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Editorial

Sustainability in Construction Engineering

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Abstract: The concept of sustainability has been expanding to all areas of economic activity, including construction engineering. Construction engineering is a complex discipline that involves designing, planning, constructing and managing infrastructures. In this Special Issue, 27 selected and peer-reviewed papers contribute to sustainable construction by offering technological, economic, social and environmental benefits through a variety of methodologies and tools, including fundamental decision-making models and methods as well as advanced multi-criteria decision-making (MCDM) methods and techniques. The papers are mainly concentrated in five areas: Sustainable architecture; construction/reconstruction technology and sustainable construction materials; construction economics, including investments, supply, contracting and costs calculation; infrastructure planning and assessment; project risk perception, analysis and assessment, with an emphasis on sustainability.

Keywords: construction engineering; sustainable construction; construction building technology; construction economics; project risk assessment; multi-criteria decision-making (MCDM)

1. Introduction

The concept of sustainability has been increasingly applied in construction engineering. Construction engineering involves all stages of the life cycle of building, including the design of a building or structure, construction planning and management, construction works, maintenance and the rehabilitation of buildings or infrastructure objects.

A large number of alternative solutions must be analyzed to obtain the most effective and sustainable decisions in the life cycle of building. Decision-making methods can facilitate making these decisions. Sustainable decision-making in construction engineering can be supported by fundamental models or modern multiple-criteria decision-making (MCDM) techniques.

In recent years, a large number of research papers have been published dealing with the achievements of fundamental sciences applied in construction. Many of these research papers were summarized in several review papers [1–6]. Meanwhile, besides the fundamental methods, MCDM developments and novel applications dealing with construction problems have been constantly growing. In particular, this group of methods can effectively support sustainable decisions when we are faced with the necessity to evaluate the performance of a large number and, in most cases, contradictory criteria. A great variety of mixed information can be successfully managed by applying multi-criteria decision-making methods [7]. The findings of the review paper [8] show that MCDM applications in civil engineering and construction have been constantly growing, and the increase is correlated with an increase of interest in sustainable development. A number of papers on sustainability problems in construction increased 7.6 times in the last decade [8]. The number of papers related to MCDM developments and applications was 7.3 times higher in the last decade [8]. Correspondingly, the number of MCDM applications in construction was 5.5 times higher in the same period [8]. These findings confirm a great potential for the research of sustainable decision-making in construction problems. A great interest for readers should attract review papers devoted to MCDM applications in construction engineering. A comprehensive review was prepared in 2014 [9], presenting an overview of popular MCDM techniques and their applications for construction problems. In 2015, the next two papers summarized applications of the methods in particular areas of civil engineering, including construction building technology and management [10,11]. Subsequently, more advanced hybrid multi-criteria decision-making (HMCDM) methods gained more popularity. The application of hybrid methods for engineering was analyzed in 2016 [12] and, in the next review paper, applications of HMCDM methods for sustainability problems, were overviewed [13]. In addition, several review papers devoted to MCDM or HMCDM applications for sustainable development problems are worth mentioning: Making sustainable decisions in architectural and engineering design [14,15]; sustainable supply chains [16]; green technologies; green building; sustainable design; and energy related problems [17–19]. A great amount of attention is devoted to risk assessment, or dealing with other uncertainties in construction engineering, by applying mathematical models and methods [20].

The above-mentioned items highlight the topicality of the issue and the need to provide a possibility for researchers to disseminate their new ideas and findings related to sustainable decisions in construction. Therefore, the current Special Issue received a great number of submissions from different institutions, countries and continents. The number of papers that were positively evaluated by qualified reviewers and editors was 27. The next chapter discusses the main research areas of submissions and a contribution of each paper to the aim of the Special Issue in terms of analyzed problems and applied methods.

2. Contributions

The Special Issue collects 23 research papers, 3 review papers and 1 case report paper. The papers contribute to sustainable construction by offering technological, economic, social and environmental benefits through a variety of methodologies and tools, including fundamental decision-making models and methods, as well as advanced multi-criteria decision-making (MCDM) methods and techniques.

The topics of the Special Issue gained attention all over the World. The paper from all four Continents have been submitted (Figure 1).

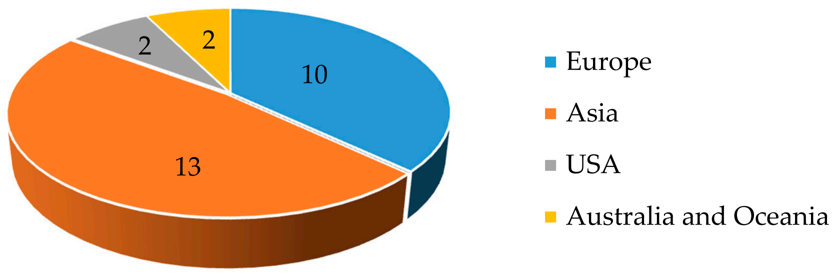

Figure 1. Number of publications from different Continents.

Regarding the origin of papers, the papers from 14 countries have been published in the Special Issue. The distribution of papers according to the authors' affiliation is presented in Table 1. Authors and co-authors from Lithuania contributed to 14 papers, those from Poland, 6 papers, those from Iran, 4 papers, and those from Korea, 3 papers. The authors from other countries, listed in Table 1, contributed to 1 or 2 papers.

Table 1. Publications by countries.

Countries	Number of Papers
Lithuania	4
Poland	4
Korea	3
Iran and Lithuania	4
Poland and Lithuania	2
Australia and Lithuania	1
USA and Lithuania	1
Turkey and Lithuania	1
Cambodia, New Zeland and Lithuania	1
USA	1
China	1
Taiwan	1
China and Taiwan	1
Qatar	1
Italy	1

The papers are mainly concentrated in five areas: Sustainable architecture; construction/reconstruction technology and sustainable construction materials; construction economics, including investments, supply, contracting and costs calculation; infrastructure planning and assessment; project risk perception, analysis and assessment, with an emphasis on sustainability.

As can be seen in Figure 2, the most numerous research areas are construction building technology and materials, including reconstruction and rehabilitation, as well as construction economics, covering a wide spectrum of problems related to investments and costs calculation, contracting and supply chains.

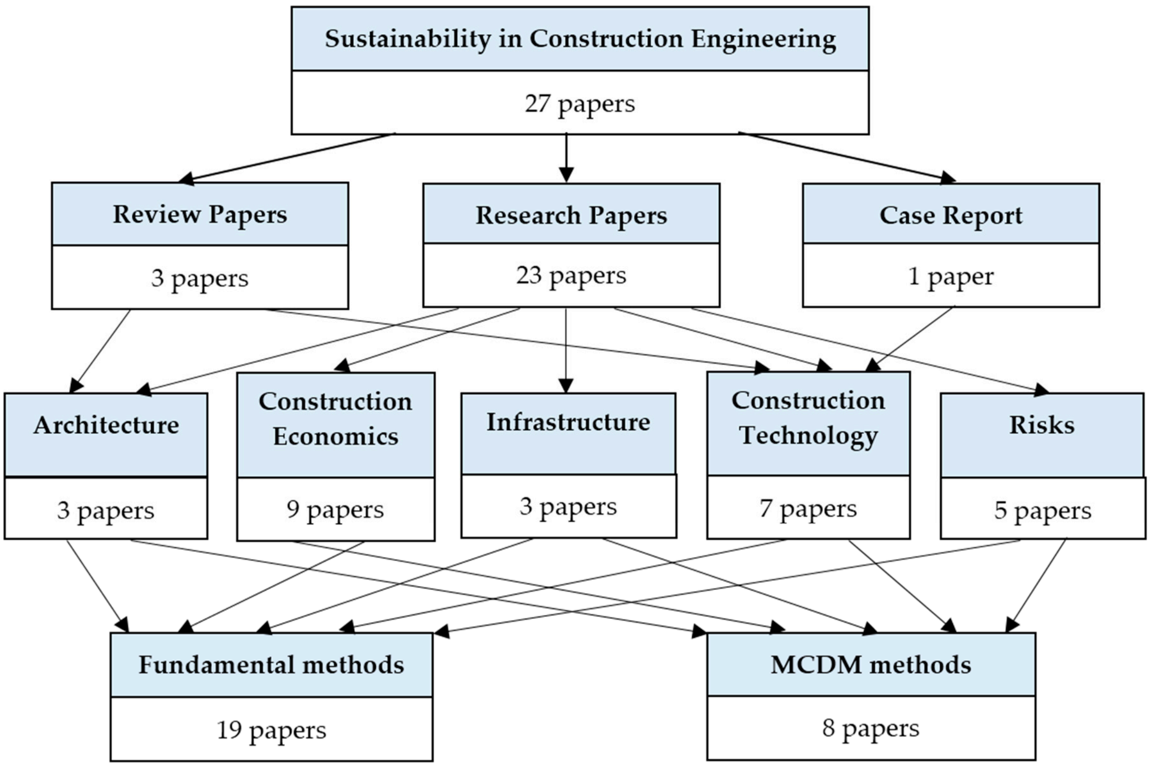

Figure 2. Types and research areas of publications.

A number of papers are very closely related to topical issues of sustainability in construction. The Issue received a paper related to Green Building, suggesting a building evaluation system by applying a combination of a Decision Making Trial and Evaluation Laboratory (DEMATEL) and an Analytic Network Process (ANP), called DEMATEL-based ANP (DANP) [21]. The other paper presents a construction project assessment according to sustainable development criteria and also suggests the application of a combination of MCDM methods—a Fuzzy Analytic Hierarchy Process and an improved Grey Relational Analysis (GRA) model [22]. Summarizing the applications of MCDM methods for various civil engineering and construction building technology problems is summarized in the review paper [8].

Tall residential building construction is analyzed [23], while sustainable renovation of buildings, with an emphasis on key performance indicators, is provided [24].

A couple of papers deal with construction materials and techniques for the construction or reconstruction/rehabilitation of buildings or infrastructure objects. A tool for CO_2 emission evaluation in the life cycle of concrete is presented [25]. The emission of Volatile Organic Compounds (VOCs) from dispersion and cementitious waterproofing products is analyzed [26].

In papers related to infrastructure objects, sustainable techniques for gravel road rehabilitation [27] and problems related to the displacement measures of bridges [28] are discussed.

As a part of a sustainable built environment, infrastructure for electric vehicles in cities and resorts is evaluated [29].

The next group of papers (9 papers) is related to construction economics and involves different topics. The construction industry is analyzed in terms of sustainability in Poland [30] and in Cambodia [31]. Promoting sustainability in construction investments through Building Information Modeling (BIM) implementation [32] or proper judicial conflict-resolution is suggested [33]. Two papers analyze the construction project cost calculation, considering the requirements of sustainable development [34,35], and the next paper is focused on the prices of implemented housing projects [36]. A new group decision-making model for contractor assessment based on a combination of MCDM methods under uncertainty is presented [37]. A topical issue of sustainable supply chains is reflected in a single paper in the current Issue [38].

It is worthwhile talking about risk-related papers individually. Two papers apply advanced MCDM methods for project risk assessment [39] and occupational risks on a construction site [40]. The paper [41] suggests the use of Bayesian Networks for project portfolio risk identification. Two more papers are devoted to sustainable construction risk perception [42,43].

Finally, the Special Issue touched a very unique topic that has been little studied heretofore in connection with sustainability—architecture. One research paper, focussing on the analysis of the key factor of sustainable architecture by the fuzzy HMCDM method, has been published [44]. Additionally, two very comprehensive review papers are elaborated [45,46], which are expected to attract a large interest from the architecture community.

3. Conclusions

The scope of the Special Issue raised the interest of researchers all over the World. Papers from 14 countries, located in four Continents, were published.

The main topics of the papers published in the Issue mainly cover five research areas: Construction/reconstruction technology and materials, construction economics, risk analysis, sustainable infrastructure and sustainable architecture.

The papers contribute to sustainable construction by offering technological, economic, social and environmental benefits through a variety of methodologies and tools. Multi-criteria decision-making techniques proved to be very suitable for sustainability assessment. Almost one third of papers (8 papers from 27) apply MCDM methods.

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