

2nd International Joint Conference on Innovative Solutions in Construction Engineering and Management: 16th Lithuanian-German-Polish colloquium and 6th meeting of EURO working group Operational Research in Sustainable Development and Civil Engineering 24 May- 2nd International Workshop on flexibility in sustainable construction, ORSDCE 2017, 24-26 April 2017, Poznan-Puszczykowo, Poland

Harmonization of cyclical construction processes: a systematic review

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Abstract

Sustainable development is first defined as development that satisfies the needs of the present without compromising the ability of future generations to satisfy theirs. Sustainable development is possible if conditions of respect for the environment, preventing the exhaustion of natural resources and preserving the overall balance, are fulfilled. The necessity of the development and maintenance of habitats also emphasized. Construction processes have important role in creation of built environment and their impacts have to be measured as construction contributes to air pollution, land use and contamination, usage of resources, water and materials depletion, water pollution, impacts on human health, and climate change. Previous (own) research revealed, that the key categories of Web of Science, which encompass the research on the sustainable built environment, cover construction and building technologies, environmental science and studies, and civil engineering. The article presents a review of the literature on efforts to harmonize the construction processes, which was made on the basis of the Web of Science Core Collection database. The analysis of the number of publications was made according to years of publication and research areas. To honour the contribution made by Prof Oleg Kapliński in the field of Sustainable Development and Decision-Making, and to commemorate his 75th anniversary, this article also highlights his academic career and research.

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Peer-review under responsibility of the scientific committee of ORSDCE 2017.

Keywords: Construction Processes; Sustainability; Multi Criteria Decision-Making

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1. Developments towards sustainable construction

The title problems of harmonization is positioned in sustainable development [1]. This section summarizes some of the dynamic characteristics of construction industry in today's complex global environment, identifies key trends, and highlights common strategic concerns regarding the role of construction industry and its interrelationships with sustainability issues. The material is based upon the review of articles published in period of 1970 – 2017.

The welfare of the whole society depends on the sustainability of the built environment that is a complex physical and social phenomenon under constant development [2]. The quality of latter strongly depends on the developments and advance in construction industry.

Construction industry is still not the powerful industry that it could be. Several reasons have to be mentioned, i.e. uniqueness of the building projects, lack of strong clients besides the national and local governments, a strong focus on minimum price, uncertainty due to the fact that buildings and civil engineering products have to be build on-site, low take-up of information and communications technologies (ITC), etc.

Recent studies discuss the possibilities of better collaboration of construction participants [3-6], introduce new means for information exchange or information and knowledge sharing [7-10] and new technologies and methodologies based on Building Information Modelling (BIM) for the customers to get more grip on the process and on the end result [11-15]. The issue of collaboration means there is a huge amount of information that needs to be communicated. Technical data, the project planning and other information must be communicated to sub-contractors, suppliers and every worker, taking the form of work orders. Current practice show that information exchange in the construction industry is mainly paper-based. Liu et al 2017 [6] identified and classified eight concepts influencing the development of BIM collaboration: (1) IT capacity, (2) technology management, (3) attitude and behavior, (4) role-taking, (5) trust, (6) communication, (7) leadership, (8) learning and experience. If an electronic way of communication could reach the same level of trust and, also important, the same legal status, it could replace much of the paper-based communication, with the possible advantages of speed and accuracy associated with electronic communication.

Smart sustainable cities situated within ecologically and technologically advanced societies [16]. But smart sustainable cities due to impact of technologies lead risks to environmental sustainability. Therefore, resent research is asserting that smart sustainable cities need to be reoriented in a more environmentally sustainable direction.

Researches emphasize the usefulness of global sustainability assessment methods based on LEED [17], BREEAM [18] and other sustainability assessment systems to define major strategies, especially in the early stages of the design [19, 20]. But for environmental assessment of measures applied in buildings the Life Cycle Assessment (LCA) approach is commonly used [21-24]. Although LCA is a powerful tool to assess the environmental impacts, it does not actually solve all dilemmas or facilitate the selection process - it is not a decision-making method. For this reason, Multi Criteria Decision Analysis often appears here like a complementary tool to LCA or LCC [25-27]. Despite the large number of methods and tools a relatively low interest in environmental management systems (EMS) and a lack of knowledge is noticeable within the construction sector [28].

In achieving the sustainable development, the construction industry is a key player, because the built environment is responsible for significant use of the final energy (62%) and is a major source of greenhouse gas emissions (55%) [2]. In view of the international climate objectives, providing energy efficient buildings has become a challenging task for cities and communities. This applies equally for new constructions as well as refurbishments of existing buildings. Society setting the standards for the Nearly Zero Energy Buildings which in the European Union by the end of 2018 will apply for all new public buildings and for all new buildings from 2020.

The energy efficiency of buildings has to be estimated at an early design stage [29]. Solutions made at this stage determine building's environmental performance during the entire life cycle. An integrated or whole building design process involves the analysis of the impacts and interactions of all building components and external factors on the energy demand. Such factors, as the location; the building envelope; the design of heating, ventilation, air conditioning (HVAC) and lighting systems, and chosen control strategies have significant impact on the energy consumption in building.

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