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Sustainable Construction as a Competitive Advantage

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Abstract: Nowadays, sustainable construction (SC) is considered as a measure to support a healthy economy. The SC concept ensures quality of life and helps minimize the negative impact on the environment, human health, and biodiversity. SC fits into the modern sustainable development (SD) concept due to the ability to improve the environment, energy efficiency, and care for future generations. Despite numerous studies dedicated to the SC concept and implementation, practical matters related to SC including the importance of macroeconomic environmental sustainability are still insufficiently explored. The objective of this research is to study the practical issues of SC in the example of developing countries. Moreover, this work is aimed at determining the importance of the sustainable macroeconomic environment in ensuring SC. With the help of correlation and regression analysis effected for the purposes of the study, the direct connection and strong correlation between the GDP growth in the country and the number of large sustainable infrastructure facilities constructed and put into operation in the Russian Federation and China (correlation coefficient comprised 0.9987) were revealed. Within the current study, the experience of developing countries in SC is also discussed. It has been outlined that for emerging countries, the development of the construction industry environment within the framework of SC is possible in a sustainable business environment. The competitive advantages for SC are considered in social, economic, and environmental systems. Moreover, the models of formation and ensuring competitive advantages of the SC enterprise are presented. This paper reveals that the stability of the macroeconomic environment is a key factor in construction industry growth within the SC for developing countries.

Keywords: competitive advantages; economic aspect; environmental aspect; green building; social aspect; sustainable construction

1. Introduction

The concept of sustainability combines various spheres of life to achieve harmony between economic, social, and environmental aspects of human activity. Sustainability remains crucial for the building industry since its ultimate goal is to find a coherent and long-lasting balance between the three aspects mentioned above. The construction industry has different, specific features delineating this sector from all other sectors. One such feature is the widespread use of subcontracting, which makes achieving and maintaining sustainable development (SD) one of the main challenges for the construction industry [1]. According to the statistics, the construction industry is responsible for 35% of total greenhouse gas emissions [2] and produces one-third of all waste [3]. However, this sector can become the most powerful driver of economic growth [4]. In developing economies, the construction industry makes an important contribution by developing new infrastructure and buildings, while in developed economies the construction industry is more focused on the provision of professional services, repair, and maintenance construction [5].

These days, the construction industry has expanded its focus from issues of limiting energy consumption to site planning, waste management, materials selection and design. Together with energy consumption planning, these factors form the building sector's agenda and are critical in solving the environmental crisis [6].

Despite the obvious advantages, green project management meets with obstacles in the process of its implementation. Its development requires significant changes in the professional vision of the participants of the corresponding stages of the capital structures' life cycle. In the meantime, decisions on traditional building management and the assessment of the technical parameters of buildings are supplemented by an evaluation of their consumer characteristics, typical for the operation phase [7]. The application of green building standards becomes an additional marketing strategy for the company. It helps to strengthen the corporate culture of the enterprise, attracts the best specialists in the field of project management, allows reducing project risks, and leads to the saving of project resources, including energy [8]. Furthermore, the search for opportunities to reduce environmental impact increases the likelihood of creating a "breakthrough" innovation in construction technologies for Research and Development (R&D) [6].

Construction management involves the organization of many important events at the construction site, without which the building cannot be finished. In particular, it involves the registration of the land, formation of an economic model of the project under construction, obtainment of construction permits, negotiations with the authorities, development of technical specifications, pre-project preparation, obtainment of technical conditions for connecting to utilities, and support of design work until the receipt of results of state expertise. Additionally, construction management includes monitoring and technical supervision of the construction process, consisting of quality management, resource management, and occupational health and safety management as well as control over the acceptance of work performed. To be converted into a green project management system, the business orientation of construction management allows for the introduction of an integrated management system designed from a set of the most common certified "green" standards [9].

Green building is a new stage in the development of construction technologies. It is the practice of operating and erecting structures, preserving or improving their quality and internal environment to reduce the energy consumption and material resources. Nowadays, the following principal green building standards are developed:

- BREEAM (Building Research Establishment's Environmental Assessment Method, the United Kingdom), since 1990, has certified about 200 thousand buildings in 50 countries in nine environmental sections:
  - ✓ Management;
  - ✓ Health and wellbeing;
  - ✓ Energy;
  - ✓ Transport;
  - ✓ Water;
  - ✓ Materials;
  - ✓ Waste;
  - ✓ Land use and ecology;
  - ✓ Pollution.
- LEED (Leadership in Energy and Environmental Design, USA), since 2000, has certified about 70 thousand buildings in six sections:
  - ✓ Sustainable sites;

- ✓ Energy and atmosphere;
- ✓ Water efficiency;
- ✓ Materials and Resources;
- ✓ Indoor environmental quality;
- ✓ Innovation.

- DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen, Germany), since 2009, has certified about a thousand buildings; is a "second-generation" rating system, giving a more holistic evaluation of the entire life cycle of a building in terms of SD [6,7,10]. The success of achieving green building goals depends on the professional skills and in-depth knowledge of the personnel involved [11]. In particular, project management knowledge and skills for green construction include:

  - ✓ Good navigation and understanding of American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards;
  - ✓ Understanding of the energy sector standards of other countries;
  - ✓ Awareness of the theory and practice of solving problems with CO2, refrigerants, nox4, and other emissions;
  - ✓ Familiar knowledge of climatology and the modern climate doctrine as well as the ability to apply this knowledge in practice.

  Moreover, one must have an idea and be able to apply:

  - ✓ Mathematical modeling for the analysis of design solutions for heating, ventilation, and air conditioning systems inside the building;
  - ✓ Computer modeling and testing of structural strength;
  - ✓ Life Cycle Assessment (LCA);
  - ✓ Life-cycle cost analysis (LCCA);
  - ✓ Building information modeling (BIM);
  - ✓ ISO 26000 practical guide.

These requirements are based on the Life Cycle Assessment (LCA) methodology for assessing environmental impacts, which evaluates raw material extraction through materials processing, manufacturing, distribution, use, repair and maintenance, and eventual disposal or recycling. Furthermore, all the green building standards comply with the environmental management standards ISO 14001 [12].

These days, the implementation of SC continues to be among the global trends of the greening industry. Companies are greatly influenced by customers' pressure to do business in a more environmentally-friendly way [13]. Modern industrial strategies for SC can contribute to the achievement of SD themes by embracing the following objectives [2]:

- Being more profitable and competitive;
- Delivering buildings and structures that provide greater satisfaction, wellbeing, and value for customers and users;
- Respecting and treating its stakeholders more fairly;
- Enhancing and better protecting the natural environment;
- Minimizing its consumption of energy.

Benefits of sustainable construction (SC) projects for investors, property owners, developers, planners, and management companies are as follows [14]:

- Greater competitiveness in promoting a project or solution as environmentally friendly and consistent with the principles of SD of the environment;

- Guarantee that during the construction, technologies that meet the basic principles of SD were applied;
- Intensified search for innovative solutions that minimize environmental impact;
- Reduction of operating costs and improvement of working and living environment quality;
- Compliance of the facility with a standard that moves towards corporate and organizational environmental goals.

In other words, the project's adaptation to SD parameters becomes a significant competitive advantage, which increases the profitability of the project through higher rents and lower expenses, which is particularly appreciated by potential investors [15].

On the one hand, it is empirically established that the presence of eco-friendly production positively correlates with the profitability of the enterprise and its competitiveness [16]. However, the question of how the introduction of the SC concept can increase the investment attractiveness of the company remains open. Traditionally, SC is considered within environmental, economic, medical, and social contexts [17,18]. Nevertheless, most studies on these matters are empirical and based on survey data. Thus, the influence of various factors on the stability of construction companies and their competitiveness is still poorly examined.

The current research presents an investigation of the SC industry's practical impact on a country's macroeconomic development. It is illustrated in each section of the paper. In particular, Section 2 sets out a general understanding of the above issues in the context of other researchers' work. Section 3 presents the stages and procedures of the study. The main determinants of the research—its empirical and theoretical parts—are described in Section 4. Section 5 manifests related points of view on the problems and approaches to assessing the role of SC and GDP in national welfare. The last section of the study presents constructive analytics based on the totality of research elements.

2. Literature Review

Generally, SC is defined as a construction process, which is carried out by incorporating the basic objectives of SD. Such construction processes would thus bring environmental responsibility, social awareness, and economic profitability to a new built environment and facilities for the wider community [12]. To assess the financial performance of companies in the field of SD, researchers use the Dow Jones Sustainability World Index (DJSI World). The DJSI World data provide a general understanding of a positive relationship's presence between indicators of sustainability and business performance, leading to an investment increase in SD projects [19]. The growth of the construction enterprises' competitiveness is considered to be connected with an increase in short-term profitability, long-term profit [20], an improvement in the price-quality ratio [21], and the rise in productivity [22]. In the construction industry, competitiveness is examined at the firm and project level [19,23–26]. An inverse relationship between contractors' sustainability performance and international revenue and a direct relationship between contractors' sustainability performance and international revenue growth are discovered empirically [27]. The most competitive are those construction companies that achieve a balanced necessary level of business activity while maintaining a certain degree of centralized control and coordination [13].

Static assessments of the impact of sustainable real estate development (SRED) on the investment attractiveness of construction demonstrate the four benefits associated with SRED, which include higher building value (HBV), productivity gains (PG), cost savings (CS), and environmental gains (EG). There is a direct relationship between the volume of investments and building value, as well as between productivity and environmental gains. In addition, no connection was established between the investment volume and the level of cost savings when applying the SC concept [28]. Generally, SC is associated with significant cost savings achieved by increasing employee productivity and enhancing the benefits of improved health and safety, as well as by providing energy savings, maintenance, and operating costs [28]. At the same time, the statistics show that SC requires small upfront costs in the construction industry, which will be offset by revenue in the future [29]. For the successful implementation of the SC concept, the resources and market position of organizations are crucial [30].

In the construction industry, social sustainability is manifested indirectly through raising social standards, quality of life, and the implementation of social projects. The objective of social sustainability is to provide customer satisfaction, close cooperation with employees, suppliers, clients, and local communities [19].

The development of buildings' energy efficiency improves resources and energy costs. At the construction stage, increasing the environmental friendliness of the process reduces noise, vibration, and various emissions [31]. Considering SC from macroeconomic and political points of view, it can be found that the legislative support in developed countries is not as essential as in developing countries [32] since construction companies will adhere to the SC concept regardless of what the law says. The analysis of cross-industrial best practices and future trends in the contemporary resource-based competitive model of the firm reveals that the SC development requires stable macroeconomic conditions, appropriate government policy, and the presence of a general competitive strategy [33]. Therefore, to gain a competitive advantage in the market, companies should enter into long-term strategic alliances that implement SC technologies and are oriented towards social needs [34].

Although studies have been conducted by many authors, practical matters of SC are still insufficiently explored. Researchers considered the experience of SC concept implementation, without indicating the importance of macroeconomic environmental sustainability. Considering this, the current work aims to study the practical issues of SC in the example of developing countries to determine the necessity of macroeconomic environmental stability in ensuring SC.

3. Research Methods

3.1. Research Context and Factors

The SD of the construction industry is not a new phenomenon for developing countries. It is implemented through the infrastructure projects application, which is impossible without government support and appropriate business conditions. A literature review on SD in developing countries [35–39] enables us to identify favorable trends for SD in the construction industry. In many respects, the development of sustainable projects in developing countries is due to the fact that the region's relatively skilled labor force can be absorbed by a dynamic green economy, supported by an increasingly vibrant private sector to multiply the level and impact of green investment [40]. Thus, there is a solid potential in this region to create decent jobs in green or newly greened activities, such as renewable energy, waste recycling, or energy-efficiency retrofits. Green market products could be a source of wealth creation that, combined with anti-poverty measures, would result in improved quality of life for many people in underdeveloped areas and among vulnerable groups. If targeted well, the green economy could also mitigate the gender gap in employment and create opportunities for greater gender equity in this part of the region [41].

The statistical data on GDP growth from 2015 to 2018 in the Russian Federation and from 2012 to 2015 in China, along with the number of green building standards certified large sustainable infrastructure facilities constructed and put into operation over the last years, are considered. For the analysis, data on star labeling projects in green building and technical evaluation standards for the Russian Federation and China are applied. A bright example of a large sustainable infrastructure facility is "Bolshoi" Sports Palace in Sochi (Russian Federation), which was granted the international environmental certificate BREEAM (the third level out of five—"Very Good") for energy efficiency and green technology the day after the closing of the XXII Olympic Winter Games [35]. The information under consideration is retrieved from national databases and scientific articles [35,36,42–44].

Within the framework of the study, a polynomial function is used for a mathematical description of the evaluation process. The function with the maximum informativeness and correlation coefficient is considered optimal since it has a small number of regressors that describe random deviations.

The construction of the polynomial regression line is proposed to be performed according to the following algorithm:

1. Construction of variants for the polygonal regression equation, excluding points where the trend for the SD in the construction industry is doubtful (if necessary);
2. Construction of the most informative polynomial of degree k to describe the data set;
3. Analysis of the obtained results and the model selection.

3.2. Research Design

As a part of the hypothesis test, a relationship between the GDP growth indicators (as the main indicator reflecting the macroeconomic reality of the country) and the number of large sustainable infrastructure facilities put into operation is built. In order to assess the relationship, a mathematical model of dependence between the above indicators should be developed through correlation and regression analysis. The use of correlation and regression analysis assumes the presence of effective and factorial signs.

The assessment process includes:

1. Correlation identification between x and y through graphical and grouping methods;
2. Examination of the x-y relationship strength based on an empirical correlation;
3. Construction of a simple linear regression model for the relationship between x and y;
4. Determination of the adequacy and practical suitability of the created model.

4. Results

The results of correlation and regression analysis effected with the purposes of the study show that there is a direct connection and strong correlation between the GDP growth in the country and the number of large sustainable infrastructure facilities constructed and put into operation in the country.

Tables 1 and 2 provide statistics on GDP growth indicators and the number of large sustainable infrastructure facilities put into operation. Figures 1 and 2 are based on data in Tables 1 and 2 and illustrate the graphical dependencies of the above factors and the constructed dependence polynomials.

Table 1. GDP growth and the number of sustainable infrastructure facilities in Russia.

Year	**2015**	**2016**	**2017**	**2018**
GDP growth (%)	97.5	100.3	101.6	102.3
Year	2013	2014	2015	2016
Number of infrastructure facilities	8	18	22	23

Note: a time lag of two years is explained by the average time of facilities' commissioning. Source: developed by the authors on data retrieved from Tabunschikov and Federal State Statistic Service [35,36].

Table 2. GDP growth and the number of sustainable infrastructure facilities in China.

Year	**2012**	**2013**	**2014**	**2015**
GDP growth (%)	102.8	99.9	99.6	99.4
Year	2012	2013	2014	2015
Number of infrastructure facilities	441	736	718	246

Note: developed by the authors on data retrieved from Zhang et al., Knoema Enterprise Data Solutions and National Bureau of Statistics of the People's Republic of China [42–44].

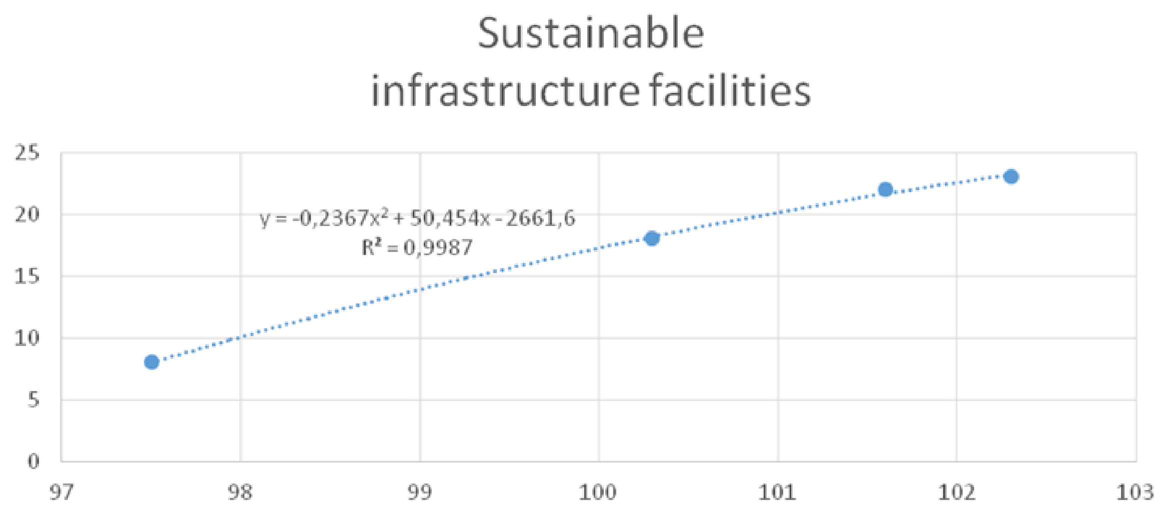

Figure 1. Dependence between the number of infrastructure facilities and GDP growth (%), Russia. Note: developed by the authors.

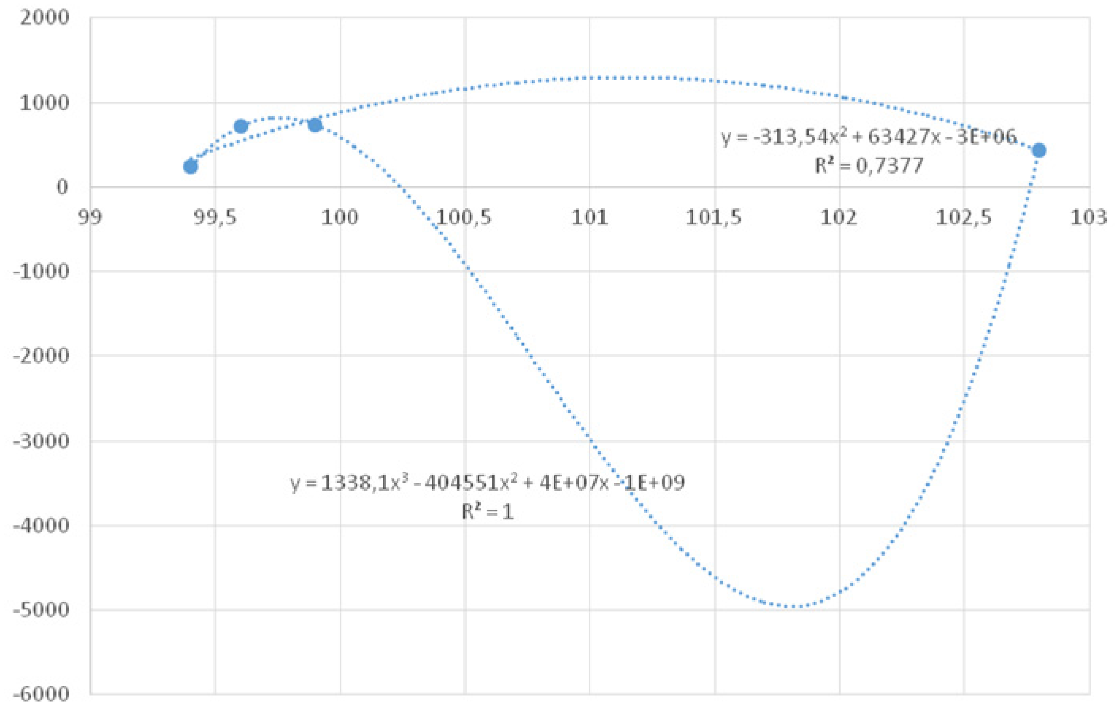

Figure 2. Dependence between the number of infrastructure facilities and GDP growth (%), China. Note: developed by the authors.

Based on the data obtained, regression dependencies are constructed:

$$Y(RF) = -0.2367x^2 + 50.454x - 2661.6,$$

where x is the GDP growth rate (%) and y is the number of large sustainable infrastructure facilities put into operation.

Correlation coefficient: $R^2 = 0.9987.$

$$Y\ (China) = -313.54x^2 + 63427x - 3E + 06$$

$R^2 = 0.7377$

$$Y\ (China) = 1338.1x^3 - 404551x^2 + 4E + 07x - 1E + 09\ R^2 = 1,$$

where x is the GDP growth rate (%) and y is the number of large sustainable infrastructure facilities put into operation.

Since the correlation coefficient exceeds 0.8, the developed models may be deemed adequate. Consequently, the construction industry can benefit from the SC framework, which consists of social, environmental, and economic components, if the national business environment is sustainable.

Based on the calculations, it is clear that there is a dependence of GDP on the construction industry. This may be attributed to the fact that the construction industry continues to be among the drivers of innovation in the modern world. It influences the development of relative industrial activities (engineering, metallurgy, electricity production, transport, etc.) while being the foremost consumer of their products. Moreover, the construction industry determines the socio-economic well-being of the country. Hence, the development in the construction sector meets the needs for construction projects and contributes to infrastructure improvement, therefore creating additional jobs and affecting people's employment. Accordingly, the construction industry and its sustainability, implemented through various projects, directly affect most aspects of life (including its quality) of a particular society (in this case, Russian and Chinese).

Opportunities for a transformation of SD lie in fostering healthier and reduced consumption as well as in healthy and job-creating green developments. This, however, requires the development of a better understanding of the implications of green developments on employment and health and their societal co-benefits, thereby preventing undesired effects. Large public health savings are possible by investing in transport, cleaner air, water, and greener energy [41]. It remains a matter of great importance because today, for Russia and China, energy consumption in the construction sector is about 25% of the total primary energy or about 40% of the final energy demand [45]. Thus, in the process of transitioning to SD in the construction industry, the state receives an increase in national welfare (it was proven empirically), an improvement in the quality of life of the population, and resource saving. However, since the construction industry integrates other sub-sectors, harmonization of the sustainability policy is crucial not only for construction projects but also for building materials procurement, energy generation, and city management.

A striking example of the inconsistency of SD policies is that one-quarter of the world's forests are situated in the European region, of which approximately four-fifths are in the Russian Federation. In the Caucasus and Central Asia, forest area has been expanding mainly due to major afforestation and reforestation programs. Nevertheless, forest cover in China remains low and must compete with other land uses [46]. The overall area of protected forests is now about 40 million hectares, 17.5 million of which are in the Russian Federation. Forests provide watershed services such as storage, purification, and release of water to surface water bodies and subsurface aquifers. In parallel, they also contribute to the slowing down of erosion and desertification phenomena. The regions' forest ecosystems are key to SD, contributing to climate change mitigation through carbon storage in trees, litter, soil, and harvested wood products, and providing renewable construction material and sources of energy. Along with the overall forest area in the region, forest fragmentation also increases and has a detrimental effect on the most important habitats, which violates the principles and algorithms of SC at the raw material procurement level [47].

The trend towards green building began in the 1970s in the wake of the oil crisis, when energy importers faced a fourfold rise in energy costs. The post-war modernist housing development in Europe turned out to be wasteful. In Russia, this is clearly seen in the example of Khruschev-era houses—they were built only for 20 years without any wall insulation since it was assumed that energy would be almost free in the communist future. Such houses operate even now, and servicing those old buildings "steals" the benefits and income that the country receives from SC. Hence, despite the proven positive impact of SC on social welfare, in practice, it may be weakly felt due to the imbalance in the previous policies.

As mentioned above, SC is, to a certain extent, a response to the volatility of energy markets. For the People's Republic of China (PRC), whose economy is highly energy-intensive, the factor of energy costs has become determining. According to the theses of the Ministry of Housing and Urban-Rural Development of the PRC, modern China can save on average four times more energy than invest in new energy capacities [48]. The Five-sphere Integrated Plan of the PRC (the general plan for the development of China, put forward at the 18th CPC (Communist Party of China) National Congress in 2012) declares that he country can no longer afford the inefficient construction and operation of buildings [49]. Today, PRC tends to build huge eco-cities rather than develop individual projects on SC within specific settlements. Such a decision primarily resulted from the unification of facility management (facilities built for common technologies and requiring an integrated approach to maintenance) and the harmonization of sustainability policies in the same territory (which allows for recognizing the advantages of SD in construction that were not eliminated by previous shortcomings).

Therefore, in conditions where sustainability policy is harmonized and includes sub-sectors that adhere to general principles and standards, SC becomes a significant competitive advantage for countries in international (strengthening the energy and economic security of the nation) and domestic markets (increasing the competitiveness of products, services, and technologies). Moreover, SC opens up new perspectives on the environmental background (rational use of raw materials) and social background (job creation and reduction of social inequality), as well as improving the population welfare.

5. Discussion

It is essential to bear in mind that measuring SD means moving beyond GDP. Green accounting is a technique for assessing and better recognizing the contribution of ecosystems and other natural resources to GDP. If GDP growth is achieved by depleting natural capital, then GDP figures should be adjusted downward by the estimated value of depleted natural resources or the degraded ability of ecosystems to deliver economic benefits or cultural services [50]. Measuring natural capital is of vital importance for the transition to a green economy. Accounting for natural capital and valuing ecosystem services and biodiversity is necessary for effective government policymaking and reallocating investments. Changes in stocks can be evaluated in monetary terms and incorporated into the national accounts, as in the System of Environmental-Economic Accounts developed by the United Nations Statistical Division and in the adjusted net national savings methods of the World Bank [51]. Progress has already been made on accounting for marketed resources, such as minerals, and efforts are underway to value non-marketed resources, e.g., flood protection. The broader use of such complementary measures, including net domestic product and actual savings rates, would provide a more accurate and realistic indication of the level of economic output and total inclusive wealth, including stocks of physical, human, and natural capital [52]. In such a manner, GDP remains the most understandable and quantitatively measurable reflection of the country's economic reality. However, it does not allow assessing the real quality of life of a society and its degree of stability. The use of GDP in the calculations should be practiced only for the quantitative assessment of specific dependencies, while sustainability in construction can be evaluated through other parameters. For example, studies linking employment and energy efficiency estimate that between 40 and 100 new jobs could be created per petajoule of primary energy saved [53].

Green buildings, retrofitting, or energy-efficient building components lead to benefits in terms of direct, indirect, and induced jobs [54]. Many initiatives for better efficiency in buildings at the country level have been implemented: the formation of green building councils (Germany, Romania), energy-efficiency standards (e.g., Passivhaus/Passive House in Germany and the United Kingdom, Haute Qualité Environnementale in France, Minergie in Switzerland), and retrofitting programs (e.g., German Alliance for Work and the Environment's Initiative to Retrofit German Homes).

The German Alliance for Work and the Environment's retrofitting program, launched in 2001, has created around 140,000 new jobs and reduced annual CO_2 emissions from buildings by about 2%. Given the high percentage of pollution caused by conventional buildings, this retrofitting program continues to be one of Germany's major strategies to reduce emissions by 40% in the period from 1990 to 2020 [55].

Developing countries rely on somewhat more straightforward approaches and require support from supranational institutions. The Global Environment Facility and United Nations Development Programme (UNDP) are partners in promoting Energy Efficiency in the Construction Sectors of Armenia, Kazakhstan, Kyrgyzstan, Turkmenistan, and Uzbekistan. This project was launched in 2008/09, with an overall objective to reduce energy consumption and greenhouse gas emissions in construction sectors by 30–40% against the starting level [56]. The implementation of such programs enables the achievement of the related SD goals, such as a decrease in air and noise pollution, and improvement of the opportunities for physical activity. It provides a powerful incentive to review how the construction sector can contribute to enhancing human health.

6. Conclusions

The growth and development of the world have a large impact on our natural environment. The importance of the SC concept implementation is explained by the fact that the building industry generates 35% of the total greenhouse gas emissions and 33% of all waste. At the present stage of the development of society, SC ensures the quality of human life and the safety of the environment. The SC concept helps to minimize the negative impact on the environment, human health, and biodiversity. Moreover, green building technologies allow using non-renewable resources more optimally.

In the construction industry, the following elements of SD can be distinguished:

- Economy (facility life-cycle cost, low building operating costs, landscaping, and greening of adjacent territories);
- Environment (limited use of raw materials and natural energy sources and ecosystem protection);
- Society (improved quality of life, provision for social self-determination and cultural diversity, protection and promotion of human health through a healthy and safe working environment).

This paper reveals how important macroeconomic sustainability is for the implementation of innovative projects in the construction industry within the framework of SD. Large sustainable projects can only be implemented if the business environment reaches SD.

Within the framework of the study, linear regression models are constructed that depict the connection between the GDP growth and the number of large sustainable infrastructure facilities put into operation. The correlation coefficient of 0.9987 corresponds to a strong correlation.

Limitations of the study lie in the fact that the investigation covered only developing countries, and the methodology for determining which may vary. The proven practical value of this research can be attributed solely to the countries under consideration. For other developing nations, this value is hypothetical.

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