sustainability

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Editorial

Architectural, Civil, and Infrastructure Engineering in View of Sustainability: Editor's Comment

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1. Introduction

Sustainability in engineering has been one of the most often discussed topics in recent years and is one of the key factors in the engineering and economics of a sustainable environment. The Sustainable Development Goals (SDGs) are expected to be achieved through new solutions in architecture and engineering which are going to bring economic, social, and environmental benefits. The general public expects professionals to answer various questions, above all: How will we live? Are the existing design paradigms sufficient? What innovations in architectural, civil, and infrastructure engineering are needed? Contemporary challenges are significant: they force specialists to react to climate change or compel a reaction to energy constraints (already widespread), or the depletion of raw materials. The set of articles in the current Special Issue is an attempt to answer these questions. At the same time, we see a justification for the statement that the most interesting achievements are the result of cooperation between all entities of the investment process, of all disciplines, and the concept of research should be present at all stages of this process, as well as in the advanced design. The current Special Issue is devoted to the infiltration of research, and its importance in civil engineering, technical infrastructure, and architecture. The reader has the opportunity to learn about new developments. It is worth noting that this is a continuation of the theme of the two previous Special Issues on the interpenetration of architecture and engineering. Both editions were crowned in the form of books available online [1,2].

2. Contributions

The current Special Issue aroused the interest of the scientific and academic community and received many submissions. After a rigorous scientific review by editors and reviewers, fourteen papers were accepted and published. The authors dealt with various substantive problems and proposed various models of solutions. 50 authors or co-authors took part in total, The authors originate from 10 countries, with participants from Poland and China predominating. Figure 1 presents detailed information about the distribution of authors by country.

The reader is offered a decent dose of selected references. Their total number is 724 quoted items.

The review of published articles indicates that they are all original research papers, their issues are multithreaded, and they overlap to a great extent in content. Nevertheless, several issue groups can be distinguished. These are the dominant threads, and they are: (A) energy, (B) economy, (C) pro-health activities, (D) designing. Figure 2 presents them with characteristic topics. Each group has been assigned 3 characteristic topics.

Table 1 is designed to make it easier for the reader to find answers to specific questions, to find interesting topics and instruments. It is a synthesis of the content of the works, taking into account three premises:

(a) Subject of the research,
(b) Research problem,
(c) Research techniques. Instrumentality.

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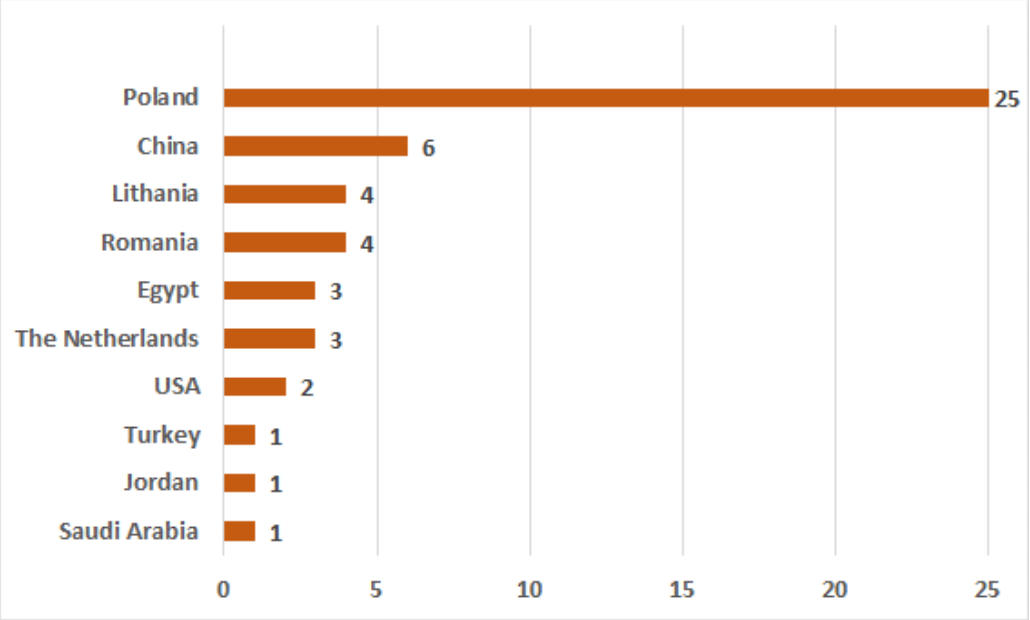

Figure 1. Distribution of authors by country.

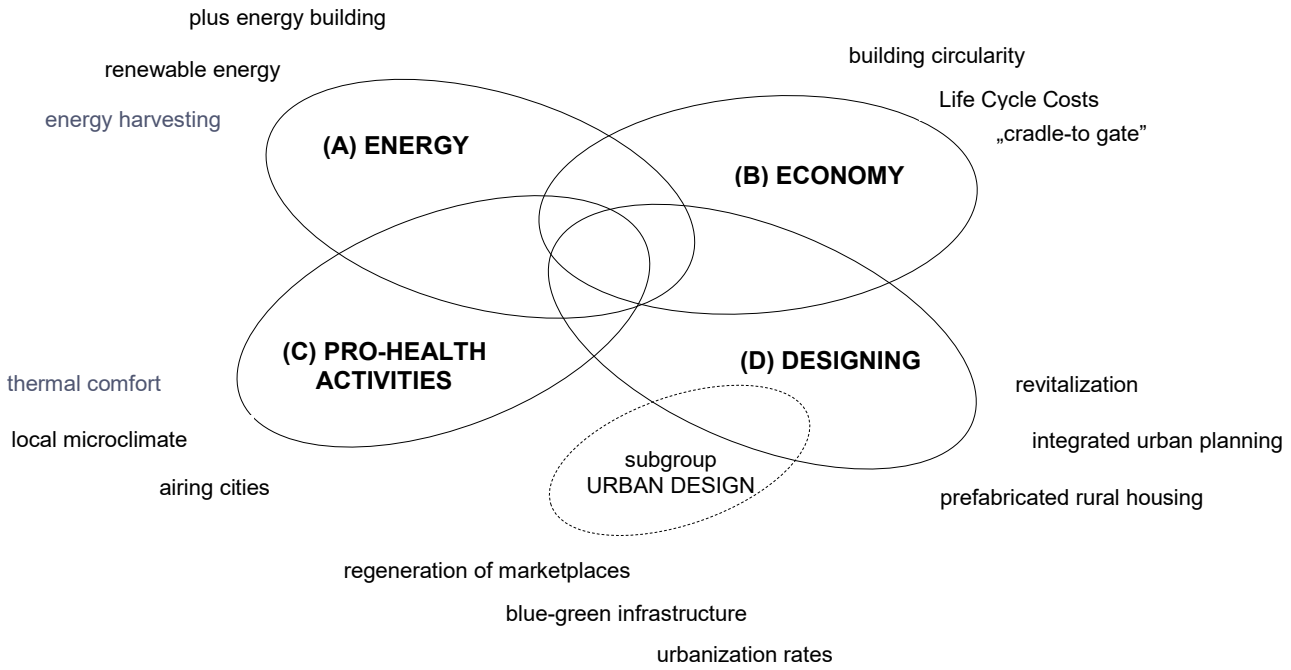

Figure 2. Dominating research threads in the current SI.

In the 'Subject of the research' field, physical objects or phenomena were indicated, in the 'Research problem' field, sought relationships and scientific values were presented. The 'Research techniques. Instrumentality' group collects characteristic research methods and tools. As you can see, this group is the most diverse. Here are just some of them: the new building circularity calculation method, the space syntax method, the automated greenery design, the multi-criteria approach, and the green BIM.

Table 1. The content of a special issue "Architectural, Civil, and Infrastructure Engineering in View of Sustainability". Synthetic collation.

Author	Subject of the Research	Research Problem	Research Techniques Instrumentality
Group (A) Energy			
Kasperski et al.	The innovative photovoltaic powered seasonal thermal storage system Plus energy building in Poland	The required size of a storage stack	TMY data (Typical meteorological year) The innovative HVAC installation Testing the numerical model
Al-Refaie & Lepkova	Renewable energy policies and photovoltaic policy in Jordan	High level of clean energy security Social acceptability	The feed-in-tariffs (FiTs) Dynamic forecast model Optimal FiTs prices, subsidies
Fernandez & Wojtkiewicz	Vibrational Energy Harvesters Bridge operation Distributed garden concept implementation USA	The cable-stayed bridge model. Integrating the weight of the harvester into the bridge structure.	The equations of motion for the nominal and modified structures.
Group (B) Economy			
Plebankiewicz & Gracki	Multi-functional buildings Maintenance costs Polish law regulations	Maintenance costs in the Total Life Cycle Costs A proposal to extend the method of determining operating costs	Net Present Value (NPV) LCC—Life Cycle Costs
Zhang et al.	Circular Economy (CE) Implementing CE in the AEC industry (Architecture, Engineering, and Construction)	Building circularity calculation method (BC) New Material Passport (MP) European Material Passport BAMB (Building as Material Banks)	The equations for building circularity scoring Proposal: New Building Circularity Calculation Method
Group (C) Pro-health activities			
Bonenberg et al.	The circular economy Integrated water management Use of rainwater Multi-family settlements in Krakow, Poland	The Bio-Morpheme reference unit. Open water reservoir	Eurostat Statistics The fractal reference model unit Comparisons with the reference model Proposed Bio-Morpheme complex
Borucka et al.	Transformation of public areas Regeneration of marketplaces in the Oliwa district (Poland)	Space syntax Evaluation of the three design models	The design variants for the revitalisation of the marketplace
Maxineasa et al.	Steel as a construction material can provide a sustainable solution for the built environment The steel cubic modules	The construction sector in view of sustainable development Three categories of indicators: Global Warming, Ozone Depletion, Human Toxicity Steel Structure Impact vs. RC Slab Impact	The cradle-to gate analysis Life Cycle Assessment
Elhadary et al.	Improving the working environment and increasing productivity. Three types of mechanical ventilation systems The forced ventilation system. The space inside the factory (Saudi Arabia)	The computational fluid dynamics (CFD) simulations	The ANSYS Fluent software The ventilation effectiveness factor (VEF)
Sędzicki et al.	Digital method of selection and design of greenery	Automated greenery design (AGD)	Greenery Scenarios New parameter sheet Test model with Grasshopper for Rhinoceros. Green BIM

Table 1. *Cont.*

Author	Subject of the Research	Research Problem	Research Techniques Instrumentality
Qi et al.	Rural areas planning The village landscape pattern and the local microclimate Adaptability of inhabitants of traditional villages (northern China)	The adaptive design mechanism A way of expressing morphological parameters. Coupling calculation method of landscape pattern and microclimate	Numerical simulation The Rhino modelling platform Grasshopper software
Badach et al.	Shaping city ventilation systems Air quality management	Integrated urban planning Urban form for city ventilation	Geographic information system (GIS) Computational fluid dynamics (CFD) simulations Autodesk CFD Historical city plans
Group (D) Designing			
Shi & Sun	Prefabricated rural housing Counties in China	Prefabrication as a sustainable construction method PEST aspects	Multi-criteria approach Model TOPSIS Weight values determined by entropy Urbanization rates
Zaleckis et al.	The perception of architectural transformations Facades of cultural heritage buildings The city centre of Kaunas (Lithuania)	The monitoring of the transformation of cultural heritage objects Visual perception	Sociological survey The space syntax method The theory of Nikos Salingaros Bill Hillier's methodology (symmetry index analysis)

The interweaving of the three premises from (a) to (c) with the four groups of substantive issues (from A to D), identified in Figure 2, with their characteristic values refined, are displayed below. Of course, this classification has features of subjective classification.

Group (A) Energy—is exceptional, unique, and has considerable potential for development because the topic of energy comes up in almost each of the fourteen articles. Kasperski et al. [3] present a plus energy building, introduce The innovative HVAC installation, and experiment with a seasonal heat storage system. This is the result of cooperation between power engineers and architects. Renewable energy policies are presented by Al-Refaie & Lepkova [4]. The authors highlight energy costs and social acceptability. Fernandez & Wojtkiewicz [5] deal with energy harvesting, or more precisely—harvesting energy during a bridge structure vibration. The idea of the authors is based on the harvester mass integration with the bridge structure.

Group (B) Economy—focuses on the life cycle, circular economy, and operating costs. Plebankiewicz & Gracki [6] deal with maintenance costs in the Total Life Cycle Costs. The analysis tool here is the Net Present Value method (NPV). The authors propose to extend the current method of determining operating costs. Circular Economy (CE) is the domain of Zhang et al. [7]. Because there is ambiguity and inconsistency in the Building Circularity (BC) assessment, the authors redefine the concept of BC assessment with three circularity cycles and five indicators. The method to be used. The three subsequent articles fall into both (B) Economy and (D) Designing categories. In the background of article [8] (Bonenberg et al.) there is a circular economy and improving the efficiency of rainwater utilisation. A Bio-Morpheme complex is proposed, including an open water reservoir. The comparison with the reference model is made on the examples of multi-family settlements in Krakow. Borucka et al. [9] focus on the transformation of public spaces, including the economic analysis of revitalization of the marketplace variants. The space syntax method is used. The small town of Oliwa on the Polish coast is the object of research. In the next article (Maxineasa et al. [10]), steel as a construction material is analysed in the "cradle-to-gate" option. The proposed structural modules can be a solution to minimize the environmental load levels.

Another set of articles is to be found in **Pro-health activities group (C).** Colleagues from Saudi Arabia and Egypt (Elhadary et al. [11]) highlight the issue of thermal comfort. Improving the working environment and increasing productivity is the subject of the research. With the help of ANSYS Fluent software, three types of mechanical ventilation systems are discussed. Article [12] is heading in the direction of Green BIM. The authors (Sędzicki et al.) present a digital method of selecting and designing greenery. The method, called Automated Greenery Design (AGD), enables taking design decisions supported by objective measures from the early stages of design concepts. The authors suggest that the AGD method can be used in coordinating the most important elements of an architectural design. The relationship between man–rural buildings–microclimate is the subject of research completed by authors from China (Qi et al. [13]). Studies of the village landscape pattern, local microclimate, and adaptability of inhabitants are supported by the analysis of morphological parameters and the use of Rhino modelling platform and Grasshopper software. The issue of air quality management in cities is the domain of the research completed by the team of Badach et al. [4]. The authors propose Integrated Urban Planning. The urban form for ventilation is determined using the computational fluid dynamics (CFD) simulations, Autodesk CFD and GIS.

The scope of **group (D) Designing** is also wide. It includes improving methods and suggesting new solutions, projects, and applications. It most often combines elements of technology with economics. This group also includes articles discussed in the previous groups. Within group (A) Energy—designing plus energy house [3] and the cable-stayed bridge model construction [5] were discussed. Within group (B) Economy—Bio-Morpheme complex design [8], marketplace variants [9], design and testing of steel cubic modules [10] are presented. Within group (C) Pro-health activities—the following topics and articles are indicated: space within the factory [11], green design [12], rural planning [13], blue-green infrastructure [14].

Group (D) is closed with two articles on the following topics. Prefabrication as a sustainable construction method is the slogan of an article by colleagues Shi & Sun [15] from China. However, the emphasis is on the potential of implementing prefabricated houses in rural agglomerations, and on how to determine this potential. Their studies identify 16 evaluation indicators in four dimensions: political, economic, social, and technological (PEST), and use the entropy-weighted TOPSIS model. The transformation of cultural heritage structures, including the design of the facades of these buildings, is a topic of Lithuanian research (Zaleckis et al. [16]). The research context is based on sociological aspects. The space syntax method and Bill Hillier's methodology (for symmetry index analysis) are used.

3. Discussion and Comments

An overview of the achievements of the current Special Issue allows us to make a few observations.

Firstly, there is a thematic diversity despite the keystone connecting the architectural, civil, and infrastructure engineering topics in the form of sustainability. The issues presented in the articles are multi-layered and multi-threaded.

Secondly, the urban design subgroup may be extracted from the four groups synthesizing the subject matter, shown in Figure 2. It includes the following topics: multi-family settlements in the context of integrated water management [8], regeneration of marketplaces [9], landscape and greenery design [12], rural areas planning and local microclimate [13], blue-green infrastructure, urban ventilation, integrated urban planning [14], rural areas, urbanization rates [15]. The richness of this subgroup shows a gradual change in the scope of research and design from individual buildings to the development of larger spaces.

Thirdly, in addition to problem indications and technological topics, the reader is provided with an overview of methods and research instruments in the area of sustainability. The range of methods and tools is presented in the right column of Table 1. They include, among others: The space syntax method, Multi-criteria approach, Integrated urban

planning, Computational fluid dynamics (CFD) simulations, Dynamic forecast model, The Building Circularity Calculation Method, Net Present Value (NPV), Life Cycle Costs (LCC), The Bill Hillier's methodology, Sociological survey. This review does not conclude the existence and development of other attractive and useful tools in the area of sustainability. The development of new sophisticated methods is exceptionally dynamic.

Fourthly, the prevalence of energy topics in the submitted and published articles is visible. Emphasizing the seriousness of this issue, i.e., energy matters may lead to the elusive conclusion that energy efficiency is almost the currency of our times.

Fifth, all articles fit into the basic analysis of EST, i.e., economic, social, and technological dimensions. Nonetheless, in this SI, there is an extension to PEST, i.e., the political dimension, which is clearly visible in two articles [4,15]. The development of the design level can be reduced to the following chain: "from conventional practice, green buildings, sustainable design (degenerating—reducing impact) to restorative design, regenerative design". The submitted articles charge at the middle part of this sequence, so it is worth interesting the reader and researchers in restorative and regenerative design (see website [17]).

Sixth, there is a certain trend: plenty of teamwork. There are 50 authors and 14 articles, which means 3.57 authors per publication. Yes, modern research or design is a team game. The co-authors of the current Special Issue come from different universities, and faculties, i.e., from different specialties and disciplines, which confirms the fact that success and concrete results are at the interface of two or more disciplines. A combination of architects with power engineers is characteristic. Work [3] is a vivid example of this statement. International works have also appeared (c.f. [4,9,11,13]. This tendency should be preserved for the sake of research dedicated to sustainability.

4. Conclusions

The interface between sustainability and engineering—especially the architectural, civil, and infrastructure classes—is multi-dimensional. Hence, the issues of research and design gain special importance.

The matter is almost unequivocal: solving sustainability problems becomes a team game. The need for such an approach arose naturally, today it becomes almost a compulsion. It is an interdisciplinary and even international game. Methods and tools exist, they are being developed, and they are becoming more and more sophisticated, thus teams of specialists are needed.

The analysis of the submitted articles shows that the environment is a widely understood concept. Man becomes an evident subject. It is satisfactory that, in addition to technological and energy issues, the authors have taken into account social aspects and presented pro-health activities. The understanding of the principles of organic design in the sphere of sustainability is increasing.

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