Scientific Journal of Riga Technical University
Economics and Business
2011
Volume 21

Sustainable Development in Construction: Conceptual Model and Latvia's Case Study

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***Abstract* — Science and society, when facing the challenges created by globalization of economy, devote more and more attention to the matters of sustainable development. Buildings and other constructions produced by the construction industry provide a material basis to ensure conformity of products manufactured by other economic sectors to the criteria of sustainable development. The society and scientists pay great attention to the outcome of the construction process, its technical, ethical and ecological conformity. Location of constructions, amount of building materials used in construction, their heat engineering and mechanical properties, operational consumption of energy resources, functional conformity of the layout of the premises and interior, and other features are used to evaluate a construction with regard to sustainability requirements. Up to now, less notice is given to matters of sustainable development of the building process both on micro and macro level. Effective usage of the available resources by construction companies is the "backbone" of sustainable development process of the construction industry. In various phases of the economy development cycle not only the demanded volume and price of construction products are changing. In the period of economic growth, favorable conditions give construction merchants an ability to increase efficiency of the available resource usage. That provides the economic and technical basis for competitiveness of construction companies, which is necessary to overcome economic recession caused demand and supply mismatch associated with decrease in market equilibrium price. For the purpose of maintaining competitiveness in conditions of recession, businesses are forced to implement measures aimed at increasing usage efficiency of resources at their disposal more actively, meeting the main conditions of sustainable development of the national economy.**

***Keywords* — sustainable development; construction industry; efficiency measures; environment; conceptual model**

I. INTRODUCTION

Studies on sustainable development of the construction industry pay more attention to the correspondence of the created construction product to specific sustainability criteria, at the same time failing to study in sufficient detail the use of resources available to construction entrepreneurs as the most important aspect of correspondence of the construction product manufacturing process to sustainable development fundamentals on macro level. The definitions and models developed in this study make a clear distinction between the sustainable construction process and the product created by this process, which must meet the sustainability criteria defined in the society. This approach is linked to the necessity of expanding the scope of research to cover the questions related to the correspondence of the construction process to the sustainable development guidelines and criteria on both micro and macro levels. Studying the situation in the construction industry in Latvia between 2003 and 2010, intensive economic growth was observed, it was followed by a sharp recession with great changes in the efficiency parameters for the use of resources available to construction entrepreneurs. Rapid decline in the efficiency of resource usage was observed in construction. This trend is characteristic of a period of explosive economic growth, while it contradicts the fundamentals of sustainable development. As the recession set in, the efficiency of the use of resources available to construction contractors increased.

The results of the study clearly identify the need to pay greater attention to sustainable development issues on a macro level, allowing the government to develop and implement more efficient measures for developing social, economic and ecological processes in compliance with sustainable development guidelines and criteria, promoting increased efficiency of the use of resources available to a society and reducing the destructive impact of economic activity on the environment.

II. ENVIRONMENTAL IMPACT OF CONSTRUCTION AND INDUSTRY PRODUCED PRODUCTS

Researchers of environmental and construction processes have found out that environmental impact of construction and construction products is characterized by 37 various aspects, from continuous increase of built-up land area to waste created by constructions and degradation of the environment [1]. According to the study carried out by the US Department of Energy on the construction processes, operation and maintenance of the finished constructions consume 39% of the energy resources used in the country annually, 68% of electric power, 12% of water, and create 38% of the CO2 emissions in the country [2]. In the United Kingdom various constructions produce about 50% of the state CO2 emission volume, the constructions consume 50% of the total amount of water used in economic activity and produce 30% of solid waste. The construction industry utilizes 25% of the raw materials consumed in the national economy. 27% of the total CO2 emissions in the country are produced at homes, and 73% from this amount come from home heating and water heating [3]. In order to reduce the destructive impact of constructions on the environment, scientific studies are conducted in the United Kingdom to find possible solutions in order to design the buildings, which would not emit CO2 gas into the atmosphere, by 2016.. The first experimental zero-carbon buildings, fully absorbing the created carbon dioxide, were built already in 2009 [4].

In different countries construction industry consumes 66% of saw timber cut down in forests, the industry exerts a lot of pressure on consumption of non-ferrous metals. The main worries are caused by increase in consumption of zinc and copper in construction, as reserves of these materials are estimated to last only for the next 30 years. Amount of metals used annually in construction in various countries ranges from 1 to 8 tons per capita. Metal recycling and repeated use decrease metal consumption by 90% and enable saving up to 70% of the power that is necessary to manufacture the respective amount of metal from metallic ores [5]. About 1.3 billion tons of waste is produced annually in the European Union, of which 510 million tons can be attributed to construction industry, i.e. 1.13 tons per capita and 1.03 tons per 1000 EUR of the manufactured production. In Latvia, 87% of the hazardous waste produced since 2002 is related to construction industry [6].

In comparison with ES-15 and other most developed countries of the world, the buildings that are built in Latvia have considerably lower power efficiency and the indices of destructive environmental impact are considerably higher. Thus, 5.2 thousand GWh of thermal energy were supplied to households in 2009, of which only 2.7 GWh, or 53.4% of the energy produced by boiler rooms, were used efficiently. Thermal energy losses in heating systems amount to 760.4 GWh, and 1.7 GWh of electric power is consumed inexpediently in households [7]. The utmost losses of thermal energy can be attributed to the low usage efficiency of the supplied energy in the majority of homes. Annual specific consumption of thermal energy in apartments and other types of residences built on the territory of Latvia ranges from 220 to 250 kWh/m^2, but this parameter does not exceed 60-120 kWh/m^2 in homes with high power efficiency [8]. Consumption of thermal energy in passive houses built in Finland is within 20-30 kWh/m$^{2.}$, For multi-storey blocks of flats of conventional construction built in Finland the consumption of thermal energy does not exceed 70 kWh/m^2 [9]. Finland's experience in construction of power efficient homes convincingly proves that there are reserves for decreasing consumption of thermal energy in Latvia and many other European countries.

III. SUSTAINABLE CONSTRUCTION AND EXPLANATION OF THE CONCEPT OF SUSTAINABLE CONSTRUCTION PRODUCT

For the purpose to improve environment protection and to maintain the ability of natural resources to renew, the conception of the so-called "sustainable development" is analyzed. Within this framework, more attention is paid not only to reducing the negative impact of production of various goods and the transport system on the environment, but also to optimization of consumption of goods and services and to increasing efficiency of the resource usage. In the set of these measures, a significant role is played by sustainable construction and sustainable buildings. The uncertainty and contradictory nature inherent in the concept of sustainable development gives a favorable ground for wide discussions about sustainable existence and development of the construction industry and the products produced by the industry.

The international construction research organization "Conseil International du Batiment" [10] defines the concept "sustainable construction" in the following way:

"sustainable construction – a process of creating a building that is applicable for the specific purposes and that is environmentally friendly, in operation and management of which high efficiency of resource usage is ensured". This definition does not take into account the competence of the construction contractor and the owner of the building in a sustainable building production and in the features of life-cycle of a sustainable building. In construction industry, unlike in other national economy sectors, unique products are produced. Those products completely correspond to the client's requirements that are included in the building's technical documentation. For that reason the above mentioned definition is largely referable to the concept of a sustainable building rather than sustainable construction.

The definition drawn up by the European Union demonstrates unspecific and superficial approach to exposure of content of the concept of sustainable construction, indicating that "…Sustainable construction can be defined as a dynamic of developers of new solutions, investors, the construction industry, professional services, industry suppliers and other relevant parties towards achieving sustainable development, taking into consideration environmental, socio-economic and cultural issues." [11]. The EU definition indicates that politicians are willing to lay responsibility for environment protection issues and achievement of socio-economic development objectives on the shoulders of entrepreneurs. Comparison of operating objectives of an entrepreneur to environmental, socio-economic and cultural development objectives demonstrates a formal approach to the issues of development of sustainable construction.

Considering the significance of the concepts of sustainable construction and sustainable building in development of the construction industry and the entire national economy, and for the achievement of the public socio-economic development goals, and the existing functional, economically technical and legal differences between these concepts, the definition of the concept of sustainable construction is proposed in the following wording:

"sustainable construction is the process of designing, placement, production and demolition of a construction product, which ensures conformity of the finished product to the criteria of sustainable development, technical documentation and other laws and regulations with regard to safety and harmlessness of the production process and the finished product, high efficiency of using resources at one's disposal, a possibly minimal impact on the environment".

The definition strictly differentiates the construction process from the further operation of the building after the construction process is finished and the buildings are transferred to its owner and user. In the definition it is taken into account that the construction industry is included in the regulated area of business activity, construction process sustainability requirements or criteria are set in the respective regulatory enactments.

Preconditions that are included in the project and regulatory enactments for a sustainable building to meet the functional requirements in accordance with the main conditions and criteria of sustainable development during its operation are created in the construction process. However, it is the owner and/or user of the building who is economically and ecologically responsible for continuous increase in efficiency of using resources involved in operation and maintenance of a building. It is important to mark a borderline between the builder and the user of the building in the definition of sustainable building, presenting it out in the following wording:

"sustainable construction product is a building, in production of which requirements of regulatory enactments are met with regard to safety and harmlessness of the production process, the included constructive elements and technological solutions enable to ensure high efficiency of resource usage and a minimal possible impact on the environment during operation and maintenance of the building, as well as conformity with other criteria of sustainable development".

As it may noticed, in the definition of sustainable construction product, emphasis is made on the possibilities created in the construction process to use resources more effectively and safely with a minimum possible destructive impact on the environment. The requirements included in the definition are combined with other criteria of sustainable development that are changing along with changes in mechanical, physical and ecological properties of construction materials, construction technologies, environment condition and natural resource renewal ability [12]. Exactly the criteria of sustainable development that are included in the respective state regulatory enactments is one of the most relevant aspects in increasing power efficiency of the raised buildings and in implementing other conditions necessary for sustainable development in construction.

IV. Models of Sustainable Construction and Sustainable Construction Product

Considering the above mentioned definitions, models of sustainable construction and construction products are developed, revealing the existing differences and the options to promote sustainable development of the national economy and the entire state. Taking into account that the general meaning of the concept "construction" includes the construction industry, the public authorities supervising the construction industry, construction entrepreneurs and nongovernmental builders' organizations within the framework of the study the focus is on construction as on a sector of the national economy and on construction company as a producer of construction products. In the development of the models, systemic approach is used to tackle sustainable development problems on a local, national, international and global level [12].

As it shown on the model presented in Fig. 1, the basics of sustainable construction are formed by a national policy of sustainable construction development and the consequent criteria of sustainable development of the construction

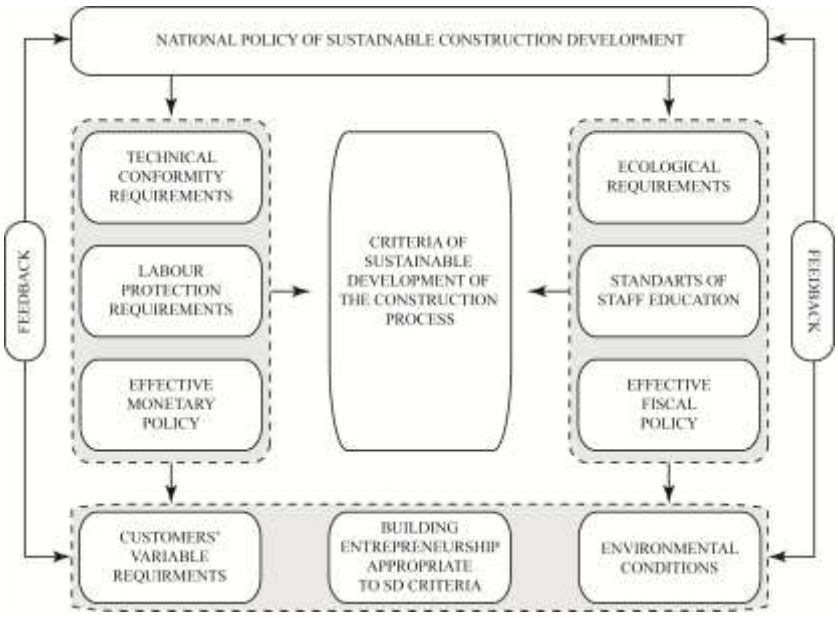

Fig. 1. Functional model of sustainable development of the construction industry (abbreviations: SD - Sustainable Development)

industry. Up to now major attention in national construction policy is paid to technical conformity requirements that are included in various standards, construction regulations and other regulatory enactments. It is demonstrated in the model that the criteria of sustainable development of the construction industry take shape considering technical and occupational safety and ecological requirements of construction work. An effective monetary and fiscal policy is added to them, as it enables the construction industry to retain sustainable development nature, avoiding unreasonably rapid growth and the recession following it. In this case, comparatively high conformity of the total increase in construction product and increase in demand is implemented in the framework of an effective monetary and fiscal policy, thus enabling to maintain slight price fluctuations for the produced construction products and stability of development of the industry.

Sustainable development criteria of construction process take shape considering the requirements that establish conformity of manufacturing process of construction products to technical, social, ecological and economic requirements shown in Fig. 2. These requirements are largely related to sustainable development policy of the construction industry implemented by the state, and determination of a construction company to participate in processes that are aimed to continuous improvement of working conditions in construction, increase of efficiency of using resources at one's disposal, and retaining of ability of natural resources to renew.

As it may be seen in the model presented in Fig. 3, sustainable usage criteria of various buildings take shape on the basis of sustainable development policy of the national economy. These criteria apply to possibilities to continuously update the used technologies and to increase efficiency of resource usage in economic activity processes that are performed in the respective building, as well as in operation, reconstruction, renovation and demolition of the respective building. That enables to increase production of goods and services using the resources at the disposal of the national economy subjects and the entire society. A significant criterion of a sustainable building is conformity of the working environment and microclimate to the human physiological requirements. It is aimed to reduce sickness rate of the people employed in construction, and to increase labor productivity and quality. The criterion "minimal influence on the environment" includes the requirements fixed by regulatory enactments regarding reduction of environmentally harmful gas emissions and other waste in operation and maintenance of a building, including construction waste that is produced when the respective building is demolished.

As follows from the models presented in the previous figures, the criteria of sustainable development of construction and construction business and usage of sustainable buildings are constantly changing, along with the changes in results of scientific research, development of engineering solutions and technologies, environmental conditions, and considering constantly changing requirements of the clients. With the help of feedback, these aspects and the changes that have taken place in them are included in the policy of sustainable development of the national economy and construction industry in order to timely make the necessary changes in regulatory enactments and to make corresponding corrections in the national monetary and fiscal policy.

Further in the study the main attention is devoted to sustainable development of the Latvian construction industry

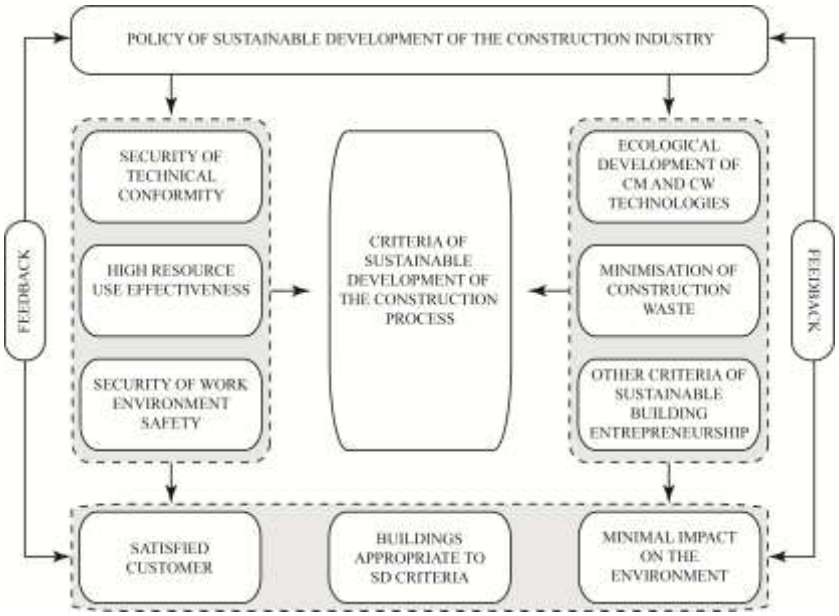

Fig. 2. Functional model of sustainable development of the construction process (abbreviations: SD - Sustainable Development; CM - Construction Materials; CW - Construction Work)

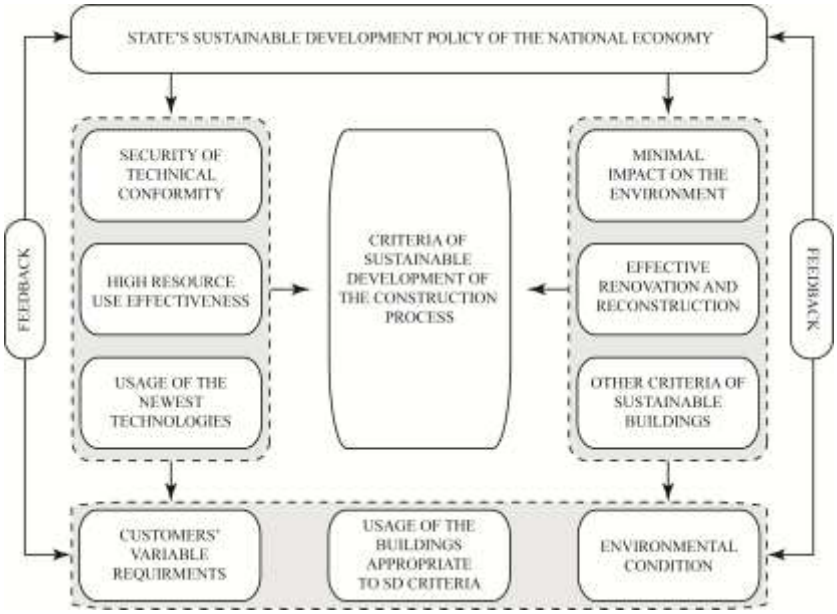

Fig. 3. Functional model of sustainable development of the construction process (abbreviations: SD - Sustainable Development)

in relation to changes in efficiency of usage of resources that are at the disposal of entrepreneurs working in the industry, the trends of these changes in the period of rapid growth and economic recession.

V. Positive and Negative Side Effects of Sustainable Construction

Experience in sustainable construction development and operation of buildings constructed in accordance with the sustainable development criteria collected from several most advanced countries in the world allows us to make a number of fundamental conclusions in favour of this new trend in construction development. Considering the broad range of sustainable construction development criteria and the extensive spectrum of its effects, in many developed countries such buildings are certified using the U.S. certification system Leadership in Energy and Environmental Design, or LEED. This system includes comprehensive technical, ecological and financial auditing of the building to make sure that the result of the certification process corresponds to one of the 4 types of certificate: basic, silver, gold or platinum. The LEED system evaluates 39 criteria with a maximum of 69 points. The building evaluation is divided into the following categories [13]:

- Correspondence of the location of the building to sustainable development of the environment and the building;
- Efficiency of water use within the building;
- Usage efficiency of energy sources and air pollution during the maintenance of the building;
- Safety, non-hazardousness of construction materials used, their impact on the environment, efficiency of resource usage during operation and maintenance of the building;
- Microenvironment quality inside the building;
- Applied innovative solutions in the building design, construction, operation and maintenance.

In a 2006 study of a large number of various educational, scientific and health care buildings, the U.S. scientists concluded that the costs of buildings meeting the sustainable development criteria are 0.7 to 6.5% higher than those of conventional buildings with similar functionality. A number of cases were established among the buildings inspected where conventional buildings turned out considerably more expensive than green buildings [14]. A group of companies in the U.S. that devoted attention to sustainable buildings, updating their interior facilities and design to ensure an optimal microclimate for people's health, has managed to save around 250 million USD in a year. This economic effect was achieved due to increased productivity and quality of work [15].

Studies have shown that the increase in construction expenses of sustainable buildings differs among countries. In New Zealand, it varies from 2 to 6%; in the United Kingdom, from 4 to 10%; in Australia, from 50 to 204% [16]. An important factor is reduced power consumption by green houses, which ranges from 35 to 50%. A considerable socioeconomic effect is achieved by properly adjusting indoor microclimate of the buildings. Within retail spaces, where artificial lighting is replaced with sunlight coming through the roof, the sales may increase by 35-40% [17]. Interesting data

were obtained regarding the impact of daylighting on the operation of educational institutions. Inside school classrooms where children studied under natural light, math scores grew by 20% and reading skills improved by 26% compared to classrooms where schoolchildren were exposed to artificially lit environment [18].

Sustainable buildings constructed within the European Union allow savings 3-6 billion euros per year due to 8-25% reduction in episodes of allergy and asthma. Thanks to purposeful reconstruction and renovation works, the syndromes characteristic of "sick buildings" have been reduced by 20-50%: this promotes higher productivity, increasing production by 15-45 billion euros per year. As a result of improvements in work environment and microclimate, the productivity of employees within commercial spaces and industrial structures increased by 0.5 to 5%, providing an economic effect of 30-240 billion euros per year [11]. By 2030, the European Union intends to reach ambitious milestones in sustainable construction. These plans involve reducing energy intensity for construction materials by 30% and reducing production waste by 40% in industries producing construction materials. It is planned to reduce power consumption in operation and maintenance of the buildings by an average of 50%. The technologies available at that time will allow producing the power consumed by those buildings without generating CO2 [19].

As it may be observed in the European Union and other developed countries in the world, sustainable development criteria have been disseminating quickly, annually increasing these countries' output of construction materials that comply with the sustainable development guidelines. An understanding of the causes and consequences of positive and negative side effects of sustainable construction allows each entrepreneur and member of the public to comprehend their role in promoting sustainable development of construction and the entire country.

VI. Changes in Efficiency of Usage of Resources During Rapid Economic Growth and in Conditions of Recession

The following part of the study is devoted to the most significant aspect of sustainable construction development – changes in efficiency of usage of available resources in Latvia. A unique situation was observed in the national economy during the last 5-7 years. In the period from year 2004 until year 2008, the value of the goods and services produced in the country increased 2.2 times, but the amount increased only by 30.7% [20], assuming that no fundamental changes in the range of the produced goods and services happened at this time.

The most dynamic changes in the period of time from year 2003 until 2010 took place in the construction industry, causing sharp changes in efficiency of using resources at the disposal of the entrepreneurs working in the industry. The statistical data and calculation results characterizing the period of rapid growth and recession are presented in Table 1.

Growth of the Latvian national economy in the period of time from year 2003 until year 2007 was characterized by an unprecedented increase dynamics. Intensity of increase of the value of goods and services produced in the state in the actual prices in this period increased from 11.0% in 2003 to 32.5% in 2007. In the comparative prices the GDP increase is considerably lower, 7.2% and 12.2% in 2003 and 2006 respectively. Recession in the national economy started in 2008 when the volume of the production decreased by 4.2%. Top recession intensity in the national economy was reached in 2009 when the volume of production and product taxes in the actual prices decreased by 19.2%, but in comparative prices – by 18.0%. To evaluate the intensity of fluctuation, fluctuation range index is used – on the level of national economy it reaches 51.5%, which is the highest result in the entire European Union [21] and does not correspond with the basic conditions of sustainable development on macro level [12].

The unprecedented fast increase of internal demand sharply increased profitability in several business sectors and caused resonance of demand in various national economy sectors, increasing demand for construction products and the following supply. Already in 2004, production intensity of the construction product evaluated in the actual prices increased nearly twice compared to 2003, reaching 20.8%, although in the actual prices the increase intensity remained at the level reached in the previous year. The sharpest increase rate was recognized in 2006 and 2007 when the construction product in the actual prices increased by 47.9% and 62.1% respectively,

TABLE 1
Period of Rapid Growth and Recession in the Latvian Economy

Showing	Changes in intensity of increase of results by years – %								Fluctuation range – %
	2003.	2004.	2005.	2006.	2007.	2008.	2009.	2010.	
GDP in the actual prices	11,02	16,29	21,85	23,32	32,30	9,53	-19,18	-1,50	51,48
GDP in the comparative prices	7,19	8,68	10,60	12,23	9,98	-4,24	-17,95	-1,25	30,19
CP in the actual prices	11,67	20,76	26,64	47,92	62,09	11,26	-40,36	-24,00	102,45
CP in the comparative prices	13,72	13,33	15,46	21,50	15,73	-2,62	-33,57	-27,00	55,07

(abbreviations: GDP - Gross domestic product; CP - construction product)

TABLE 2

CHANGES IN EFFICIENCY OF USING RESOURCES IN CONSTRUCTION DURING RAPID GROWTH AND RECESSION

Figures used in construction	Intensity of changes in resource usage efficiency figures by years – %								Fluctuation range – %
	2003.	2004.	2005.	2006.	2007.	2008.	2009.	2010.	
Fixed assets and other long-term investments	-4,1	-15,4	-20,1	-9,6	-13,5	3,8	6,8	0,5	26,9
Construction materials and other current assets	-18,7	-25,2	-31,3	-23,1	-9,0	7,5	35,5	17,3	66,8
Total assets	-13,7	-22,1	-28,1	-19,7	-10,2	6,5	26,4	11,4	54,5
Labour	-7,83	-2,86	10,74	5,83	-4,26	-2,55	10,14	5,26	18,57

but in the comparative prices – by 21.5% and 15.7%. Therefore, intensity results of the Latvian construction industry beat the growth rate registered in the European Union [21], [22], [23]. The rapid growth was followed by recession of similar nature, which reached culmination in 2009, when the produced construction product in the actual prices decreased by 40.4%, but in the comparative prices – by 33.6%. Recession trends in the construction industry lasted also in 2010, as the produced construction product volume decreased by 27% and in terms of value by 24%, considerably surpassing the intensity of recession in other national economy sectors in 2010 [20].

Higher rate of increase in production of construction product in the period of rapid growth was caused by the increasing mismatch between the total demand and supply of construction product. Construction companies, unable to offer the volume of the construction product in demand, raised the sale price, thus ensuring parity between demand and supply. For the maintenance of market balance in the period of time after 2003, price increase of the produced goods facilitated sharp increase in profit of construction entrepreneurs, creating favorable conditions to increase labor productivity and efficiency of using the assets of construction companies. The figures included in Table 2 demonstrate how these favorable conditions were used so that Latvian construction companies would incorporate in their operation the most significant condition of sustainable development and would increase efficiency of using the resources at their disposal.

Volume of resources at the disposal of the entrepreneurs working in the construction industry in 2010 is foreseen by usage of statistical data on decrease of resources in 2009 and considering the correlative relation of resources with quantitative changes in the produced construction product. In the calculations of efficiency of using resources at the disposal of entrepreneurs, the negative effect of price increase on efficiency of resource usage is reduced to the utmost, but figures of usage efficiency of construction materials and fixed assets are affected by structural changes in these resource groups and qualitative changes in content of the construction product.

As follows from the figures presented in Table 2, resource usage efficiency figures included in assets are decreasing as the production intensity of the construction product increases. Usage efficiency of fixed assets that are included in the fixed assets and other long-term investments shows a negative increase rate value already in 2003, decreasing by 4.1% in comparison with the level reached in 2003. In the further years of rapid growth, usage efficiency of the capital at the disposal of entrepreneurs continues declining, reaching the sharpest decrease of 20.1% and 13.5% in 2005 and 2007 respectively. Along with recession, capital usage efficiency starts to rise gradually. A similar trend, with a more dynamic intensity, can be observed in changes of usage efficiency of construction materials and other current assets. Already in 2003 this figure declines by 18.7% compared to the previous year level. In the following 2 years, the calculated values in the comparative prices of construction production to produce a unit, value of the utilized construction materials and other current assets in the prices of 2000 sharply increases and in 2005 the increase rate reaches 31.5%. In the following 2 years the intensity decreases, but efficiency of using construction materials continues to decrease. Only upon recession, in 2008 this figure starts to improve by 7.5%, reaching the top value of 35.5% in 2009.

Considering the absolute limitedness of labor force supply and the hard working conditions in construction, one of the most important figures in sustainable construction development is increase in labor productivity, which enables to increase the physical volume of the produced construction product within a time unit, thus reducing the production time. As it may be observed from the figures presented in Table 2, changes in labor productivity are of sharply changing character, but the common trend remains – as the intensity of the produced construction product increases, the labor productivity decreases. Already in 2003 when the volume of the construction product in comparative prices increased by 13%, labor productivity changed in the opposite direction, decreasing by 7.8%. Even though in 2005 labor productivity returns to the level of 2001 and surpasses it in 2006 by 6% [20], in the following years it decreases again by 4.3% and 2.6% respectively. The positive changes in labor productivity are observed as the recession grows deeper in 2009 when labor

productivity surpasses the level of 2001 by 7%, and this trend lasts also in 2010.

VII. CONCLUSIONS

The conducted study on sustainable development trends of the construction industry in terms of resource usage in the period of rapid economic development and in conditions of recession leads to the following conclusions:

Studies on the sustainable development of the construction industry pay more attention to the conformity of the created construction product to specific sustainability criteria. At the same time the use of resources available to construction entrepreneurs as the most important aspect of correspondence of the construction product manufacturing process to the main conditions of sustainable development on macro level is not studied in sufficient detail;

The definitions and models developed within the study clearly differentiate between the process of sustainable construction and the product produced in this process, which must correspond to the criteria of sustainable development established in the society. Such approach is conditioned by the necessity to expand the research on the issues that are related to conformity of construction process to the basic principles and criteria of sustainable development both on micro and macro level;

In the period from 2003 until 2010, intensive economic growth was observed in the Latvian national economy. It was followed by rapid recession, which is accompanied by sharp changes in the usage efficiency indices of the resources at the disposal of construction entrepreneurs. The period of rapid growth of the economy in construction is characterized by sharp decrease in efficiency of resource usage, which comes into contradiction with the basic principles of sustainable development. As recession sets in, usage efficiency of the resources at the disposal of construction entrepreneurs starts to increase;

Results of the study clearly indicate at the necessity to pay more attention to sustainable development issues on macro level, which would enable governments of the countries of different development levels to develop and implement more effective measures to ensure conformity of socio-economic and ecological processes to the basic principles and criteria of sustainable development, thus promoting the increase in usage efficiency of resources at the disposal of the society and lessening the destructive impact of economic activity on the environment.

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Jānis Vanags, Georgs Mote. Ilgtspējīga attīstība būvniecībā: konceptuālais modelis un situācijas Latvijā analīze
Pētījumos par būvniecības ilgtspējīgas attīstību lielāka uzmanība tiek veltīta saražotā būvniecības produkta atbilstību noteiktiem ilgtspējīgas attīstības kritērijiem, bet nepietiekoši tiek pētīta būvkomersantu rīcībā esošo resursu izmantošanai kā nozīmīgākajam aspektam būvniecības produktu ražošanas procesa atbilstībai ilgtspējīgas attīstības pamatnosacījumiem makro līmenī. Šī pētījuma ietvaros izstrādātajās definīcijās un modeļos precīzi tiek nošķirts ilgtspējīgas būvniecības process no šajā procesā saražotā produkta, kuram, jāatbilst sabiedrībā noteiktiem ilgtspējīgas attīstības kritērijiem. Šāda pieeja saistīta ar nepieciešamību paplašināt pētījumus ar jautājumiem, kuri saistīti ar būvniecības procesa atbilstību ilgtspējīgas attīstības pamatprincipiem un kritērijiem gan mikro, gan makro līmenī. Pētot situāciju būvniecība Latvijā laika periodā no 2003. līdz 2010.gadam tika novērota augstas intensitātes ekonomiskā izaugsme un tai sekojoša strauja recesija, kuru pavada krasas pārmaiņas būvkomersantu rīcībā esošo resursu izmantošanas efektivitātes rādītājos. Būvniecībā konstatēts straujas ekonomikas izaugsmes periodam raksturīga resursu izmantošanas efektivitātes strauja samazināšanās, nonākot pretrunā ar ilgtspējīgas attīstības pamatnostādnēm. Iestājoties recesijai, būvkomersantu rīcībā esošo resursu izmantošanas efektivitāte paaugstinās.
Pētījuma rezultāti skaidri norāda uz nepieciešamību lielāku uzmanību ilgtspējīgas attīstības jautājumiem pievērst makro līmenī, kas dotu iespēju valdībai izstrādāt un īstenot efektīvākus pasākumus sociāli ekonomisko un ekoloģisko procesu atbilstībai ilgtspējīgas attīstības pamatnostādnēm un kritērijiem, sekmējot sabiedrības rīcībā esošo resursu izmantošanas efektivitātes paaugstināšanos un samazinot saimnieciskās darbības destruktīvo ietekmi uz apkārtējo vidi.

Янис Ванагс, Георгс Моте. Устойчивое развитие в строительной отрасли: концептуальная модель и анализ ситуации в Латвии
В настоящее время при исследовании устойчивого развития в строительной отрасли наибольшее внимание уделяется соответствию произведенного продукта определенным критериям. В то же время, недостаточное внимание уделяется использованию ресурсов, находящихся в распоряжении коммерсантов, как наиболее значимому аспекту соответствия процесса производства продукта в строительстве основным условиям устойчивого развития на макроуровне. В разработанных в ходе исследования дефинициях и моделях процесс устойчивого развития в строительстве отделен от произведенного продукта. Такой подход связан с необходимостью расширить исследование в направлениях, связанных с соответствием процессов в строительстве принципам и критериям устойчивого развития на микро и макроуровнях. В ходе изучения ситуации в строительной области в Латвии в период 2003 - 2010 годов отмечается высокая интенсивность экономического развития и последующая резкая рецессия, которой соответсвуют резкие изменения показателей эффективности использования ресурсов, находящихся в распоряжении коммерсантов в строительной области. В период быстрого экономического роста в строительной отрасли констатировано резкое снижение эффективности использования ресурсов, которое вошло в противоречие с основами устойчивого развития. В свою очередь, в период наступившей рецессии увеличилась эффективность использования ресурсов коммерсантами строительной отрасли.
Результаты исследования указывают на необходимость привлечь повышенное внимание вопросам устойчивого развития на макро уровне, что дало бы возможность правительству разрабатывать и претворять в жизнь эффективные мероприятия по приведению социально-экономических процессов в соответствие с основными положениями и критериями устойчивого развития, способствуя, таким образом, повышению эффективности использования имеющихся в распоряжении общества ресурсов, а так же снижению деструктивного влияния хозяйственной деятельности на окружающую среду.