ljiljana, Čuković Ignjatović, Nataša, Nedić, Miloš. 2013. *National typology of residential buildings in Serbia*. Faculty of Architecture, University of Belgrade.
- Konstantinou, Thaleia, and Dimitrijević, Branka. 2018. "Sustainable Refurbishment for an Adaptable Built Environment." *Sustainable and Resilient Building Design, Approaches, Methods and Tools*: 205-224. TU Delft Open.
- Ministry of Environmental Protection, Government of the Republic of Serbia. 2011. Rulebook on energy efficiency of buildings. Official Gazette of RS. 61/2011. Accessed April 17, 2023. [https://www.paragraf.rs/proписi/pravilnik\\_o\\_energetskoj\\_efikasnosti\\_zgrada.html](https://www.paragraf.rs/proписi/pravilnik_o_energetskoj_efikasnosti_zgrada.html)
- Official Gazette of SFRJ 45/67. 1967. Regulation on minimum technical conditions for the construction of apartments.

**CIP - Каталогизacija у публикацији  
Народна библиотека Србије, Београд**

711.4.01(082)(0.034.2)  
711.4:005.591.6(082)(0.034.2)

INTERNATIONAL Academic Conference on Places  
and Technologies (8 ; 2023 ; Beograd)

Keeping up with technologies to imagine and build  
together sustainable, inclusive, and beautiful cities  
[Elektronski izvor] : proceedings / 8th International  
Academic Conference on Places and Technologies,  
Belgrade, 2023 ; editors Aleksandra Djukić ... [et al.]. -  
Belgrade : University of Belgrade, Faculty of Architecture,  
2024 (Belgrade : University of Belgrade, Faculty of  
Architecture). - 1 USB (fleš memorija) ; 6 x 2 x 1 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovnog  
ekrana. - Tiraž 50. - Abstracts. - Bibliografija uz svaki rad.

**ISBN 978-86-7924-343-0**

1. Đukić, Aleksandra, 1964- [urednik]  
a) Градови - Мултидисциплинарни приступ -  
Зборници б) Урбанистичко планирање -  
Технолошки развој - Зборници

COBISS.SR-ID 143080457

## INVITATION LETTER



PT23

Dear Professor Ljiljana Đukanović,

We are delighted to invite you to participate as an invited speaker at the **8<sup>th</sup> International Academic Conference on Places and Technologies – PT2023**, which will be held on October 19-21, 2023. The conference venue is the University of Belgrade-Faculty of Architecture, Bulevar Kralja Aleksandra 73/2, 11000 Belgrade, Serbia. The topic of the forthcoming conference is “**Keeping up with technologies to imagine and build together sustainable, inclusive, and beautiful cities**”.

The general goal of all PT conferences is to link the different disciplines that tackle **space and technologies**, including successful and holistic concepts in the development, design and construction of cities, buildings and infrastructure that will be able to respond to the future challenges. You are welcome to meet multinational participants from all over Europe and beyond, from different fields.

We look forward to welcoming you as **an invited speaker** who can significantly contribute to PT2023 Conference. This includes the official submission of an authored research (abstract/paper) which should be orally presented at the conference.

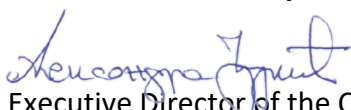
We would be grateful if you could confirm your participation before **the deadline of abstract submission**.

**More information** about the forthcoming PT2023 Conference, topics, and submission details: <https://sites.google.com/view/places-and-technologies/>.

I am looking forward to seeing you at the PT2023 Conference in Belgrade.

Kind regards,

On behalf of PT2023 Organising Committee  
Prof Dr. Aleksandra Djukić



Executive Director of the Conference

Belgrade, February 2023