

The Urban Book Series

Eugenio Arbizzani · Eliana Cangelli ·
Carola Clemente · Fabrizio Cumo ·
Francesca Giofrè · Anna Maria Giovenale ·
Massimo Palme · Spartaco Paris *Editors*

Technological Imagination in the Green and Digital Transition

OPEN ACCESS

 Springer

The Urban Book Series

Editorial Board

Margarita Angelidou, Aristotle University of Thessaloniki, Thessaloniki, Greece

Fatemeh Farnaz Arefian, The Bartlett Development Planning Unit, UCL, Silk Cities, London, UK

Michael Batty, Centre for Advanced Spatial Analysis, UCL, London, UK

Simin Davoudi, Planning & Landscape Department GURU, Newcastle University, Newcastle, UK

Geoffrey DeVerteuil, School of Planning and Geography, Cardiff University, Cardiff, UK

Jesús M. González Pérez, Department of Geography, University of the Balearic Islands, Palma (Mallorca), Spain

Daniel B. Hess , Department of Urban and Regional Planning, University at Buffalo, State University, Buffalo, NY, USA

Paul Jones, School of Architecture, Design and Planning, University of Sydney, Sydney, NSW, Australia

Andrew Karvonen, Division of Urban and Regional Studies, KTH Royal Institute of Technology, Stockholm, Stockholms Län, Sweden

Andrew Kirby, New College, Arizona State University, Phoenix, AZ, USA

Karl Kropf, Department of Planning, Headington Campus, Oxford Brookes University, Oxford, UK

Karen Lucas, Institute for Transport Studies, University of Leeds, Leeds, UK

Marco Maretto, DICATeA, Department of Civil and Environmental Engineering, University of Parma, Parma, Italy

Ali Modarres, Tacoma Urban Studies, University of Washington Tacoma, Tacoma, WA, USA

Fabian Neuhaus, Faculty of Environmental Design, University of Calgary, Calgary, AB, Canada

Steffen Nijhuis, Architecture and the Built Environment, Delft University of Technology, Delft, The Netherlands

Vitor Manuel Araújo de Oliveira , Porto University, Porto, Portugal

Christopher Silver, College of Design, University of Florida, Gainesville, FL, USA

Giuseppe Strappa, Facoltà di Architettura, Sapienza University of Rome, Rome, Roma, Italy

Igor Vojnovic, Department of Geography, Michigan State University, East Lansing, MI, USA

Claudia Yamu, Department of Built Environment, Oslo Metropolitan University, Oslo, Norway

Qunshan Zhao, School of Social and Political Sciences, University of Glasgow, Glasgow, UK

The Urban Book Series is a resource for urban studies and geography research worldwide. It provides a unique and innovative resource for the latest developments in the field, nurturing a comprehensive and encompassing publication venue for urban studies, urban geography, planning and regional development.

The series publishes peer-reviewed volumes related to urbanization, sustainability, urban environments, sustainable urbanism, governance, globalization, urban and sustainable development, spatial and area studies, urban management, transport systems, urban infrastructure, urban dynamics, green cities and urban landscapes. It also invites research which documents urbanization processes and urban dynamics on a national, regional and local level, welcoming case studies, as well as comparative and applied research.

The series will appeal to urbanists, geographers, planners, engineers, architects, policy makers, and to all of those interested in a wide-ranging overview of contemporary urban studies and innovations in the field. It accepts monographs, edited volumes and textbooks.

Indexed by Scopus.

Eugenio Arbizzani · Eliana Cangelli ·
Carola Clemente · Fabrizio Cumo ·
Francesca Giofrè · Anna Maria Giovenale ·
Massimo Palme · Spartaco Paris
Editors

Technological Imagination in the Green and Digital Transition

 Springer

Editors

Eugenio Arbizzani
Dipartimento di Architettura e Progetto
Sapienza University of Rome
Rome, Italy

Eliana Cangelli
Dipartimento di Architettura e Progetto
Sapienza University of Rome
Rome, Italy

Carola Clemente
Dipartimento di Architettura e Progetto
Sapienza University of Rome
Rome, Italy

Fabrizio Cumo
Dipartimento Pianificazione, Design,
Tecnologia dell'Architettura
Sapienza University of Rome
Rome, Italy

Francesca Giofrè
Dipartimento di Architettura e Progetto
Sapienza University of Rome
Rome, Italy

Anna Maria Giovenale
Dipartimento di Architettura e Progetto
Sapienza University of Rome
Rome, Italy

Massimo Palme
Departamento de Arquitectura
Universidad Técnica Federico Santa Maria
Antofagasta, Chile

Spartaco Paris
Dipartimento di Ingegneria Strutturale e
Geotecnica
Sapienza University of Rome
Rome, Italy



ISSN 2365-757X

ISSN 2365-7588 (electronic)

The Urban Book Series

ISBN 978-3-031-29514-0

ISBN 978-3-031-29515-7 (eBook)

<https://doi.org/10.1007/978-3-031-29515-7>

© The Editor(s) (if applicable) and The Author(s) 2023. This book is an open access publication.

Open Access This book is licensed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this book are included in the book's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the book's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Committee

Sapienza University of Rome

DIAP—Department of Architecture and Design

LAB.ITECH—Laboratory of Architecture, Building Innovation and Technology, Environment and Climate Changes, Health

Fondazione Roma Sapienza

International Scientific Committee

David Allison, Clemson University, South Carolina, USA

Ruzica Bozovic-Stamenovic, National University of Singapore, China

Federico Butera, Polytechnic University of Milan, Italy

Orazio Carpenzano, Sapienza University of Rome, Italy

Ljiljana Dukanović, University of Belgrade, Serbia

Peter Droege, University of Liechtenstein, Liechtenstein

Boyan Georgiev, UAGEC-Department of Tecnology, Bulgaria

Anna Maria Giovenale, Sapienza University of Rome, Italy

Mario Losasso, University of Naples Federico II, Italy

Robinson Manguro, Kirinyaga University, Kenya

Saverio Mecca, University of Florence, Italy

Mario Morcellini, Sapienza University of Rome, Italy

Iva Muraj, Faculty of Architecture, University of Zagreb, Croatia

Silvia Naldini, Delft University of Technology, Netherland

Roberto Pagani, Polytechnic University of Turin, Italy

Massimo Palme, Federico Santa Maria Technical University, Valparaiso, Chile

Mario Raul Ramirez de Leon, University of San Carlos Guatemala, USAC, Guatemala

Fabrizio Schiaffonati, Polytechnic University of Milan, Italy

Markus Schwai, Norwegian University of Science and Technology, Norway

Begoña Serrano Lanzarote, Polytechnic University of Valencia, Spain

Wei Xing Shi, Tongji University, China
Belinda Tato, Harvard Graduate School of Design, USA

Scientific Coordination Committee

Eugenio Arbizzani, Sapienza University of Rome
Rosalba Belibani, Sapienza University of Rome
Eliana Cangelli, Sapienza University of Rome
Carola Clemente, Sapienza University of Rome
Fabrizio Cumo, Sapienza University of Rome
Alfonso Giancotti, Sapienza University of Rome
Francesca Giofré, Sapienza University of Rome
Spartaco Paris, Sapienza University of Rome

Organizing Committee

Anna Mangiatordi, Sapienza University of Rome
Elisa Pennacchia, Sapienza University of Rome
Virginia Adele Tiburcio, Sapienza University of Rome

Editorial coordination

Eugenio Arbizzani, Sapienza University of Rome
Anna Mangiatordi, Sapienza University of Rome
Mariangela Zagaria, Sapienza University of Rome

Foreword by Antonella Polimeni

Good afternoon to all participants, ladies and gentlemen, and welcome to Rome.

On behalf of the Community of Sapienza University of Rome, it is a real pleasure to welcome all of you to the first edition of the International Conference “Technological imagination in the green and digital transition”. I am also pleased to give my best welcome to Dr Antonio Parenti, Head of the European Commission Representation in Italy, and to Prof. Mario Losasso, President of the Italian Society of Architectural Technology, as well as to all guests, students and colleagues.

The conference that we are about to open, organised by the Department of Architecture and Design and directed by Prof. Alessandra Capuano in cooperation with Sapienza Foundation, is to be a moment of methodological debate about built environments and the rise of contemporary urban challenges, so engaging for public and private institutions at national and international level.

The proposed key points of this conference—namely Innovation, Technology, Environment, Climate Changes and Health—are all interconnected priorities that cannot be further postponed, representing in the meantime strategic research and education activities for our University, perfectly aligned with the Italian National Recovery and Resilience plan, to be implemented in Italy as well as European member States, in order to overcome the present financial and social challenges.

I truly believe that Universities are, by definition, places of imagination, where planning the future is intended as an unavoidable “existential condition” as well as an essential moment of collective participation for an accomplished society.

Thank you for your attention, and I wish you a fruitful continuation of the conference.

Antonella Polimeni
Magnificent Rector
Sapienza University of Rome
Rome, Italy
antonella.polimeni@uniroma1.it

Foreword by Eugenio Gaudio

My warmest greetings to Dr. Antonio Parenti, Head of the European Commission Representation in Italy, to the President of the Italian Society of Architectural Technology Mario Losasso, to the Director Alessandra Capuano, and to Pietro Montani who will open with a Philosophical Lecture the Conference “Technological imagination in the green and digital transition”.

A special greeting to Prof. Anna Maria Giovenale, my dear colleague and friend, who invited me to be here today. Thank you Anna Maria.

Let me also greet all other speakers as well other participant that will follow this Conference organized by the Department of Architecture and Design, together with the Fondazione Roma Sapienza.

From the very beginning, as President of the Fondazione Roma Sapienza, I supported the initiative of an international Conference on the theme of “Technological Imagination” having clear in mind that human imagination is inseparable from the “technical practice” with which it is entangled from the earliest origins of mankind, as Pietro Montani states in his book, *Technological destinies of the imagination*.

When the contents of the Conference were increasingly defined and focused around the areas of the green and digital transition, I realized that the very core of the Conference was becoming an attempt to respond to the contemporary challenges of the National Recovery and Resilience Plan, in their key role of revitalization for Research and University.

In this sense, the potential of technological culture is reaffirming its role of strategic tool for the conceiving, design and validation of future scenarios.

The sessions into which the Conference is structured, namely: Innovation, Technology, Environment, Climate Changes and Health, identified in order to outline the evolutionary scenarios of architectures and cities, allowing us to reflect at different levels on innovative models of building and management process, as well as design and products.

The goals of promoting digital transformation, supporting innovation in the production system, improving sustainability and ensuring an equitable environmental transition, find their clarification in the elaborations and experimentation presented through the contributions in the different sessions.

Modern technological innovation allowing multiple possibilities in all areas: nowadays digital technologies are enabling us to interact with people and things, all over the world.

There are astonishing, yet untapped potentials, suggesting that digitization, rather than a strict sense adaptive development, should be seen as an important evolutionary phenomenon and in the meantime a great opportunity.

Innovations connected with new technologies can provide to civil society a better quality of life, both at indoor and urban scale settings, addressing scientific development toward an effective culture of sustainability, reuse and security.

The employment of new technologies, a careful approach to the containment of land consumption as well as a careful consideration towards soil coverage modality and urban density, the recycling strategies and technological and typological redevelopment of degraded areas and buildings applying an energetic and eco-systemic approach, are the key elements for the conception of healthy and resilient urban habitats, able to adapt to the present global changes, as well as promoting prosperity, inclusiveness and social equity.

Last but not least, “health” issues, that need to be conceived at the very core of the potential determined by technological innovation and processes of ecological and digital transition.

The structure of the Conference is rooted on all these interrelated themes, and on that same basis also research needs to be reoriented.

I am confident that this first edition of the Technological imagination conference will contribute to pave the way of an innovative and interdisciplinary scientific approach to technology and policies for built environments, considered the real human challenge of the twenty-first century.

Thank you so much for your attention and enjoy the Conference.

Eugenio Gaudio
President
Fondazione Roma Sapienza
Rome, Italy
eugenio.gaudio@uniroma1.it

Foreword by Antonio Parenti

New European Bauhaus

Good morning,

*Magnificent Rector of Sapienza University of Rome Professor Antonella Polimeni
President Fondazione Roma Sapienza Professor Eugenio Gaudio,
Director Department of Architecture and Design Professor Alessandra Capuano
and others.*

Ladies and Gentlemen,

It is my pleasure to address you today and to open this International Conference “Technological Imagination in the digital and green transition” organized by Sapienza University of Rome.

Let me say that the title, the contents, and the proposals envisaged by the Conference match perfectly with the main pillars of the flagship initiative shaped by the President Ursula von der Leyen and launched in September 2021: the New European Bauhaus.

The New European Bauhaus is by nature transdisciplinary: it invites architects, designers, artists, scientists, engineers, artisans and citizens to share their expertise in preparing for the future.

With the New European Bauhaus, we want to make the European Green Deal tangible and “palpable”.

We want to add a cultural dimension to the economic and technological transformation. This is essential to achieve our overarching goal: making Europe the first climate neutral continent by 2050. And thus reconciling our way of life with nature.

To get there, we need both: a real transformation of our economy and society, and a debate about how we can live in respect of nature and our planet.

The historical Bauhaus was founded in Weimar and Dessau. It turned into a worldwide movement. This did not happen by chance. Some ingredients of what made the historical Bauhaus a success can also be an inspiration for the New European Bauhaus.

Let me mention three.

The first ingredient: The historical Bauhaus was created in a time of **profound transformation**. People were facing the challenges of industrialisation. Gropius and the founders wanted to respond to the emerging needs of a new era. They aimed for solutions that were functional, affordable, but also beautiful. With this principle in mind, they shaped buildings, fabrics and furniture. They always aimed higher than just innovative design. The New European Bauhaus is also striving for this mix of aesthetics and affordability. But we want to add another element: sustainability. Because the New European Bauhaus wants to match sustainability with style.

Now, the second ingredient: **The historical Bauhaus boldly promoted new materials like steel and cement**. Today, we also need to look into new building materials. But this time, it is about sustainability. It is about materials that need less CO₂ in their production process. The New European Bauhaus wants to accelerate the transition of the built environment. It wants to scale up nature-based materials, to support circular design and architecture. Buildings are responsible for 40% of our energy consumption. And if we manage to change this, we have a chance to keep global warming below 1.5 degrees.

The third important element from the historical Bauhaus is **interdisciplinarity**. We want to convene people from different backgrounds and with different competences to share and grow their ideas and visions. We can create a better tomorrow, if culture and technology, innovation and design go hand in hand.

For our New European Bauhaus, the European Commission needs scientists, activists, artists, designers, architects and entrepreneurs. We want to include the ideas and perspectives of all ages and all backgrounds.

Today, at this conference we can contribute to this evolving New European Bauhaus network.

This project is a project of hope. It is a project of change and of economic transformation.

So I hope that this conference can contribute further to making the transformation happen and to connecting more and more people who want to make it happen.

Thank you very much and have a great conference.

Antonio Parenti
Head of the European Commission
Representation
Rome, Italy
antonio.parenti@ec.europa.eu

Foreword by Mario Losasso

Presentation of CONF.ITECH 2022

The green and digital transition represent in the contemporary research field the two new challenges for the evolution of technology within the themes of sociotechnical innovation. Consequently, technology and innovation in contemporary world must adapt to this general objective. Innovation in its hard and digital components once again becomes a central factor in the experimental propulsion that the project is assuming within a processuality and technologies that enable its conception and implementation.

Today, research is increasingly characterised by the need to focus on specialisms that lead to and contribute to the advancement of knowledge and the predictive value of what is studied in the disciplinary fields. However, with respect to the evolving complexity of phenomena, research requires continuous disciplinary interactions to be developed because we understand that one disciplinary field cannot alone address the most important challenges of contemporary society.

New forms of coexistence must be organized in a vision of interdependence and connection, while the green transition requires the definition of the limits of design action and the characteristics of the transformation processes. The new perspective of co-evolution will have to express a design attitude that allows to repair and, where necessary, rebuild the lost links between man, technology and nature.

The green and digital transition represent the two new challenges for the evolution of technology within the themes of social innovation. The Italian society of architectural technology SITdA has been working for a long time on the topics of the relationship between technology and urban and building development within a process-oriented and eco-systemic approach. In the field of technological design of architecture, the scientific society of the technology of architecture has activated research and training sensitivities on the themes of design experimentation framed within process and ecosystem dynamics, aimed at optimising the efficiency of products and processes by reducing inefficiencies and waste.

The SITdA supports research and spin-off outcome on territories through the activities of its scientific clusters. The Scientific Society SITdA has granted its patronage to the CONF.ITECH 2022 Conference, sharing its importance and topicality in view of the new challenges identified in the urban construction and environmental fields by the Next Generation EU Programme and the implementation programmes in the various nations of the European Union.

The topics that will be addressed during the three-day conference are fascinating and challenging, linking innovation, technology, environment, climate change and health.

These topics are strongly interrelated themes in which we are realising that it is impossible to deal with them separately, arriving in the most recent reflections at considering a single health for human beings and for the entire environment which is their living environment.

I would like to remind that the topic of digital culture, nature and technology was the central topic of the SITdA Naples 2020 Conference held last July with a delay due to pandemic difficulties, while the 2022 Conference of the Scientific Society is focused on the topic of the centrality of processes. As we can see, the work carried out in the Departments of Architecture and by the Scientific Societies in the area of architecture is an activity that has picked up significantly, foreshadowing new approaches, new fields of enquiry and new paradigms necessary for the new complexities that constitute the reference scenario of the future.

The experience of this Conference can provide a significant contribution to the sustainable and environmental evolution of the design area in its trans-scalar, multidisciplinary and challenging dimension, overcoming technocratic responses to a demand that requires the integration of the humanistic and technical-scientific dimensions.

Mario Losasso
President
Italian Society of Architectural
Technology—SITdA
Rome, Italy
mariorosario.losasso@unina.it

Foreword by Orazio Carpenzano

Welcoming Address from the Dean

On behalf of the Faculty, I wish to thank the organisers for asking me to give this opening address, while congratulating them on their efforts to bring together, in an international encounter, various perspectives on topics of such decisive importance for the future of our respective territories, as well as their people, living organisms and architecture.

My thanks go to Anna Maria Giovenale, Fabrizio Cumo, Eugenio Arbizzani, Carola Clemente, Eliana Cangelli and Francesca Giofrè, who will be giving talks on technological innovation, the environment, climate change and public health.

Thinking of energy in terms of how it relates to architecture during the green and digital transition means cultivating a *technological imagination*, a topic which leads to the broader question of the man–nature relationship and the possibility that architecture, by applying innovative ideas and concepts while promoting a growing social and emotional intelligence of its own, can contribute to inventing of new types of habitat for mankind on the planet earth, under a new pact for survival that allows all elements, both artificial and natural, to coexist in a sustainable balance which can serve as a preventive measure against the intrinsic destructive force of the Cosmos, an especially pressing problem where mankind has neglected certain methods for dissipating the energy of calamitous events made available by both ancient wisdom and scientific advances.

The 2021 Architecture Biennial, entitled “How Will We Live Together?”, implicitly drew the attention of visitors to the need for a new approach to the man–nature relationship, following a thorough review of its historical and ethical premises. Hashim Sarkis, the curator of the exposition’s seventeenth edition, passed on the following message: “In a scenario of exasperated political divisions and growing economic inequality, we call upon architects to imagine spaces in which we can all live in fruitful fellowship”.

The man–nature relationship has always been a distinctive feature of humanistic and artistic thought on things technical, expressed in the construction of the *civitas*, the physical and political synthesis of civilisation. Medieval mysticism viewed nature as a foreboding wilderness, while the Renaissance redeemed the sense of *technè*, and the Romantic Period, with its high-strung, emotive outlook, led to the elaboration of the concept of the sublime.

Controlling and putting to use the energy generated by nature through sources of heat and movement (wind, sun, water), first through manual effort and then using the tools and machines produced by human ingenuity, was also a topic and challenge that led architecture to express, during the Modern Movement, boundless enthusiasm for the theories of Taylorism, which Corbusier summed up by interpreting human dwellings as machines of habitation.

But it is from the time of Vitruvius that architecture, engaged more or less explicitly with the triad of *utilitas-firmitas-venustas*, has addressed the problem of dissipating heat (or thermal inertia), as well as kinetic and elastic energy (in the case of earthquakes), at various latitudes of the globe, drawing on the available resources and raw materials. Historic Italian buildings, for example, built with walls roughly a metre thick and a structural layout measuring 4×4 or 5×5 m, have offered excellent thermo-hygrometric performance (in terms of energy consumption), as well as structural dependability (against seismic risk). In both cases the objective is to “mitigate”, a term used by many modern-day scholars, the dissipation of different types of energy.

The history of architecture is filled with archetypes that need to be updated and reinvented. Think of the ingenuity it took to build Venice atop a giant underwater forest, or the aesthetic quality of the Tu’rat walls constructed by Southern Italian peasants, the windmills of Northern Europe and countless other magnificent examples of *swarm intelligence* collected by Bernard Rudofsky in his well-known book *Architecture without Architects: a short introduction to non-pedigreed architecture*, published by Doubleday & Company Inc., Garden City, (in 1964), following an exhibition at New York’s Museum of Modern Art. Though, in truth, Roberto Pane and Gino Capponi had already touched on the topic in articles on the architecture of Ischia published in “Architettura e Arti decorative” in 1927, as did Giuseppe Pagano at the Milan Triennial “Rural Italian Architecture”, published in the Notebooks of the Milan Triennial by Hoepli in 1936.

Looking beyond the confines of architecture, a recent reconsideration of the topic of Cinema and Energy can provide potentially useful points of affinity with architecture, especially in the collection of essays found in issues 7 and 8 of the periodical *Imago*, under the title *Cinema & Energy. Interdisciplinary Outlooks Combining Science, Aesthetics and Technology*, edited by Marco Maria Gazzano and Enrico Carocci (and published by Bulzoni in 2013). In an essay entitled *Dissipation and Aesthetic Experience*, the physicist Giuseppe Vitiello, in commenting on the film *TransEurope Hotel* by Luigi Cinque, writes: “The brain [which leads me to think of *swarm intelligence*] is described as an open system engaged in continuous exchanges

with its surrounding environment. In both models and films, antinomies such as information/knowledge, feeling/knowing, blend with each other in the aesthetic experience, the favourable connection between ‘me and the object’ that characterises our existential dimension.”

Dissipation, therefore, should be seen as part of the evolution of our ecosystem, of our contemporary habitat. It gauges the possibilities for losing and exchanging, through a rekindling of collective emotional intelligence and technical and intellectual micro-revolutions. It is a risk that we must continue to face, as otherwise architecture will die, depriving man of an indispensable tool for managing the complexity of the physical habitat through creativity, in order to transfigure energy in a way that, at times, can prove so unreal, and yet so effective and indispensable, that it leads to the construction of new values and sublime beauty.

Orazio Carpenzano
Dean
Faculty of Architecture
Sapienza University of Rome
Rome, Italy
orazio.carpenzano@uniroma1.it

Acknowledgments

Thanks to:

The Magnificent Rector of the Sapienza University of Rome, Prof. Antonella Polimeni, and to the President of Foundation of the Sapienza University, Professor Eugenio Gaudio;

Dr. Antonio Parenti, Head of the European Commission's Representation in Italy, to Prof. Mario Losasso, President of the Italian Society of Architectural Technology, and to Prof. Orazio Carpenzano, Dean of Faculty of Architecture of the Sapienza University of Roma;

All the patrons of the conference: the Ministry of Ecological Transition; the European Commission; the Italian Society of Architectural Technology; the European Association for Architectural Education; Eurosolar; Healthy Urban Environment;

The Sponsors: CEFMECTP, the Joint Body for Construction Training and Safety of the City and Province of Rome; the Construction Pension Fund of the City and Province of Rome;

The Scientific Committee, all the reviewers and the Organizing Committee.

Contents

1	From a Liquid Society, Through Technological Imagination, to Beyond the Knowledge Society	1
	Anna Maria Giovenale	
2	Opening Lecture: Digital Spaces and the Material Culture	11
	Pietro Montani	
Part I Session Innovation		
3	Innovation for the Digitization Process of the AECO Sector	21
	Fabrizio Cumo	
4	The Digital Revolution and the Art of Co-creation	27
	Maurizio Talamo	
5	Toward a New Humanism of Technological Innovation in Design of the Built Environment	37
	Spartaco Paris	
6	A BIM-Based Approach to Energy Analysis of Existing Buildings in the Italian Context	47
	Marco Morini, Francesca Caffari, Nicolandrea Calabrese, and Giulia Centi	
7	Short-Term Wind Speed Forecasting Model Using Hybrid Neural Networks and Wavelet Packet Decomposition	57
	Adel Lakzadeh, Mohammad Hassani, Azim Heydari, Farshid Keynia, Daniele Groppi, and Davide Astiaso Garcia	
8	COGNIBUILD: Cognitive Digital Twin Framework for Advanced Building Management and Predictive Maintenance	69
	Sofia Agostinelli	

9 Design of CCHP System with the Help of Combined Chiller System, Solar Energy, and Gas Microturbine 79
Samaneh Safaei, Farshid Keynia, Sam Haghdaday,
Azim Heydari, and Mario Lamagna

10 Digital Construction and Management the Public’s Infrastructures 93
Giuseppe Orsini and Giuseppe Piras

11 An Innovative Multi-objective Optimization Digital Workflow for Social Housing Deep Energy Renovation Design Process 111
Adriana Ciardiello, Jacopo Dell’Olmo, Federica Rosso,
Lorenzo Mario Pastore, Marco Ferrero, and Ferdinando Salata

12 Digital Information Management in the Built Environment: Data-Driven Approaches for Building Process Optimization 123
Francesco Muzi, Riccardo Marzo, and Francesco Nardi

13 Immersive Facility Management—A Methodological Approach Based on BIM and Mixed Reality for Training and Maintenance Operations 133
Sofia Agostinelli and Benedetto Nastasi

14 A Digital Information Model for Coastal Maintenance and Waterfront Recovery 145
Francesca Ciampa

15 Sustainable Workplace: Space Planning Model to Optimize Environmental Impact 157
Alice Paola Pomè, Chiara Tagliaro, and Andrea Ciaramella

16 Digital Twin Models Supporting Cognitive Buildings for Ambient Assisted Living 167
Alessandra Corneli, Leonardo Binni, Berardo Naticchia,
and Massimo Vaccarini

17 Less Automation More Information: A Learning Tool for a Post-occupancy Operation and Evaluation 179
Chiara Tonelli, Barbara Cardone, Roberto D’Autilia,
and Giuliana Nardi

18 A Prosumer Approach for Feeding the Digital Twin. Testing the MUST Application in the Old Harbour Waterfront of Genoa 193
Serena Viola, Antonio Novellino, Alberto Zinno,
and Marco Di Ludovico

19 Untapping the Potential of the Digital Towards the Green Imperative: The Interdisciplinary BeXLab Experience 203
 Gisella Calcagno, Antonella Trombadore, Giacomo Pierucci, and Lucia Montoni

20 Digital—Twin for an Innovative Waterfront Management Strategy. Pilot Project DSH2030 217
 Maria Giovanna Pacifico, Maria Rita Pinto, and Antonio Novellino

21 BIM and BPMN 2.0 Integration for Interoperability Challenge in Construction Industry 227
 Hosam Al-Siah and Antonio Fioravanti

22 Digital Twin Approach for Maintenance Management 237
 Massimo Lauria and Maria Azzalin

23 Digital Infrastructure for Student Accommodation in European University Cities: The “HOME” Project 247
 Oscar Eugenio Bellini, Matteo Gambaro, Maria Teresa Gullace, Marianna Arcieri, Carla Álvarez Benito, Sabri Ben Rommane, Steven Boon, and Maria F. Figueira

Part II Session | Technology

24 Technologies for the Construction of Buildings and Cities of the Near Future 263
 Eugenio Arbizzani

25 The Living Lab for Autonomous Driving as Applied Research of MaaS Models in the Smart City: The Case Study of MASA—Modena Automotive Smart Area 273
 Francesco Leali and Francesco Pasquale

26 Expanding the Wave of Smartness: Smart Buildings, Another Frontier of the Digital Revolution 285
 Valentina Frighi

27 Sharing Innovation. The Acceptability of Off-site Industrialized Systems for Housing 295
 Gianluca Pozzi, Giulia Vignati, and Elisabetta Ginelli

28 3D Printing for Housing. Recurring Architectural Themes 309
 Giulio Paparella and Maura Percoco

29 Photovoltaic Breakthrough in Architecture: Integration and Innovation Best Practice 321
 Guido Callegari, Eleonora Merolla, and Paolo Simeone

30 Reworking Studio Design Education Driven by 3D Printing Technologies 335
 Jelena Milošević, Aleksandra Nenadović, Maša Žujović,
 Marko Gavrilović, and Milijana Živković

31 The New Technological Paradigm in the Post-digital Era. Three Convergent Paths Between Creative Action and Computational Tools 345
 Roberto Bianchi

32 Technological Innovation for Circularity and Sustainability Throughout Building Life Cycle: Policy, Initiatives, and Stakeholders’ Perspective 357
 Serena Giorgi

33 Fair Play: Why Reliable Data for Low-Tech Construction and Non-conventional Materials Are Needed 367
 Redina Mazelli, Martina Bocci, Arthur Bohn,
 Edwin Zea Escamilla, Guillaume Habert, and Andrea Bocco

Part III Session | Environment

34 Technological Innovation for the Next Ecosystem Transition: From a High-Tech to Low-Tech Intensity—High Efficiency Environment 383
 Carola Clemente

35 Technological Imagination to Stay Within Planetary Boundaries 391
 Massimo Palme

36 Quality-Based Design for Environmentally Conscious Architecture 399
 Helena Coch Roura and Pablo Garrido Torres

37 Digital Transformation Projects for the Future Digicircular Society 403
 Irene Fiesoli

38 The Regulatory Apparatus at the Service of Sustainable Planning of the Built Environment: The Case of Law 338/2000 ... 417
 Claudio Piferi

39 From Nature to Architecture for Low Tech Solutions: Biomimetic Principles for Climate-Adaptive Building Envelope ... 429
 Francesco Sommese and Gigliola Ausiello

40 Soft Technologies for the Circular Transition: Practical Experimentation of the Product “Material Passport” 439
 Tecla Caroli

41 Imagining a Carbon Neutral University 449
 Antonella Violano and Monica Cannaviello

42 Life Cycle Assessment at the Early Stage of Building Design 461
 Anna Dalla Valle

**43 Design Scenarios for a Circular Vision of Post-disaster
 Temporary Settlements** 471
 Maria Vittoria Arnetoli and Roberto Bologna

**44 Towards Climate Neutrality: Progressing Key Actions
 for Positive Energy Districts Implementation** 483
 Rosa Romano, Maria Beatrice Andreucci,
 and Emanuela Giancola

**45 Remanufacturing Towards Circularity in the Construction
 Sector: The Role of Digital Technologies** 493
 Nazly Atta

**46 Territorial Energy Potential for Energy Community
 and Climate Mitigation Actions: Experimentation on Pilot
 Cases in Rome** 505
 Paola Marrone and Ilaria Montella

**47 Integrated Design Approach to Build a Safe and Sustainable
 Dual Intended Use Center in Praslin Island, Seychelles** 523
 Vincenzo Gattulli, Elisabetta Palumbo, and Carlo Vannini

Part IV Session | Climate Changes

48 Climate Change: New Ways to Inhabit the Earth 537
 Eliana Cangelli

**49 The Climate Report Informing the Response to Climate
 Change in Urban Development** 547
 Anna Pirani

**50 The Urban Riverfront Greenway: A Linear Attractor
 for Sustainable Urban Development** 557
 Luciana Mastrodonardo

**51 The Buildings Reuse for a Music District Aimed
 at a Sustainable Urban Development** 567
 Donatella Radogna

**52 Environmental Design for a Sustainable District and Civic
 Hub** 577
 Elena Mussinelli, Andrea Tartaglia, and Giovanni Castaldo

53 Earth Observation Technologies for Mitigating Urban Climate Changes 589
 Federico Cinquepalmi and Giuseppe Piras

54 A Systematic Catalogue of Design Solutions for the Regeneration of Urban Environment Contrasting the Climate Change Impact 601
 Roberto Bologna and Giulio Hasanaj

55 Digital Twins for Climate-Neutral and Resilient Cities. State of the Art and Future Development as Tools to Support Urban Decision-Making 617
 Guglielmo Ricciardi and Guido Callegari

56 The Urban Potential of Multifamily Housing Renovation 627
 Laura Daglio

57 A “Stepping Stone” Approach to Exploiting Urban Density 639
 Raffaella De Martino, Rossella Franchino, and Caterina Frettoloso

58 Metropolitan Farms: Long Term Agri-Food Systems for Sustainable Urban Landscapes 649
 Giancarlo Paganin, Filippo Orsini, Marco Migliore, Konstantinos Venis, and Matteo Poli

59 Resilient Design for Outdoor Sports Infrastructure 659
 Silvia Battaglia, Marta Cognigni, and Maria Pilar Vettori

60 Sustainable Reuse Indicators for Ecclesiastic Built Heritage Regeneration 669
 Maria Rita Pinto, Martina Bosone, and Francesca Ciampa

61 A Green Technological Rehabilitation of the Built Environment. From Public Residential Estates to Eco-Districts ... 683
 Lidia Errante

62 Adaptive Building Technologies for Building Envelopes Under Climate Change Conditions 695
 Martino Milardi

63 The Importance of Testing Activities for a “New” Generation of Building Envelope 703
 Martino Milardi, Evelyn Grillo, and Mariateresa Mandaglio

64 Data Visualization and Web-Based Mapping for SGDs and Adaptation to Climate Change in the Urban Environment ... 715
 Maria Canepa, Adriano Magliocco, and Nicola Pisani

65 Fog Water Harvesting Through Smart Façade for a Climate Resilient Built Environment 725
 Maria Giovanna Di Bitonto, Alara Kutlu, and Alessandra Zanelli

66 Building Façade Retrofit: A Comparison Between Current Methodologies and Innovative Membranes Strategies for Overcoming the Existing Retrofit Constraints 735
 Giulia Procaccini and Carol Monticelli

67 Technologies and Solutions for Collaborative Processes in Mutating Cities 745
 Daniele Fanzini, Irina Rotaru, and Nour Zreika

68 New Perspectives for the Building Heritage in Depopulated Areas: A Methodological Approach for Evaluating Sustainable Reuse and Upcycling Strategies 757
 Antonello Monsù Scolaro, Stefania De Medici, Salvatore Giuffrida, Maria Rosa Trovato, Cheren Cappello, Ludovica Nasca, and Fuat Emre Kaya

69 Climate Adaptation in Urban Regeneration: A Cross-Scale Digital Design Workflow 769
 Michele Morganti and Diletta Ricci

70 Adaptive “Velari” 783
 Alberto Raimondi and Laura Rosini

71 Temporary Climate Change Adaptation: 5 Measures for Outdoor Spaces of the Mid-Adriatic City 801
 Timothy Daniel Brownlee

72 A Serious Game Proposal for Exploring and Designing Urban Sustainability 811
 Manuela Romano and Alessandro Rogora

73 Energy Efficiency Improvement in Industrial Brownfield Heritage Buildings: Case Study of “Beko” 821
 Jelena Pavlović, Ana Šabanović, and Nataša Ćuković-Ignjatović

74 Industrial Heritage of Belgrade: Brownfield Sites Revitalization Status, Potentials and Opportunities Missed 831
 Jelena Pavlović, Ana Šabanović, and Nataša Ćuković-Ignjatović

75 Challenges and Potentials of Green Roof Retrofit: A Case Study 843
 Nikola Miletić, Bojana Zeković, Nataša Ćuković Ignjatović, and Dušan Ignjatović

76 Designing with Nature Climate-Resilient Cities: A Lesson from Copenhagen 853
 Maicol Negrello

77 New Urban Centralities: Universities as a Paradigm for a Sustainable City 863
Camilla Maitan and Emilio Faroldi

Part V Session | Health

78 Environment for Healthy Living 875
Francesca Giofrè

79 New Paradigms for Indoor Healthy Living 883
Alberto De Capua

80 Healthy and Empowering Life in Schoolyards. The Case of Dante Alighieri School in Milan 893
Valentina Dessì, Maria Fianchini, Franca Zuccoli, Raffaella Colombo, and Noemi Morrone

81 Design for Emergency: Inclusive Housing Solution 907
Francesca Giglio and Sara Sansotta

82 Environmental Sensing and Simulation for Healthy Districts: A Comparison Between Field Measurements and CFD Model 921
Matteo Giovanardi, Matteo Trane, and Riccardo Pollo

83 A Synthesis Paradigm as a Way of Bringing Back to Life the Artistic Monuments Inspired by the Motives of the People’s Liberation Struggle and Revolution of Yugoslavia 935
Meri Batakoja and Tihana Hrastar

84 Social Sustainability and Inclusive Environments in Neighbourhood Sustainability Assessment Tools 947
Rosaria Revellini

85 Inclusive Neighborhoods in a Healthy City: Walkability Assessment and Guidance in Rome 959
Mohamed Eledeisy

86 Tools and Strategies for Health Promotion in Urban Context: Technology and Innovation for Enhancing Parish Ecclesiastical Heritage Through Sport and Inclusion 969
Francesca Daprà, Davide Allegri, and Erica Isa Mosca

87 Nursing Homes During COVID-19 Pandemic—A Systematic Literature Review for COVID-19 Proof Architecture Design Strategies 981
Silvia Mangili, Tianzhi Sun, and Alexander Achille Johnson

88 A New Generation of Territorial Healthcare Infrastructures After COVID-19. The Transition to Community Homes and Community Hospitals into the Framework of the Italian Recovery Plan 991
Andrea Brambilla, Erica Brusamolín, Stefano Arruzzoli, and Stefano Capolongo

89 Wood Snoezelen. Multisensory Wooden Environments for the Care and Rehabilitation of People with Severe and Very Severe Cognitive Disabilities 1003
Agata Tonetti and Massimo Rossetti

90 The Proximity of Urban Green Spaces as Urban Health Strategy to Promote Active, Inclusive and Salutogenic Cities 1017
Maddalena Buffoli and Andrea Rebecchi

91 Environmental Attributes for Healthcare Professional’s Well-Being 1029
Zakia Hammouni and Walter Wittich

Contributors

- Sofia Agostinelli** Sapienza University of Rome, Rome, Italy
- Hosam Al-Siah** Sapienza University of Rome, Rome, Italy
- Davide Allegri** Polytechnic University of Milan, Milan, Italy
- Maria Beatrice Andreucci** Sapienza University of Rome, Rome, Italy
- Eugenio Arbizzani** Sapienza University of Rome, Rome, Italy
- Marianna Arcieri** Polytechnic University of Milan, Milan, Italy
- Maria Vittoria Arnetoli** University of Florence, Florence, Italy
- Stefano Arruzzoli** Polytechnic University of Milan, Milan, Italy
- Davide Astiaso Garcia** Sapienza University of Rome, Rome, Italy
- Nazly Atta** Polytechnic University of Milan, Milan, Italy
- Gigliola Ausiello** University of Naples Federico II, Naples, Italy
- Maria Azzalin** Mediterranean University of Reggio Calabria, Reggio Calabria, Italy
- Meri Batakoja** Ss. Cyril and Methodius University, Skopje, North Macedonia
- Silvia Battaglia** Polytechnic University of Milan, Milan, Italy
- Oscar Eugenio Bellini** Polytechnic University of Milan, Milan, Italy
- Carla Álvarez Benito** European University Foundation (EUF), Brussels, Belgium
- Roberto Bianchi** Mercatorum University, Rome, Italy
- Leonardo Binni** Polytechnic University of Marche, Ancona, Italy
- Martina Bocci** Polytechnic University of Turin, Turin, Italy
- Andrea Bocco** Polytechnic University of Turin, Turin, Italy

- Arthur Bohn** Polytechnic University of Turin, Turin, Italy
- Roberto Bologna** University of Florence, Florence, Italy
- Steven Boon** Housing Anywhere, Rotterdam, Netherlands
- Martina Bosone** Research Institute on Innovation and Services for Development of the Italian National Research Council (CNR-IRISS), Naples, Italy
- Andrea Brambilla** Polytechnic University of Milan, Milan, Italy
- Timothy Daniel Brownlee** University of Camerino, Camerino, Italy
- Erica Brusamolín** Polytechnic University of Milan, Milan, Italy
- Maddalena Buffoli** Polytechnic University of Milan, Milan, Italy
- Francesca Caffari** ENEA, Rome, Italy
- Nicolandrea Calabrese** ENEA, Rome, Italy
- Gisella Calcagno** University of Florence, Florence, Italy
- Guido Callegari** Polytechnic University of Turin, Turin, Italy
- Maria Canepa** University of Genoa, Genoa, Italy
- Eliana Cangelli** Sapienza University of Rome, Rome, Italy
- Monica Cannaviello** University of Campania “L. Vanvitelli”, Aversa, Italy
- Stefano Capolongo** Polytechnic University of Milan, Milan, Italy
- Cheren Cappello** University of Sassari, Sassari, Italy
- Barbara Cardone** University of Roma Tre, Rome, Italy
- Tecla Caroli** Polytechnic University of Milan, Milan, Italy
- Giovanni Castaldo** Polytechnic University of Milan, Milan, Italy
- Giulia Centi** ENEA, Rome, Italy
- Francesca Ciampa** University of Naples Federico II, Naples, Italy
- Andrea Ciaramella** Polytechnic University of Milan, Milan, Italy
- Adriana Ciardiello** Sapienza University of Rome, Rome, Italy
- Federico Cinquepalmi** Sapienza University of Rome, Rome, Italy
- Carola Clemente** Sapienza University of Rome, Rome, Italy
- Marta Cognigni** Polytechnic University of Milan, Milan, Italy
- Raffaella Colombo** Istituto Comprensivo Rinnovata Pizzigoni, Milan, Italy
- Alessandra Corneli** Polytechnic University of Marche, Ancona, Italy

- Nataša Ćuković-Ignjatović** University of Belgrade, Belgrade, Serbia
- Fabrizio Cumo** Sapienza University of Rome, Rome, Italy
- Laura Daglio** Polytechnic University of Milan, Milan, Italy
- Anna Dalla Valle** Polytechnic University of Milan, Milan, Italy
- Francesca Daprà** Polytechnic University of Milan, Milan, Italy
- Roberto D’Autilia** University of Roma Tre, Rome, Italy
- Alberto De Capua** Mediterranea University of Reggio Calabria, Reggio Calabria, Italy
- Jacopo Dell’Olmo** Sapienza University of Rome, Rome, Italy
- Valentina Dessì** Polytechnic University of Milan, Milan, Italy
- Raffaella De Martino** University of Campania L. Vanvitelli, Aversa, Italy
- Stefania De Medici** University of Catania, Catania, Italy
- Maria Giovanna Di Bitonto** Polytechnic University of Milan, Milan, Italy
- Marco Di Ludovico** University of Naples Federico II, Naples, Italy
- Mohamed Eledeisy** Sapienza University of Rome, Rome, Italy
- Lidia Errante** Mediterranea University of Reggio Calabria, Reggio Calabria, Italy
- Daniele Fanzini** Polytechnic University of Milan, Milan, Italy
- Emilio Faroldi** Polytechnic University of Milan, Milan, Italy
- Marco Ferrero** Sapienza University of Rome, Rome, Italy
- Maria Fianchini** Polytechnic University of Milan, Milan, Italy
- Irene Fiesoli** University of Florence, Florence, Italy
- Maria F. Figueira** International Union of Property Owners (UIPI), Brussels, Belgium
- Antonio Fioravanti** Sapienza University of Rome, Rome, Italy
- Rossella Franchino** University of Campania L. Vanvitelli, Aversa, Italy
- Caterina Frettoloso** University of Campania L. Vanvitelli, Aversa, Italy
- Valentina Frighi** University of Ferrara, Ferrara, Italy
- Matteo Gambaro** Polytechnic University of Milan, Milan, Italy
- Pablo Garrido Torres** Universitat Politècnica de Catalunya, Barcelona, Spain
- Vincenzo Gattulli** Sapienza University of Rome, Rome, Italy
- Marko Gavrilović** University of Belgrade, Belgrade, Serbia

- Emanuela Giancola** UiE3-CIEMAT, Madrid, Spain
- Francesca Giglio** Mediterranea University of Reggio Calabria, Reggio Calabria, Italy
- Elisabetta Ginelli** Polytechnic University of Milan, Milan, Italy
- Francesca Giofrè** Sapienza University of Rome, Rome, Italy
- Serena Giorgi** Polytechnic University of Milan, Milan, Italy
- Matteo Giovanardi** Polytechnic University of Turin, Turin, Italy
- Anna Maria Giovenale** Sapienza University of Rome, Rome, Italy
- Salvatore Giuffrida** University of Catania, Catania, Italy
- Evelyn Grillo** Mediterranea University of Reggio Calabria, Reggio Calabria, Italy
- Daniele Groppi** Sapienza University of Rome, Rome, Italy
- Maria Teresa Gullace** Polytechnic University of Milan, Milan, Italy
- Guillaume Habert** ETH Zürich, Zürich, Switzerland
- Sam Haghdamy** Islamic Azad University, Mashhad, Iran
- Zakia Hammouni** CRIR (Centre for Interdisciplinary Rehabilitation Research of Greater Montréal), Université de Montréal, Montréal, Canada;
Université McGill, Montréal, Canada;
Université du Québec à Trois-Rivière, Trois-Rivière, Canada
- Giulio Hasanaj** University of Florence, Florence, Italy
- Mohammad Hassani** Islamic Azad University, Kerman Branch, Iran
- Tihana Hrastar** University of Zagreb, Zagreb, Croatia
- Azim Heydari** Sapienza University of Rome, Rome, Italy;
Graduate University of Advanced Technology, Kerman, Iran
- Dušan Ignjatović** University of Belgrade – Faculty of Architecture, Belgrade, Serbia
- Nataša Ćuković Ignjatović** University of Belgrade – Faculty of Architecture, Belgrade, Serbia
- Alexander Achille Johnson** Vagelos College of Physicians and Surgeons, Columbia University, New York, USA
- Fuat Emre Kaya** University of Sassari, Sassari, Italy
- Farshid Keynia** Graduate University of Advanced Technology, Kerman, Iran
- Alara Kutlu** Polytechnic University of Milan, Milan, Italy
- Adel Lakzadeh** Islamic Azad University, Kerman Branch, Iran

- Mario Lamagna** Sapienza University of Rome, Rome, Italy
- Massimo Lauria** Mediterranean University of Reggio Calabria, Reggio Calabria, Italy
- Francesco Leali** UNIMORE, Modena, Italy
- Adriano Magliocco** University of Genoa, Genoa, Italy
- Camilla Maitan** Polytechnic University of Milan, Milan, Italy
- Mariateresa Mandaglio** Mediterranea University of Reggio Calabria, Reggio Calabria, Italy
- Silvia Mangili** Polytechnic University of Milan, Milan, Italy
- Paola Marrone** University of Roma Tre, Rome, Italy
- Riccardo Marzo** NCLAB, Rome, Italy
- Luciana Mastrodonato** University G. d'Annunzio, Pescara, Italy
- Redina Mazelli** Polytechnic University of Turin, Turin, Italy
- Eleonora Merolla** Polytechnic University of Turin, Turin, Italy
- Marco Migliore** Polytechnic University of Milan, Milan, Italy
- Martino Milardi** Mediterranea University of Reggio Calabria, Reggio Calabria, Italy
- Nikola Miletić** University of Belgrade – Faculty of Architecture, Belgrade, Serbia
- Jelena Milošević** University of Belgrade, Belgrade, Serbia
- Pietro Montani** Honorary Professor of Aesthetics, Sapienza University of Rome, Rome, Italy
- Ilaria Montella** University of Roma Tre, Rome, Italy
- Carol Monticelli** Polytechnic University of Milan, Milan, Italy
- Lucia Montoni** University of Florence, Florence, Italy
- Michele Morganti** Sapienza University of Rome, Rome, Italy
- Marco Morini** ENEA, Rome, Italy
- Noemi Morrone** Istituto Comprensivo Rinnovata Pizzigoni, Milan, Italy
- Erica Isa Mosca** Polytechnic University of Milan, Milan, Italy
- Elena Mussinelli** Polytechnic University of Milan, Milan, Italy
- Francesco Muzi** Sapienza University of Rome, Rome, Italy
- Francesco Nardi** NCLAB, Rome, Italy

- Giuliana Nardi** University of Roma Tre, Rome, Italy
- Ludovica Nasca** University of Catania, Catania, Italy
- Benedetto Nastasi** Sapienza University of Rome, Rome, Italy
- Berardo Naticchia** Polytechnic University of Marche, Ancona, Italy
- Maicol Negrello** Polytechnic University of Turin, Turin, Italy
- Aleksandra Nenadović** University of Belgrade, Belgrade, Serbia
- Antonio Novellino** ETT SpA, Genoa, Italy
- Filippo Orsini** Polytechnic University of Milan, Milan, Italy
- Giuseppe Orsini** Sapienza University of Rome, Rome, Italy
- Maria Giovanna Pacifico** University of Naples Federico II, Naples, Italy
- Giancarlo Paganin** Polytechnic University of Milan, Milan, Italy
- Massimo Palme** Universidad Técnica Federico Santa María, Valparaíso, Chile
- Elisabetta Palumbo** University of Bergamo, Bergamo, Italy
- Giulio Paparella** Sapienza University of Rome, Rome, Italy
- Spartaco Paris** Sapienza University of Rome, Rome, Italy
- Francesco Pasquale** UNIMORE, Modena, Italy
- Lorenzo Mario Pastore** Sapienza University of Rome, Rome, Italy
- Jelena Pavlović** University of Belgrade, Belgrade, Serbia
- Maura Percoco** Sapienza University of Rome, Rome, Italy
- Giacomo Pierucci** University of Florence, Florence, Italy
- Claudio Piferi** University of Florence, Florence, Italy
- Maria Rita Pinto** University of Naples Federico II, Naples, Italy
- Anna Pirani** Centre for Theoretical Physics, Trieste, Italy
- Giuseppe Piras** Sapienza University of Rome, Rome, Italy
- Nicola Pisani** Colouree S.r.l., Genoa, Italy
- Matteo Poli** Polytechnic University of Milan, Milan, Italy
- Riccardo Pollo** Polytechnic University of Turin, Turin, Italy
- Alice Paola Pomè** Polytechnic University of Milan, Milan, Italy
- Gianluca Pozzi** Polytechnic University of Milan, Milan, Italy
- Giulia Procaccini** Polytechnic University of Milan, Milan, Italy

Donatella Radogna University “G. D’Annunzio” of Chieti-Pescara, Pescara, Italy

Alberto Raimondi University of Roma Tre, Rome, Italy

Andrea Rebecchi Polytechnic University of Milan, Milan, Italy

Rosaria Revellini IUAV University of Venice, Venice, Italy

Diletta Ricci Sapienza University of Rome, Rome, Italy;
Delft University of Technology, Delft, Netherlands

Guglielmo Ricciardi Polytechnic University of Turin, Turin, Italy

Alessandro Rogora Polytechnic University of Milan, Milan, Italy

Manuela Romano Polytechnic University of Milan, Milan, Italy

Rosa Romano University of Florence, Florence, Italy

Sabri Ben Rommane Erasmus Student Network AISBL (ESN), Brussels, Belgium

Laura Rosini University of Roma Tre, Rome, Italy

Massimo Rossetti IUAV University of Venice, Venice, Italy

Federica Rosso Sapienza University of Rome, Rome, Italy

Irina Rotaru Saint Germain-en-Laye, France

Helena Coch Roura Universitat Politècnica de Catalunya, Barcelona, Spain

Ana Šabanović University of Belgrade, Belgrade, Serbia

Samaneh Safaei Graduate University of Advanced Technology, Kerman, Iran

Ferdinando Salata Sapienza University of Rome, Rome, Italy

Sara Sansotta Mediterranean University of Reggio Calabria, Reggio Calabria, Italy

Antonello Monsù Scolaro University of Sassari, Sassari, Italy

Paolo Simeone Polytechnic University of Turin, Turin, Italy

Francesco Sommese University of Naples Federico II, Naples, Italy

Tianzhi Sun Polytechnic University of Milan, Milan, Italy

Chiara Tagliaro Polytechnic University of Milan, Milan, Italy

Maurizio Talamo Tor Vergata University of Rome, Rome, Italy

Andrea Tartaglia Polytechnic University of Milan, Milan, Italy

Chiara Tonelli University of Roma Tre, Rome, Italy

Agata Tonetti IUAV University of Venice, Venice, Italy

Matteo Trane Polytechnic University of Turin, Turin, Italy

- Antonella Trombadore** University of Florence, Florence, Italy
- Maria Rosa Trovato** University of Catania, Catania, Italy
- Massimo Vaccarini** Polytechnic University of Marche, Ancona, Italy
- Carlo Vannini** Sapienza University of Rome, Rome, Italy
- Konstantinos Venis** Polytechnic University of Milan, Milan, Italy
- Maria Pilar Vettori** Polytechnic University of Milan, Milan, Italy
- Giulia Vignati** Polytechnic University of Milan, Milan, Italy
- Serena Viola** University of Naples Federico II, Naples, Italy
- Antonella Violano** University of Campania “L. Vanvitelli”, Aversa, Italy
- Walter Wittich** CRIR (Centre for Interdisciplinary Rehabilitation Research of Greater Montréal), Université de Montréal, Montréal, Canada
- Alessandra Zanelli** Polytechnic University of Milan, Milan, Italy
- Edwin Zea Escamilla** ETH Zürich, Zürich, Switzerland
- Bojana Zeković** University of Belgrade – Faculty of Architecture, Belgrade, Serbia
- Alberto Zinno** Stress Scarl, Naples, Italy
- Nour Zreika** Polytechnic University of Milan, Milan, Italy
- Franca Zuccoli** University of Milano-Bicocca, Milan, Italy
- Milijana Živković** University of Belgrade, Belgrade, Serbia
- Maša Žujović** University of Belgrade, Belgrade, Serbia

Chapter 74

Industrial Heritage of Belgrade: Brownfield Sites Revitalization Status, Potentials and Opportunities Missed



Jelena Pavlović, Ana Šabanović, and Nataša Ćuković-Ignjatović

Abstract Being created during the period of intensive industrialization, industrial buildings and landscapes carry importance as birth places of rapid technological progress, social and economic changes, which has established their great significance for modern human history and identity. Termination of their active function causes symptoms of decline to appear gradually, and their number decreases as the time passes. They are often endangered regardless of their protection status. Implementation of adaptive reuse principles allows for less strict approach to conservation practice, and its benefits are demonstrated worldwide. Despite that fact, industrial heritage has not been revitalized enough through adequately treated sites in Serbia. That indicates lack of understanding of the value of this cultural and historical heritage, as well as its suitable future purposes, impossible without some form of active dialog between participants in the planning process. The legal preconditions for this collaboration exist in Serbian regulations, and they are examined in the paper, but other potential causes of the lack of consensus that result in failure are also explored. In Belgrade, industrial brownfields occupy attractive locations, often targeted for market-driven redevelopment. For that reason, the paper explores current practice of revitalizing brownfield sites of industrial heritage in Belgrade. It considers the achievements, probable missed opportunities, and remaining potentials where acquired knowledge can be utilized. Key results of the research define critical points in the planning process for the preservation of values despite the modernity of brownfield sites transformations. The purpose of this paper is to help safeguard industrial landscapes of Belgrade and Serbia, and their sustainable conversion, the most adequate for the present moment, as well as to contribute to urban reconstruction of declining landscapes to which these brownfield sites belong.

J. Pavlović (✉) · A. Šabanović · N. Ćuković-Ignjatović
University of Belgrade, Belgrade, Serbia
e-mail: j.pavlovic.phd@edu.arh.bg.ac.rs

A. Šabanović
e-mail: ana.sabanovic@arh.bg.ac.rs

N. Ćuković-Ignjatović
e-mail: natasa@arh.bg.ac.rs

Keywords Sustainability · Industrial heritage · Brownfield · Revitalization

74.1 Introduction

The historical phenomenon that began with the industrial revolution has affected the entire world and its consequences continue to this day. It represents a period of accelerated social and economic changes, mechanization of production, and the transition from fragmented manufacturing to purpose-built factories with specialized production. The interconnectedness of the development of cities and industry is unquestionable and complementary. However, the restructuring of the economy and the change in the production processes triggered the industrial decline. In Serbia, overall conditions of socioeconomic transition and the failed processes of privatization of publicly owned enterprises caused the withdrawal of industrial production, thus creating deteriorating industrial brownfields. Numerous examples are situated in today's urban areas, having lost their previous purpose, or adequacy for contemporary requirements. They have great potential for improving the local context in social, economic, and environmental terms through interventions in the form of adaptive reuse and are therefore important for sustainable urban development. Supporting industrial landscapes and their conversion offers significant opportunities for the urban context and preserving cultural identity. Enhancing the vitality of the sites enables urban reconstruction of declining landscapes to which these brownfield sites belong.

Furthermore, it supports the responsible attitude toward resources, including energy and spatial resources, which represents an important aspect of climate change mitigation concept.

The paper is considering characteristics of industrial brownfields and the revitalization process. Due to the particularities, it requires responsible management that includes a participative planning process, clearly defined responsibilities, and targeted investments for each individual case. Various data on industrial heritage sites in Belgrade are analyzed, providing a multi-layered image and identifying potentials for intervention, both in legislation and in practice.

74.1.1 *Industrial Architecture*

Even the earliest examples of industrial buildings indicate high quality of elements with the design following the functional aspects. Improvement of building materials led to the discovery of newer structural systems that bridged ever-increasing spans and enabled the creation of new spatial effects. Although depending on the function, the artistic aspect cannot be a neglected part of industrial architectural design since it acts psychologically by stimulating esthetic feelings or causing resistance to its evaluation. (Mirković 1964).

Extensive studies have been conducted on industrial heritage buildings of Serbia built before the Second World War, while even significant buildings built afterward are less often subject of research. This is mostly due to them being a priori excluded (Kadijević 2012), or insufficient time has passed for them to be evaluated. In contrast, examples of good practice in neighboring European countries show the introduction of legal protection for historic industrial buildings as soon as signs of decline in their function are noticed.

The role of public participation of the local community is important in that because timely reaction and establishing financial resources can prevent deterioration of industrial sites where the loss of the original purpose is recorded. At the same time, this increases the chances of a higher success rate of reactivation success, which directly corresponds to the fulfillment of the principles of sustainability.

Architectural transformation involving improvements intended for contemporary purposes and requirements, that preserve the cultural feats of built heritage, listed or not, represents the concept of adaptive reuse. Due to its proven potentials, it is recognized within the heritage charters regarding industrial architecture, such as the Dublin Principles (International Council on Monuments and Sites (ICOMOS) 2011), as well as international architectural heritage conventions, such as the Leeuwarden Declaration (Architects' Council of Europe (ACE) 2018). It contributes to heritage preservation, urban sustainability as well as the environment.

74.2 Brownfield Locations and Their Revitalization

Brownfield revival addresses numerous problems regarding the environment. Most importantly, it supports rational use of the finite green areas, as well as decontamination—which is implied in the process of industrial brownfield redevelopment. It also offers significant contribution to socioeconomic improvements, and cultural identity preservation.

Emphasizing the sustainable use of natural and cultural heritage and natural resources, the “Spatial Development Strategy of the Republic of Serbia 2009–2013—2020” (Ministarstvo životne sredine i prostornog planiranja 2009) was adopted in 2009. It recognized the importance of utilizing brownfields and set brownfield recycling as one of fourteen key strategic priorities to help urban renewal and solving numerous economic, social, and environmental problems, preventing excessive urbanization and conversion of fertile agricultural land for construction purposes.

In 2019, a new National Strategy of Sustainable Urban Development of the Republic of Serbia until 2030 (Official Gazette of RS 2019) was adopted, in accordance with the New Urban Agenda (United Nations 2017), with accent on the Goal 11—“Make cities and human settlements inclusive, safe, resilient and sustainable,” from the 17 Sustainable Development Goals (United Nations 2015). Recycling the

existing architectural heritage by revitalizing brownfield sites represents a vast potential for lessening the stress put on greenfield construction, ultimately attenuating the effects of climate change. The National Strategy served to create a legislative framework for the utilization of existing urban assets with the aid of stakeholders' participation.

74.2.1 Jurisdiction and Funding

An integrated approach to brownfield reactivation brings together all its potentials. Successful regeneration implies active cooperation with a focus on the roles, responsibilities, and limitations of the institutional instruments. Horizontal collaboration represents the cooperation of different sectors, disciplines, and institutions at the same organizational level, while vertical collaboration is between the national, regional, and local levels. (Perić and Furundžić 2014).

Greatest responsibility for the treatment of industrial brownfields in the Republic of Serbia lies with the municipalities in which they are located given their role in urban planning and raising local awareness of the importance of brownfield revitalization. On the other hand, the fact that fiscal and legislative instruments for consolidating brownfield sites are still regulated on the national level can prevent greater implementation.

Insufficient data on brownfield sites, private ownership, or private financial institutions controlling the necessary funds also pose challenges, according to Danilović et al. (2008) Funding is provided mostly from private sources, while local authorities have a wide range of formal and informal incentive instruments—formal instruments being creating strategic priorities, directing investment programs and marketing, and informal such as assistance in pollution detection, land remediation, and consolidation.

The instrument of private–public partnership, which can range from non-profit cooperation to co-financing of the project, is irreplaceable in the case of brownfield site redevelopment in order to balance private and public interest. The basic principles of the collaboration are clear common goals, transparency and public involvement, coordination of processes and properly distributed risks. Since it is vital to gain support of the public that will be affected by the planned revitalization, involving the public in the participatory decision-making process from the very beginning of the project is advised.

74.2.2 Brownfield Types and Their Inventory

Preventing further deterioration of brownfield sites by timely revitalization and increasing revenues is of the utmost importance. In order to be well informed about

the economic potential in a particular area, the brownfield sites must be properly assessed.

According to Danilović et al. (2008), 5 types of brownfields can be distinguished according to the exclusivity of the location, investment needs and opportunities for return on investment, as well as contamination. The first type is characterized by excellent location and best effects of private investment. The second and third require greater involvement of public funds due to less attractive locations. The fourth type is characterized by pollution that needs to be remediated before the revitalization can take place. The final, fifth type, does not have any market potential, and in most cases will be demolished and restored to construction land or green areas. A unified manner, used to determine accurate data on abandoned and insufficiently utilized land, would enable a reasoned assessment of the problems and priorities of rehabilitation, as well as comparability of values in different municipalities.

Shortcomings of current databases for brownfields represent practical obstacles for accomplishing such reconstructions. Thus, a methodological framework for creating a register of brownfield sites is necessary for effective urban planning. (Đukić et al. 2014).

74.3 Industrial Brownfield Heritage Location of Belgrade

Data on Belgrade brownfield sites and industrial heritage buildings in this research have been extracted from the databases of the Museum of Science and Technology, primarily the Department for Industrial Heritage, as well as the publication “Industrial Heritage of Belgrade” by the former director of the museum, Kulenović (2009). Information obtained then was updated by researching the cadaster database and conducting field research for selected locations. The research findings are presented in the form of summarized data in Table 74.1, data distribution (Fig. 74.1), and selected features’ percentages (Fig. 74.2). A map of Belgrade is provided with positioning of sites as well as their classification according to characteristics of significance for the analysis (Fig. 74.3). The limitation of the research is the lack of updated data on certain buildings, such as structures involved in litigation.

The majority of buildings or their parts are under some level of formal protection, but the fact that Belgrade is the capital city must be considered, having regulatory systems that are generally higher than the national average. The largest number of facilities is in public ownership, with a declining trend due to numerous privatizations and the limited number of brownfields. (Fig. 74.1).

Only about one fifth of the facilities are in adequate condition for their purposes, while the rest of them have an equal share of buildings in bad or very bad condition, regarded as unsafe and requiring urgent intervention, and in good condition, where safety is not questioned, but they require renovation or reconstruction. (Fig. 2a).

Buildings that are still in their primary industry, or out of function, are less in number than the repurposed buildings, while the demolition is the least present (Fig. 2b).

Table 74.1 Industrial heritage brownfield sites in Belgrade

No	Name of building	Construction year	Main industry	Current function	Ownership status	Formal protection	State of building
01	Brewery I. Bajloni and Sons	1850–1929	F	H	PR	+	3
02	Bell foundry and tower clock factory	1854	M	N	PU	+	3
03	The main railway station Belgrade	1883–1885	TR	C	PU	+	4
04	Belgrade waterworks	1890–1992	W	U	PU	–	3
05	Meteorological observatory	1891	S	U	PU	+	3
06	Belgrade wool factory	1898–1923	TE	N	PR	+	1
07	Royal Serbian privileged sugar factory	1899–1901	F	C	PU	+	2
08	Thermal power plant for electrical companies	1899–1901	E	C	PU	+	3
09	Belgrade cotton factory	Around 1900	TE	N	PR	+	2
10	Steam bakery Soko	Around 1900	F	D	PR	–	0
11	Gliša Josipović wire factory	Around 1900	M	N	PR	+	2
12	Brickyard Polet	Around 1900	I	H	PR	–	1
13	Brickyard Record	Around 1900	I	H	PR	–	1
14	Brickyard Kozara	Around 1900	I	H	PR	–	1
15	Craft and art foundry Skulptura	Around 1900	M	O	PR	+	2
16	K. M. Shonda confectionery factory	1900–1910	F	O	PR	+	4
17	Mill Suvobor	1900–1920	F	U	PU	–	3
18	Mill of the first joint stock bakery association	1901–1902	F	H	PR	+	4
19	Turner and mill M. Simovic	1903	F	N	PR	–	1
20	Seismological institute	1906–1909	S	U	PU	+	4
21	Captaincy Belgrade	1906–1912	TR	U	PU	+	3

(continued)

Table 74.1 (continued)

No	Name of building	Construction year	Main industry	Current function	Ownership status	Formal protection	State of building
22	Captaincy Zemun	1908	TR	H	PU	+	3
23	Old telephone exchange building	1908–1911	CO	C	PU	+	3
24	Reversible water pumping station Boljevići	1910–1911	W	U	PU	–	2
25	Reversible water pumping station Jakovo	1910–1911	W	N	PU	–	2
26	Reversible water pumping station Fenek	1910–1911	W	U	PU	–	5
27	Factory of modern knitted products	1912–1914	TE	O	PR	–	5
28	Nikola Bošković bank warehouse	1920	I	O	PR	+	4
29	Milan Vape paper factory	1921–1924	P	O	PR	+	3
30	Power plant of the municipality of Belgrade	1922–1928	E	C	PU	+	3
31	Ball bearing industry-airplane factory	1923–1924	M	D	PR	+	0
32	Umčari railway station	1924	TR	U	PU	–	2
33	Belgrade railway station furnace	1926	TR	C	PU	+	1
34	Rakovica engine industry	1927–1928	M	N	PU	+	2
35	Institute for production of banknotes and coins	1927–1929	P	U	PU	–	4
36	Hangar of the old Belgrade airport	1927–1931	TR	O	PR	+	4
37	Reversible water pumping station Zidina	1929	W	N	PU	–	2
38	Astronomical observatory	1929–1932	S	U	PU	+	3
39	Mill Dimitrijević	Around 1930	F	N	LI	–	2
40	Forge shop rad	1930–1931	M	O	PR	+	3
41	Thermal power plant power and light	1930–1932	E	C	PU	+	1
42	BeKo-Belgrade clothing	1931	TE	O	PR	+	3

(continued)

Table 74.1 (continued)

No	Name of building	Construction year	Main industry	Current function	Ownership status	Formal protection	State of building
43	Danube railway station	1931–1935	TR	N	PU	–	2
44	Rev. centrifugal pumping station for water Borča	1934	W	U	PU	–	5
45	Rev. centrifugal pumping station for water Ovyča	1934	W	U	PU	–	3
46	Kosutnjak railway station	1934	TR	N	PU	+	2
47	Garage of court compositions Topčider	1934	TR	U	PU	+	2
48	Belgrade main post office	1935–1938	CO	U	PU	+	4
49	Mill Markovic	Around 1935	F	U	PR	–	3
50	Mill Falkenburger	Around 1935	F	U	PR	–	3
51	Mill S. And Z. Maric	Around 1936	F	U	PR	–	3
52	Topčider Dvorska railway station	1936	TR	N	PU	+	3
53	Warehouse of the Port of Belgrade	1936–1939	TR	H	PU	+	3
54	Belgrade publishing and graphic institute	1936–1940	P	O	PR	+	3
55	Airplane factory Ikarus	1938	TR	D	PR	–	3
56	Teleoptics	1938–1939	CO	N	PR	+	2
Main industry	Current function	Formal protection status					
CO–Communication	D–Demolished	+ Existent					
E–Energy production	N–Not functioning	– Non-existent					
F–Food industry	U–Unchanged function	State of the building					
I–Industrial warehouse	C–Culture	0–Ruined					
M–Metal industry	H–Hospitality industry	1–Very bad					
P–Paper industry	O–Office and commercial space	2–Bad					
S–science institutions	Ownership status	3–good					
TE–textile industry	PU–public property	4–very good					
TR–traffic industry	PR–private property	5–exceptional					
W–water supply	LJ–in litigation						

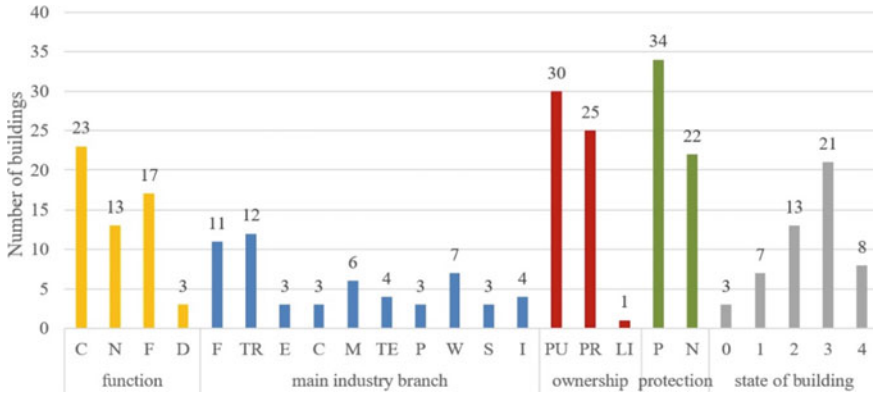


Fig. 74.1 Data distribution chart (abbreviations as per Table 74.1)

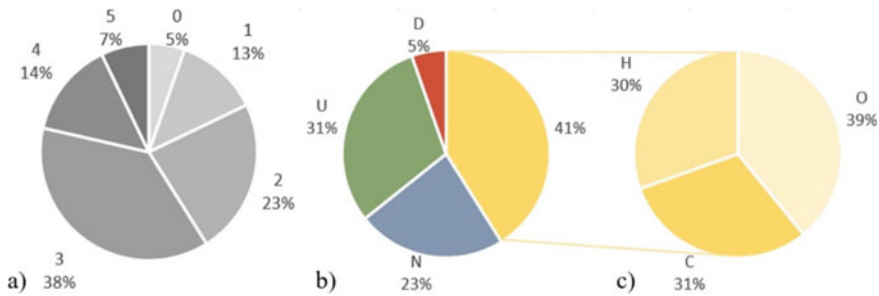


Fig. 74.2 Circular charts for selected characteristics' percentages—a state of buildings, b current function status, c repurposed buildings' function (abbreviations as per Table 74.1)

All buildings that were converted or demolished are in the central zone of the city (Fig. 74.3). Most of them are converted by market-oriented construction into residential, office or commercial space, and privately owned. A smaller part of the conversion was made for public purposes, primarily culture, and all these facilities are in public ownership (Fig. 2c). These buildings represent the few examples of good practice.

From the spatial disposition (Fig. 74.3), it can be observed that the contents occupying most attractive property (central city area) are mostly repurposed or in the phase of conversion. Few buildings are not in function and currently unconverted. These are publicly owned facilities that are not included in detailed regulatory plans that would define their possibility of conversion. The peripheral zone, on the other hand, has most sites out of function.

Regarding the demolished sites, field research revealed that new office and residential buildings were constructed in their place, having a much greater index of occupation.

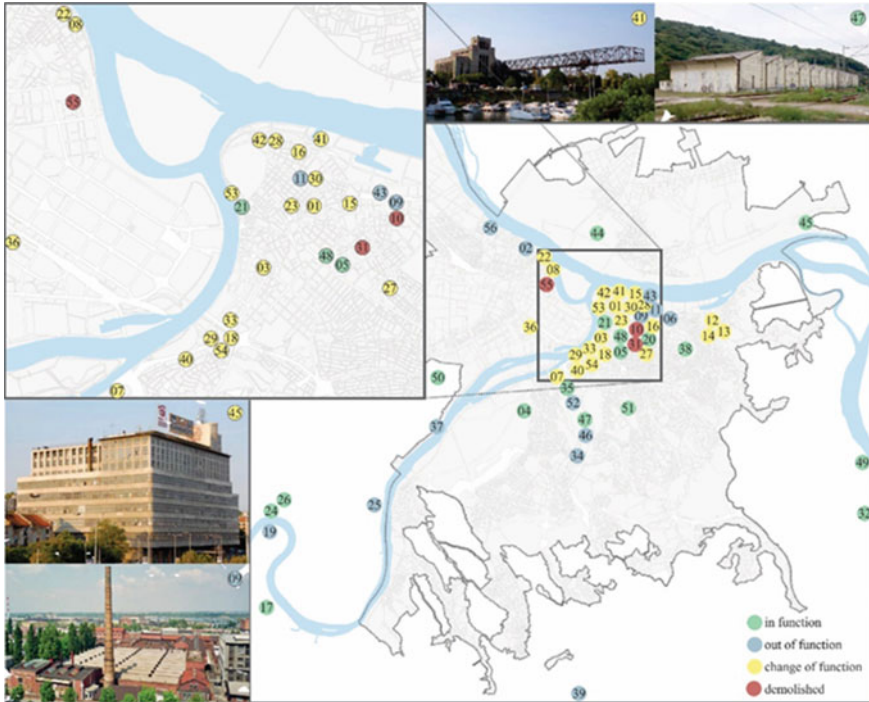


Fig. 74.3 Industrial heritage sites in Belgrade (numbering as per Table 74.1)

74.4 Conclusion

According to the data, most of the conversions of buildings were done for market demands. Only a few good practice examples applied the principles of adaptive reuse for the benefit of all stakeholders, so the opportunity for its significant gains and promotion of the concept were notably missed.

It can be concluded that the conversion has not consistently followed the plans, directives, and strategies that emphasize the significance of public functions and participation. The redevelopment of industrial brownfields in Belgrade is mostly done with the aim of maximizing revenues and profits, not paying attention to the importance of continuity of identity and cultural diversity in given locations, thus allowing damage to existing social structures, which is contrary to the strategies.

The partially incomplete data of the researched relevant sources indicate a discrepancy between plans and on-site circumstances, marking the necessity for a centralized system for planning, and monitoring the condition of industrial heritage. It indicates undefined competency for the application of existing knowledge in the field of industrial brownfields revival, lack of implementing strategies and plans defined,

poor cooperation between institutions on different levels and stages of the process. A great responsibility lies with the local governments to continue working on the data collection and synchronization of databases and strategies for reviving the sites in question carrying urban renewal.

At the same time, a potential for further research is highlighted, both thematic and practical, because there is only a finite number of brownfields of industrial heritage that is only decreasing, either by devastation or inadequate conversions that do not meet the full potential of said heritage.

A more substantial implementation of industrial brownfield revitalizations, with respect to sustainable development and growing environmental concerns apart from economical features, would bring benefits to the overall struggle against the consequences of the climate change that were aided by the process of industrialization.

Acknowledgements This paper is a part of the research funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia, grant number 451-03-68/2020-14/200090. The research is done under research lab SaRA (Sustainable and Resilient Architecture), University of Belgrade—Faculty of Architecture.

References

- Architects' Council of Europe (ACE) (2018) Leeuwarden declaration: adaptive re-use of the built heritage: preserving and enhancing the values of our built heritage for future generations. In: Conference on the adaptive re-use and transition of built heritage. Leeuwarden
- Đukić A, Simonović D, Vujičić T (eds) (2014). University of Banja Luka, Faculty of Architecture, Banja Luka
- Danićević K, Stojkov B, Zeković S, Gligorijević Ž, Damjanović D (eds) (2008) Oživljavanje braunfilda u Srbiji—Priručnik za donosiocce odluka i profesionalce, PALGO centar, Beograd. (In Serbian)
- International Council on Monuments and Sites (ICOMOS) (2011) The Dublin Principles: Joint ICOMOS—TICCIH principles for the conservation of industrial heritage sites, structures, areas and landscapes. 17th ICOMOS General Assembly, Paris
- Kadijević A (2012) Industrijska arhitektura Beograda i Srbije: Problemi istraživanja i tumačenja. In: Spasić M (ed) Godišnjak rada Beograda, knjiga LIX. Muzej grada Beograda, Beograd. (In Serbian) (pp. 11–36).
- Kulenović R (2009) Industrijsko nasleđe Beograda. Muzej nauke i tehnike, Beograd. (In Serbian)
- Ministarstvo životne sredine i prostornog planiranja (2009) Strategija prostornog razvoja Republike Srbije 2009–2013–2020, Republička agencija za prostorno planiranje i Ministarstvo životne sredine i prostornog planiranja, Beograd. (In Serbian)
- Mirković K (1964) Industrija—prostorni modulator. In: Minić O (ed) Arhitektura urbanizam, br 26. Savez arhitekata Jugoslavije i Urbanistički savez Jugoslavije, Beograd. (In Serbian), pp 27–29
- Official Gazette of RS (2019) Strategy of sustainable urban development of the Republic of Serbia until 2030. Official Gazette of RS, No. 47/2019. Official Gazette of RS, Belgrade. (In Serbian)
- Perić A, Furundžić D (2014) institutional framework of brownfield regeneration in Serbia. In: Schrenk M, Popovich V, Zeile P, Elisei P (eds) Proceedings REAL CORP 2014 Tagungsband, (pp 303–307), Vienna, Austria. <http://www.corp.at>, ISBN: 978-3-9503110-6-8 (CD-ROM); ISBN: 978-3-9503110-7-5

United Nations (2015) Transforming our world: the 2030 agenda for sustainable development, A/RES/70/1. <https://sdgs.un.org/2030agenda>
United Nations (2017) New Urban Agenda. Habitat III Secretariat, ISBN: 978-92-1-132731-1

Open Access This chapter is licensed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

