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Construction industry and sustainable development concept

Abstract. This paper is essentially an overview providing the analysis of topical foreign scientific literature published by the authors from Great Britain, Germany, USA, France, Switzerland, Poland, China, Iran and other countries in 2016 and in the first half of the current year. It also reviews the articles of some Russian scientists published during the last five years. The analysis of the scientific literature referred to herein helped to identify the key research areas ensuring sustainable development of the construction industry, namely: reducing carbon footprint, resolving the construction waste management issues etc. Construction is thought to be one of the most energy-intensive industries, which is why it is imperative that it be considered in a sustainable development context. In this regard, the paper offers an abstract scheme, based on the analyzed literature, of sustainable development of the construction industry including its constituent tangible domains – ecological safety, energy efficiency and technology – in utilizing the tools and equipment; as well as the construction process. The main purpose of this work is to identify various approaches to ensuring sustainable development of the construction industry, in particular, through ensuring ecological safety.

Keywords: sustainable development; ecological safety; construction industry; tangible and intangible domains

Introduction

The global nature, mission and concept of sustainable development, first introduced as a notion by the Canadian economics researcher John Hartwick, are analyzed by the author of this paper in the work [1], which states that the «sustainable development issues are always considered by scientists in the context of environmental issues». The author's approach to ensuring sustainable development in general, which is primarily focused on preserving the human civilization, is based on the following idea: the «sustainable development» and «ecological safety» notions should not be equated. According to the sustainable development concept as applied to the construction industry, constructing buildings is a means of gaining capital by people in the name of promoting their welfare; reconstruction, restoration, overhaul and maintenance of buildings are aimed at preserving the capital gained. These two components have a social and economic nature. But without resolving multiple global and local environmental problems, especially those associated with people's adverse environmental impact, it is impossible for the humankind to keep up their ecological niche, because preserving human capital, first of all, means preserving human beings as such on the quality level on which they were created, i. e. without mutations [ibidem].

Any industry, including construction, is a system characterized by integrity, from obtaining the needed work resources, tools and equipment through to the making of finished products. This enables a firm conclusion that sustainable development of the construction industry is also an integrated system, which was confirmed by foreign studies [2-5].

Sustainable development and ecological safety of construction industry in the studies of foreign scientists

Multidimensionality, complexity and dynamics of construction operations dictate the directions for exploring the concepts of sustainable development and ecological safety of the construction industry.

For instance, the article [2] notes that, despite the ambitious plans of the British Government to convert old and new buildings into the ecologically safe stock, i. e. «net zero energy buildings», during 2016-2020, the problem of construction waste disposal will nevertheless remain to hinder the overall sustainable development. First, out of 100 million tons of annually accumulating construction waste 13 million tons are made up by unused construction materials; second, only 20 % of the above quantity is recycled and used again – the remaining part, ending up in waste bins, adversely affects the biosphere. The authors underline that the existing approach to ensuring ecological safety does not meet the contemporary sustainable development requirements. «Net zero energy buildings», both at the operation and construction stages, prove a serious source of economic and environmental damage. Therefore, according to the authors [ibidem], solutions to the sustainable development and ecological safety tasks shall not be tackled on a government level without making coordinated decisions by various stakeholders. This primarily envisages a fusion of science and industry and practical use of professional solutions, while government directives should only be issued when «cascading» specific solutions, as it was done before.

Sustainable development of the construction industry is considered by the authors as a part of a holistic approach to ensuring the same at various building lifecycle stages, where Building Information Modeling (BIM) should be the working platform for inventing the modern construction methods precluding «inefficient management enrooting lack of culture on construction site, outdated construction technologies and poor construction logistics» [ibidem].

The decision-making ensuring sustainable development of the construction industry, starting from its various subsystems (structures, materials, processes, etc.), with the help of building information modeling is also reviewed in the work [3]. The authors hold that a body of BIM-integrated technologies ensures synergy of the economy and energy related innovations and sustainable development. A holistic approach to sustainable development for all subsystems of the construction industry is reviewed in the paper [4]. The authors underline that a sustainability assessment methodology is required for all lifecycle stages of real property. According to the authors [5, 6], the building sustainability assessment methodology should be based on the analysis of their «environmental, social and economic efficiency», taking into account the criteria of utility and efficiency of new sustainability technologies [6]. Sustainable development depends, in particular, on the actual condition of existing buildings [7], especially industrial premises [6]. Timely reconstruction, restoration and overhaul of buildings help improve their overall sustainability rating, given the choice of appliances and tools used for same is environmentally justified, and the assumed construction processes are technologically advanced.

In the paper [8], construction is described as one of the most energy-efficient industries in China (*and not only China, apparently*), which is why the assessment of sustainable development assumes special importance in environmentally unreliable districts. By the example of the provinces Hebei, Shanghai, Hubei, Yunnan and Cansu, which were recognized as environmentally unsafe

according to the 2007 assessments (being the districts involved in oil production, mining, metal and ore processing and mineral development and having major traffic routes), the ways of enhancing sustainable development are analyzed and the necessity is stressed to have the global society integrate in solving this problem.

The study of the South Korean scientists [9] notes that construction accounts for 30 % of carbon emissions causing greenhouse effect. The authors emphasize that the total carbon emissions resulting from the operation of residential buildings depend on the number of floors and the horizontal configuration of buildings. The research identified the cases where buildings should be rectangular, Y-shaped or L-shaped to meet the requirements of «high ecology standard and energy efficiency». The Chinese scientists [10], based on the research of real property at various lifecycle stages, made a conclusion that construction is not only most consuming in terms of energy [8], but also responsible for the greatest carbon footprint share (60 %). Since China recently has been resembling a «huge construction site», the issues of sustainable development in this country are becoming its top priority.

The approach to construction in general should be subject to fundamental changes reflecting global climatic changes. Some day, the construction technologies and materials, which are currently in use, will fail to meet either the sustainable development requirements, or ecological safety requirements for construction [11]. Smart energy supply, carbon footprint reduction and, finally, «low-carbon» economy have become the principal highlights in the development of a strategic policy and implementation of near-term (2011-2015), medium-term (2016-2020) and long-term (2021-2030) state energy projects unrolled in Taiwan [ibidem]. In this work, the authors, based on the analysis of the papers on SG (Smart Grid), provide general recommendations regarding energy efficient and environmentally safe construction as regards Taiwan.

In their scientific research [12], the authors, on the one hand, point to the increasingly growing interest of architects and builders to the problems and issues of sustainable development, and on the other hand, underline that on a «material level» (*meaning material engineering*), these issues are underexplored. They continue with specific studies on the manufacturing of various types of insulation, roof materials and concrete articles to find interconnections between «material costs» of material production and carbon emissions. No final conclusion was made by the authors due to the «accidental nature» of the results.

The use of materials meeting the energy efficiency requirements is often rendered impossible by the existing standards hindering the invention of alternative materials [13].

Enhancing the technological effectiveness of construction processes [14]; development, manufacturing and use of energy efficient and environmentally safe construction materials [15, 16], including biochemical materials [17, 18], management of construction [19-21] and industrial [22] waste; management of construction quality [23]; timely reconstruction and upgrading of existing buildings [24, 25] instead of their demolition; creating sufficiently safe working conditions for construction workers [27]; environmentally focused education [26] of all groups of the society – all this should fundamentally transform into the sustainable development trend and become a dominating factor in making routine decisions, based on the consensus of interests of a variety of government bodies and public organizations.

«International convergence of the construction sector», according to the authors of the work [28], can become a basis for sustainable development of the construction industry, especially in implementing mega-projects, which while updating the city appearance in any country have a large-scale impact on the environment.

Russian realities of sustainable development and ecological safety of construction industry

The review of the articles [29-31] shows that the main focal areas for seeking the subject matter, interconnection and solutions for sustainable development issues are associated with:

- environmental services of the natural territories which deterioration leads to degradation of the global human society. Such territorial environmental services include the use of non-renewable natural resources (in particular, for construction purposes);
- intrusion in the environment to establish recreation zones characterized by anti-creation stressful conditions in the natural territories and eventually leading to the exhaustion of territorial environmental services;
- banning the closure of mono-towns and creation of the necessary conditions for initiating the new stage of their near-term economic and environmental development, subject to the cluster policy.

Energy efficient reconstruction, eco-reconstruction of space through the suburbanization of urban areas reviewed by the author in the works [32-34] are the important directions relevant for both preserving mono-towns and ensuring sustainable development.

Attenuation of industrial factors affecting the environment is possible in the development of any sphere of material industry subject to observance of environmental restrictions. Figure 1 provides an abstract scheme of sustainable development of the construction industry.

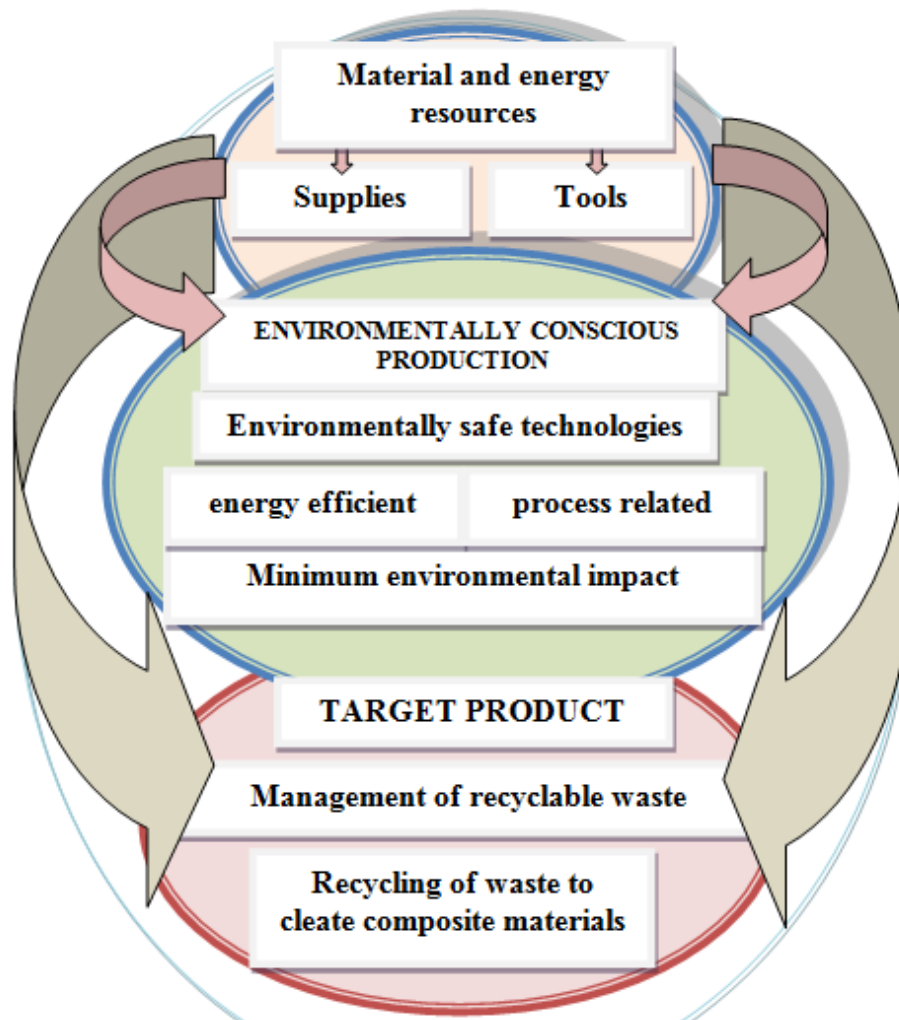


Figure 1. Abstract scheme of sustainable development of construction industry

The above scheme only indicates the constituent tangible domains: ecological safety, energy efficiency and technology – in utilizing the toolage and equipment; construction industry processes envisaging the use of energy efficient and environmentally safe technologies with minimum adverse environmental emissions and waste generation; final product conforming to all applicable environmental criteria (a completed construction or reconstruction project featuring a building or facility), where resulting waste can be recycled for further use in other construction projects. However, the accomplishment of the above is only possible with an integrated use of all intangible areas of sustainable development: environmental education, audit, insurance etc.

The provision of ecological safety at all stages of a lifecycle of construction systems is considered in the works [35, 36]. The authors point to the need of the use of GIS and BIM technologies to identify the degree of environmental disturbance during the carrying out of construction processes, especially in case of extended linear facilities.

Summary

Because construction is one of the most energy-intensive industries the consideration of its general sustainable development concept should be predominant. The sustainable development of the construction industry should always be based on a streamlined system of environmental certification of material and energy resources at the front-end engineering and design engineering stages, and ensuring their conformity at the construction stages, verification of innovative technologies for compliance with the energy efficiency requirements, environmental monitoring of related processes (measuring noise, vibration, hazardous emissions etc.), structural ecologization of organizational flows, and environmental quality monitoring.

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Строительное производство и концепция устойчивого развития

Аннотация. Данная статья по сути является обзорной, приводится анализ зарубежной научной литературы по изучаемой теме, опубликованной авторами из Великобритании, Германии, США, Франции, Швейцарии, Польши, Китая, Ирана и др. стран в 2016 году и в первом полугодии текущего года. Рассматриваются также статьи некоторых российских ученых опубликованных в последние пять лет. На основе анализа приведенной в данной статье научной литературы выявлены основные направления исследований, обеспечивающих устойчивое развитие строительного производства, а именно, снижение выбросов углекислого газа, решение проблем по утилизации строительных отходов и др. Отмечается, что строительство является одной из самых энергоемких отраслей, поэтому рассмотрение его в общей концепции устойчивого развития должно стать доминирующим. В связи с этим, на основе анализируемой литературы предлагается некая абстрактная схема устойчивого развития строительного производства с учетом составных материальных сфер – экологобезопасных, энергоэффективных и технологичных – в использовании предметов и орудий труда; процесса строительного производства. Основной целью данной работы является выявление различных подходов обеспечения устойчивого развития строительного производства, в том числе и за счет обеспечения экологической безопасности.

Ключевые слова: устойчивое развитие; экологическая безопасность; строительное производство; материальная и нематериальная сферы

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