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Does a National Innovation System Encourage Sustainability? Lessons from the Construction Industry in Serbia

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Abstract: Influences from the modern business environment indicate the need for the incorporation of sustainability concepts from an innovation system perspective. In the presented research, we emphasize the energy efficiency concept within the frame of sustainability and innovation. The aim of this research was to underline and explore the relationships between innovation, energy efficiency, and sustainability in the construction industry. To answer the research questions, a questionnaire was created to explore the impact of the energy efficiency certification process on the innovation behavior of construction industry enterprises in Serbia. The results show that energy efficiency has supported innovation, and that there exists a relationship between sustainability and innovativeness in the construction industry. Applying energy efficiency passports has influenced the co-operation of enterprises in the construction sector and other actors in the national innovation system in Serbia. The innovation concept demonstrates that enterprises in the construction industry should be observed as a part of the wider picture—the national innovation system. In turn, the specific context of a particular national innovation system should be seen within the wider picture of national innovation systems of Central and Eastern European Countries (CEECs).

Keywords: innovation; energy efficiency; sustainability; innovation system; collaboration

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1. Introduction

The modern business environment has created a new concept of sustainability, observed in relation to innovation system perspectives. The relationship between innovation and sustainability has been reported in the literature [1–4]; however, it remains under-researched [5]. A national innovation system includes complex interactions between many institutional actors and processes which encourage innovation to create sustainable development. According to the literature, the likely most-cited quote refers to innovation as a factor of economic development. The differences between nations, in terms of economic development, may be explained in terms of the differences in national innovation system efficiency [6,7]. Furthermore, sustainable development is seen as imperative for developing nations. Sustainability merges environmental, social, and economic performance, and includes different stakeholder interests with collaboration potential [5]. The same approach that takes into account stakeholder interactions could be applied to explain a national innovation system [8]. The existing literature has indicated the importance of collaboration between national innovation system actors, such as research institutions (institutes and universities), industries, and policymakers. Collaboration between national innovation system actors supports sustainable development [9]. Some aspects of collaboration between different actors have been investigated in the literature, such as that between universities and industry, with the purpose of underlining knowledge transfer towards environmental sustainability and the benefits from this kind of collaboration for all of society [10,11]. However, there is a lack of knowledge regarding collaboration between all national innovation system stakeholders within the frame of sustainability.

Some studies have investigated the influence of technological innovation on corporate sustainability and have found that Central and Eastern European Countries (CEECs) show poor innovation and sustainability potential compared with Western countries. However, despite this, the connection between innovation and sustainability has been recognized in the financial sectors of these countries [5].

The intention of this work is to provide new insights and a better understanding of sustainability-oriented innovation in the construction industry in Serbia—in particular, the national innovation system of a post-communist country—bearing in mind its huge impact on the environment. The development of energy efficiency in the construction industry encourages greater environmental responsibility toward sustainable development. Sustainability in the construction industry is based on positive long-term environmental impacts. To protect the environment and improve companies, in the context of all aspects of sustainability, enterprises apply new technologies in all parts of the construction process. The innovation process of the construction industry is basically linked to these technologies. The energy efficiency certification process is closely related to the application of all these technologies, and includes many parties. Sustainable construction increases market share and profitability, as well as strengthening ties among stakeholders and employees [12].

According to the Sustainable Development Goals defined by the United Nation (UN), there is a need to align research and development (R&D) with social expectations [8]. The UN adopted Resolution A/RES/70/1—Transforming our World: the 2030 Agenda for Sustainable Development—at the summit held in September 2015. The Agenda represents a universal strategy, obliged by signatory states to achieve 17 goals by 2030. The aim includes three dimensions of sustainable development: economic growth, social inclusion, and environmental protection [13].

The Energy Efficiency Financial Institution Group (EEFIG) considers that its recommendations for market and "policy-led actions should be considered in the context of broader structural reforms needed to improve the competitiveness of the European Union (EU) economy and ensure the Investment Plan for Europe has a sustained impact on the EU 2030 climate and energy strategy". These actions include, but are not limited to, the following:

- The improvement of building certification methodologies and energy performance certification standards and the implementation of minimum performance standards upon building upgrade, sale, or rental, in order to help build a vibrant and comparable pan-European market for building energy efficiency investments;
- The development of a project-rating system to provide a transparent assessment of the technical and financial risks of building energy renovation projects and their contracting structure [14]. Bearing that in mind, with the adoption of the National Strategy for Sustainable Development of the Republic of Serbia in 2008, with the Action Plan for Implementation, energy efficiency has been identified as a priority measure for this strategic framework. The First National Plan for Energy Efficiency of Republic of Serbia was adopted in 2010. Since then, the Republic of Serbia has been working intensively on the implementation of energy efficiency, in accordance with Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy efficiency of buildings. The key moment for further development of energy efficiency was the development of a legal framework in this area that created the conditions for the implementation of energy efficiency measures in buildings, by adopting a methodology for determining the energy performance of buildings and a methodology for calculating the energy required for heating in buildings. The adoption of this legal framework was followed by the training and licensing of responsible engineers and companies, networking, and ensuring the co-operation of stakeholders, such as the Serbian Chamber of Engineers, universities, regional

development agencies, local governments, manufacturers of construction materials, professionals, construction companies, project offices, etc. All of these inputs were included in the empirical research of the paper.

Since 2011, energy passports have been issued in Serbia. Experts and professionals in the engineering profession, representatives of ministries, employees in local self-governments throughout Serbia, employees in the business sector, and financial institutions have actively participated in the improvement of conditions and methods of the energy certification of buildings [15]. The starting point of this research was based on official data regarding the construction sector within the Statistics of Science, Technology, and Innovation of the Republic of Serbia—indicators of innovation activities for a period of ten years, starting from 2011. After the construction enterprises started the energy certification process, an increase in innovation (to 42.6%) was noticed [16–19]. The question that arose was: Does the energy efficiency certification process lead to an increase in innovation in the construction industry?

In this research, our main attention is focused on energy efficiency, as one aspect of innovation in terms of sustainability. As this process has created wider impacts, it will also tackle other aspects of sustainability. Sustainability integrates environmental, social, and economic perspectives encompassing different actors. The construction industry was chosen as one of the most important end-users of environmental resources [20]. According to the literature, some insights toward sustainability-oriented innovation in the construction industry have been put forward [21–24]. Sustainability-oriented innovation issues have not generally been investigated by scholars, and are not currently under research, especially when it comes to energy efficiency.

The presented research is in line with the growing body of literature regarding the importance of spatially bounded systems of innovation. This work focuses on the national innovation system in Serbia, which has experienced the same context of transition of the socio-economic paradigm as Central and Eastern European Countries (CEECs), but according to its own, specific pattern [25].

To shed light on these issues, as part of this research, an empirical survey was conducted in the construction industry in Serbia.

The main variable investigated in this paper is environmental sustainability, in relation to business innovation sustainability. This paper investigates the energy efficiency certification process in the construction industry within the frame of sustainability and innovation, emphasizing the importance of collaboration between all the actors involved in the national innovation system. In the following sections, the theoretical framework of the research is presented. This is followed by the method, describing the empirical design, and then the results, discussion, and conclusion, along with suggestions for future research.

2. Literature Review

2.1. National Innovation System, Regional Innovation System, and Sustainability

There is no doubt that there is a close connection between innovation and sustainability. Innovation creates business frameworks for sustainability [1–4,26,27]. The corporate sustainability aspect is of great importance for sustainable development [28]. As sustainability merges environmental, social, and economic performance, it can be observed from the stakeholder theory point of view [1], as well as from that of national innovation systems. The national innovation system concept has explained the institutional context of performing innovation activities by a nation [29,30]. The idea of this systemic approach covers not only the complex system of different actors, but also their interactions [21]. The main point is how to explain correlations between the producers and users of innovation [31]. The importance of national innovation systems arises from the networks of institutions that are significant for the innovation of firms [32].

On the other hand, sustainable development can be seen as an imperative of national development. Research has shown that inter-firm networks are essential for understanding innovation and their acceptance [33,34]. These relationships are recognized as a key aspect in economic adaptation towards eco-innovation [33]. Collaboration is seen as an ontological sustainable innovation component in the literature [35]. It is closely connected with the concept of an "innovation system", national innovation system, or regional innovation system.

Regional innovation systems are seen as a way to obtain effective national innovation systems [34,36,37]. Public support for innovation should be in line with the private sector's support for the development of regional innovation systems (RISs) and the knowledge economy [38]. The RIS concept combines the literature on innovation and the literature regarding the region. The innovation literature, from a system perspective, explains the innovation process as a result of the quality of interaction of "firms, universities, and research centers", while the literature regarding regional innovation can be observed in a spatial context, where the "socio-institutional environment and economic structure" enable knowledge creation and diffusion among the institutional actors [39].

2.2. Sustainability and Innovation in Construction Sector

Understanding innovation in construction industry enterprises has been determined by the nature of the construction industry itself, creating multidimensional impacts in many areas [40]. Some authors have shown that there are four types of influence—technological, institutional, internal action, and market influence—that lead towards a sustainable construction industry [41]. More than half of the funding for the most valuable program for research and development, Horizon 2020, is dedicated to projects regarding sustainability. It is estimated that "sustainability focus could have a strong impact on the future of the European construction industry" [42]. The transition to a sustainable economy has shaped the largest part of recent energy technology innovation process [43]. Studies that encompass sustainability and innovation for particular industries have been carried out, with most efforts having been focused on manufacturing, although there has also been some research in the financial industry [5]. Some aspects of collaboration have been noticed between actors in national innovation systems; for example, among industries and universities [10,11].

Innovation is vital for successful long-term company performance in the construction industry. Although construction innovation has advanced rapidly with companies investing in new technologies, this paper is focused on the energy efficiency certification process. The environmental impact caused by the construction sector has been emphasized. Therefore, sustainability is seen within the frame of this industry [44]. It has been recognized, in the literature, that construction industry innovation is driven by collaboration between this industry and external parties [22–24,33,34,45].

Empirical research in the Dutch construction industry indicated the following innovation drivers: environmental pressure, technological capability, knowledge exchange, and boundary spanning. This construction industry showed that innovation is driven by many actors who are interested in enabling innovation processes [46]. However, collaboration in innovation among enterprises in the construction industry and other stakeholders within the framework of national innovation systems is still under-researched.

In the construction industry, there exists the challenge that contractors must meet the emerging need to reduce the environmental impact caused by the construction process, as exerted by environmental regulations and stakeholder demands [47]. Among other things, dedication to environmental requirements satisfaction is influenced by environmental regulations [48]. An analysis of sustainable innovation has integrated the concept of the whole innovation system, including ecological, economic, and social impacts [48,49]. The same elements of sustainable development have been recognized for the construction industry, as well [50].

2.3. Central and Eastern European Countries (CEECs), Innovation, and Sustainability

During the process of transition, Central and Eastern European Countries (CEECs) began the transformation of their economic, social, and political systems, forming new patterns of economic development [51]. Their central planning systems collapsed and fundamental economic and political reform began.

National innovation systems, in general, have the ability for sustainable development. The sustainability essence of national innovation systems is based on consistent development in social, political, economic, and technological areas [52]. Central and Eastern European Countries (CEECs) have shown poor innovation and sustainability orientation compared to other Western countries [5].

The main features of national innovation systems are their changes, in accordance with the national socio-economic paradigm. Nelson underlined differences between national innovation systems in Soviet and capitalist economies. In capitalist countries, technological change is "set up as an evolutionary process", while in Soviet-style economies technological change is observed as a central planning process [53] (p. 313). The process of innovation is conceived of as a rational process, which is subject to socialist planning. Innovation in socialist economies is incremental, rather than the radical and copy-based pattern in Western countries [54]. Research, development, and innovation are not market-driven, which formed the spatial type of a non-efficient national innovation system. On the other hand, the results of research and development activities are considered innovations if there exists a market need for them [55].

In the late 1980s, after the democratic transition and collapse of Soviet-style communism in Central and Eastern Europe (CEE), the socio-economic paradigms of these countries experienced major revisions. External influences, especially from EU countries, have shaped and made easier the consequent economic reforms and structural changes toward globally integrated CEE economies [56].

The literature suggests that Central and Eastern European countries are specific national innovation systems. According to Radosevic [57], the nationally specific patterns of innovation systems in CEECs are specified by: historical heritage; institutional features; generally adopted patterns for all CEECs derived from the previous centrally planned period; and patterns of research and development (R&D) transformation determined by national specifics. Economic recovery, economic growth, and sustainability in Central and Eastern European countries in the post-communist period are closely connected with their innovation systems [58].

According to the literature [59,60], the likely most-cited quote refers to innovation as a factor of economic development. This is feasible for highly developed countries, but not for CEECs. In modern market conditions, characterized by a rapid saturation of demand, a company's competitiveness is determined by its innovation capacity, rather than its productivity. It is, therefore, necessary to ensure the timely adaptation of innovative products and processes to market requirements.

CEE countries have shown lower innovation capacity [5]. For less-developed countries, it is important to develop a stable socio-economic framework that enables innovation. There is the need for better linkage between R&D capacities and economic needs.

First of all, they should be market-driven, which directly triggers innovation activities.

The National Innovation System in Serbia was, for a long time, under the influence of an inherent socio-economic system, and it is currently under a process of transformation. A lack of effective co-operation between companies and public institutions has been identified [61].

Comparative analysis regarding innovative performances between Serbia and surrounding countries has shown that Serbia achieved lower rankings in each of the several pillars of the Global Innovation Index for 2018. Among other recommendations for the improvement of the current state is better co-operation between the state, educational and scientific institutions, and the economy, regarding innovation [62].

The process of socio-economic changes in developing countries and specific regions, such as Western Balkan countries, has triggered new challenges for national innovation systems in terms of increasing their efficiency. R&D activities should be recognized as factors for long-term economic development [63].

National innovation systems in countries under socio-economic transformation are moving toward sustainability through constant changes in development priorities based on different kinds of innovation [52]. Most developing countries have built institutions to deal with sustainability. Innovation is a seen as a positive trigger of sustainability [64].

3. Materials and Methods

3.1. Research Questions

Related to the literature review and empirical research, this paper is focused on the following research questions: investigating the prospect of introducing the concept of energy efficiency processes for Serbian construction enterprises; whether, in which context, and how energy efficiency is related to innovation in the construction industry; how the energy efficiency certification process affects co-operation among stakeholders in the national innovation system; and what are the obstacles that affect the innovation behavior of these enterprises regarding environmental issues?

In this vein, in order to elaborate upon the further presented topics, the following hypotheses were formulated:

- Energy efficiency endorses innovation in the construction industry.
- The application of energy efficiency passports influences co-operation within the national innovation system.

3.2. Questionnaire Design

In order to investigate the above-mentioned research questions, we created a questionnaire to explore the impacts of the energy efficiency certification process on the innovation behavior of construction industry enterprises. The innovative behavior in this sector is examined in the light of applying Energy efficiency regulation Official Gazette RS no. 2011/61.

The questionnaire was made as short as possible, and was logically structured in three sections. The first part covered general questions about the examined enterprises: geographical area of the headquarters of the enterprises, number of employees and their structure by gender, etc. [65,66]. The second part was dedicated to energy efficiency within the frame of the innovative behavior of construction industry enterprises [67]. The third part of the questionnaire was dedicated to co-operation with respect to innovation, and the hampering factors of such co-operation.

The majority of enterprises in the construction sector introduced energy efficiency passports, and the possible effects of these actions that could have an impact on innovation are listed in Table 1. Building on the generic innovation indicators [68,69] and elements of sustainable development in the construction industry [49], we created the list of certification process items relating to the innovation behaviors of the enterprises. They represent the necessary integration of the concepts of sustainability and energy efficiency to facilitate the innovativeness of the companies. The listed items allowed for a comprehensive approach toward environmental, economic, and social goals, such as sustainable development goals. We defined actions regarding innovation progress in the construction industry.

In order to answer the first research question, environmental sustainability was investigated in relation to business innovation sustainability. We created the following variables of interest: Environment usefulness, combining nine questions (Appendix A) referring to the environmental benefits of innovation behavior after obtaining an energy efficiency passport [67]; and the Business innovation usefulness variable, consisting of eight questions (Appendix A) referring to business process innovation within the framework of the construction industry itself. All processes related to business functions can be assessed as objects of innovation activity. In the last edition of the Oslo manual, several main functional categories for identifying the type of business process innovations have been presented [69–71].

Table 1. Percentage of companies that went through the energy efficiency certification process.

Certification Process Items	Yes	No
Improved co-operation with other enterprises	75.3	24.7
Enhancement of the expenditures of the enterprise	57.5	42.5
Hampering factors during the certification process	58.9	41.1
Underdeveloped infrastructure network as a hampering factor	72.6	27.4
Improvement of existing facilities and/or influenced design of energy efficient facilities	67.1	32.9
Information system toward sustainable development	63.0	37.0
Concepts of sustainability applying innovation systems are vital for the future business of the enterprise	75.3	24.7
Development of employee competence	71.2	28.8
Increasing of own revenues in 2020 compared to 2011	45.2	54.8

In order to answer the second research question, we examined the extent to which innovative enterprises in the construction industry co-operated better with other stakeholders in the national innovation system after obtaining energy passports. The literature has suggested that co-operation is the one important issue that improves enterprise innovation [72]. The level of obstacles that hamper innovation behavior was examined as well. Six question that describe hampering factors for enterprises' innovativeness were combined in the variable Obstacles.

The list of the significant measured survey items is given in Appendix A. The items that are presented were measured on a 4-point Likert scale [73–76]. The Environment usefulness and Business innovation usefulness items were scaled from 1—"not at all applied" to 4—"completely applied", while Obstacles items were scaled from 1—"not at all affected" to 4—"completely affected". The final measures are given as average values of items, listed in Table A1 in Appendix A. The descriptive statistics of these items are given in Table 2 in the Results section. The questionnaire also examined the amount of co-operation with different partners of construction companies. The list of partners involved Suppliers of equipment, materials, components or software, Private sector clients, Public sector clients, Competitors or other enterprises from the sector, Universities/Faculties, Research institutes, and Non-profit organizations. The amount of co-operation was also measured on a 4-point Likert scale, from 1—"not at all significant" to 4—"extremely significant".

Table 2. Descriptive statistics of assessed variables.

							Correlation Coefficients	
Variable	**Mean**	**SD**	**N of Sub-Items**	**Cronbach's Alpha**	**AVE**	**CR**	**Environment Usefulness**	**Business Innovation Usefulness**
Years of work	14.63	17.324	/	/	/	/		
N of employees	154.03	554.773	/	/	/	/		
Environment usefulness	3.01	0.700	9	0.939	0.677	0.950	/	
Business innovation usefulness	2.75	0.848	8	0.955	0.760	0.962	0.657 ***	/
Obstacles	3.29	0.655	6	0.896	0.660	0.921	0.255 *	0.202

* $p < 0.05$, *** $p < 0.001$.

There was a strong positive correlation (0.657) between Environment and Business innovation usefulness. Obstacles was weakly correlated with Environment, and not correlated with Business innovation usefulness. Next to the defined measures, Table 2 also shows the average amount of time that the construction companies had been operating in the territory of Serbia (M = 14.63, SD = 17.324 years) and the average number of employees (M = 154.03, SD = 554.773).

3.3. Data Collection Sample

During the past years of work and experience in the field, the authors obtained a list of firms operating in the construction industry in Serbia. The questionnaire was sent to the CEOs of 105 firms in September 2020. The total number of acquired responses was 86. It was gained from September to December 2020, and provided a response rate of 71.2%.

Most of the surveyed construction companies were located in Belgrade (64.4%), while 9.6% were located in Vojvodina, and the rest (26%) were located in Central and Southern Serbia. Regarding the influence of COVID-19 on the activities in the enterprise, especially concerning the building certification process, 71.2% of the surveyed companies replied that they were influenced by COVID-19.

4. Results

Our main research focus was on particular certification process items, as given in Table 1. For most construction companies, the certification process improved co-operation with other enterprises (75.3%), but also increased the expenditures of the enterprise (57.5%). Most of the companies had met some hampering factors during the certification process (58.9%), with one of the particular factors being the underdeveloped infrastructure network (72.6%).

For most companies, active enterprises with their own innovations influenced the process of the improvement of the energy efficiency of buildings (67.1%). Additionally, in 63% of cases, information systems implied the sustainable development of the structures. The concepts of sustainability and the application of innovation systems had significant importance for the future business of the enterprise in more than 75% of enterprises. Regarding Energy passports, they influenced the development of employee competence in 71.2% of cases but, on the other hand, they influenced an increase in own revenues in 2020 compared to 2011 only in 45.2% of cases.

The main descriptive statistics of the surveyed items, as defined in Section 3.2, are given in Table 2. The measurement scale Environment usefulness consisted of nine sub-items (Section 3.2, Appendix A). We used Cronbach's alpha as an appropriate measure for the internal consistency of the constructs [77]. The Cronbach's alpha for this measurement was 0.939, which indicates the excellent internal consistency of the scale [78,79]. The measurement scale Business innovation usefulness consisted of eight sub-items, and its Cronbach's alpha of 0.955 also indicated excellent internal consistency. Obstacles consisted of six sub-items and, for this scale, the Cronbach's alpha of 0.896 indicated very good, almost excellent internal consistency. Besides Cronbach's alpha, the average variance extracted (AVE) and Construct Reliability (CR) were used [80], which are appropriate measures for assessing the reliability of constructs [81]. The closer these indices are to 1, the better the internal consistency is, thus showing that the scale is more reliable. The threshold for the acceptable level for AVE is above 0.5, while that for Composite Reliability is above 0.7 [80,82]. The constructs Environment usefulness and Obstacles had AVE values above 0.6, while that of Business innovation usefulness was above 0.7. All constructs had CR values above 0.9. The potential problem of common method bias (CMB) [83–85] was examined using Harman's unrotated single factor test, which has been widely and commonly used to test for the CMB [86,87]. The results showed that the single factor of Harman's test accounted for 43.56% of all the defined items (Appendix A), which was less than the 50% threshold.

To examine our hypotheses, we combined the parametric tests as Independent samples *t*-test [88] or Pearson correlation [89,90] for the scaled variables presented in Table 2, and non-parametric Mann–Whitney (MW) [91] and Friedman [92,93] tests for variables measured on 4-point Likert scales. Table 3 presents the results of the *t*-test for Environment usefulness, Business innovation usefulness, and Obstacles between the companies with or without a particular certification process. There was a significant difference in Environment and Business innovation usefulness for companies where the certification process had improved co-operation with other enterprises. Those companies exhibited greater Environment ($p = 0.004$) and Business innovation usefulness ($p < 0.001$) as opposed to those where the certification process had not made any improvements. Yet, companies where the certification process had improved co-operation with other enterprises encountered the same amount of Obstacles in doing business ($p = 0.691$), compared to the ones where this was not the case. There was no difference in Environment usefulness ($p = 0.118$) between companies where the certification process had or had not increased expenditures, but the Business innovation usefulness was higher ($p < 0.001$) for companies where these expenditures were increased, and they encountered a higher level of Obstacles ($p = 0.011$). Companies which more frequently encountered hampering factors during the certification process had higher Environment ($p = 0.026$) and Business innovation usefulness ($p = 0.002$), and the same went for those that came across underdeveloped infrastructure networks more often ($p = 0.040$; $p = 0.035$); yet, they encountered the same level of Obstacles. Companies with an improvement in existing facilities and/or influenced the design of energy efficient facilities had higher Environment usefulness ($p = 0.028$) and Business innovation usefulness ($p = 0.001$), as well as a slightly higher level of Obstacles ($p = 0.017$). Furthermore, companies for which information systems implied sustainable development and energy efficiency had higher Environment usefulness ($p = 0.002$), Business innovation usefulness ($p < 0.001$), and Obstacles ($p = 0.011$).

Table 3. Results of the *t*-test for Environment usefulness, Business innovation usefulness, and Obstacles.

		Environment Usefulness		Business Innovation Usefulness		Obstacles	
Certification Process Items	**Hold**	**Mean**	***t*-Test Sig.**	**Mean**	***t*-Test Sig.**	**Mean**	***t*-Test Sig.**
Improved co-operation with other enterprises	Yes	3.14	$p = 0.004$	2.99	$p < 0.001$	3.31	$p = 0.691$
	No	2.60		2.03		3.24	
Enhancement of the expenditures of the enterprise	Yes	3.12	$p = 0.118$	3.06	$p < 0.001$	3.46	$p = 0.011$
	No	2.86		2.34		3.07	
Hampering factors during certification process	Yes	3.16	$p = 0.026$	3.00	$p = 0.002$	3.39	$p = 0.131$
	No	2.79		2.39		3.16	
Underdeveloped infrastructure network as a hampering factor	Yes	3.11	$p = 0.040$	2.88	$p = 0.035$	3.34	$p = 0.309$
	No	2.73		2.41		3.17	
Improvement of existing facilities and/or influenced design of energy efficient facilities	Yes	3.13	$p = 0.028$	2.98	$p = 0.001$	3.42	$p = 0.017$
	No	2.75		2.29		3.30	
Information system toward sustainable development	Yes	3.19	$p = 0.002$	3.07	$p < 0.001$	3.44	$p = 0.011$
	No	2.69		2.21		3.04	
Concepts of sustainability applied to innovation systems are vital for the future business of the enterprise	Yes	3.10	$p = 0.047$	2.91	$p = 0.005$	3.34	$p = 0.309$
	No	2.72		2.27		3.16	
Development of employee competence	Yes	3.12	$p = 0.031$	3.01	$p < 0.001$	3.38	$p = 0.086$
	No	2.73		2.12		3.09	
Increasing of own revenues in 2020 compared to 2011	Yes	3.26	$p = 0.004$	3.22	$p < 0.001$	3.43	$p = 0.111$
	No	2.80		2.36		3.18	

Furthermore, from Table 3, we can see that if the concepts of sustainability applied to innovation systems were vital for the future business of the enterprise, this resulted in higher levels of both Environment ($p = 0.047$) and Business innovation usefulness ($p = 0.005$), but a similar level of Obstacles ($p = 0.309$). Finally, companies for which Energy passports influenced the development of employee competence and the increase in own revenues in 2020 (compared to 2011) had higher Environment ($p = 0.031$ for development of employee competence, $p = 0.004$ for increase in own revenues) and Business innovation usefulness ($p < 0.001$ for both influences), yet they encountered similar levels of Obstacles ($p = 0.086$, $p = 0.111$) in doing business. All of the results from Table 3 indicate that energy efficiency is positively related to innovation, in line with our first assumption.

Further analyses regarded the partners of construction companies, including Suppliers of equipment, materials, components or software, Private sector clients, Public sector clients, Competitors or other enterprises from the sector, Universities/Faculties, Research institutes, and Non-profit organizations (as previously described in Section 3.2). Considering that the measures were on a 4-point Likert scale, we used the MW test for these analyses, which is appropriate for testing the differences between groups for Likert-type scales [94–96]. The results are given in Table 4.

Companies where the certification process had improved co-operation with other enterprises did not differ in the amount of co-operation with Suppliers of equipment, materials, components or software and Public sector clients, compared to those for which this improvement did not happen. However, they did have better co-operation with Private sector clients ($p = 0.034$), Competitors or other enterprises from the sector ($p = 0.029$), Universities/Faculties ($p = 0.005$), Research institutes ($p = 0.012$), and Non-profit organizations ($p = 0.007$). In most cases, the hampering factors did not influence co-operation with partners. Innovative companies, whose innovation actions improved existing facilities and/or influenced designing energy efficient facilities, had better co-operation with Private sector clients ($p = 0.001$), Competitors or other enterprises from the sector ($p = 0.013$), Research institutes ($p = 0.014$), and Non-profit organizations ($p = 0.001$). On the other hand, companies where an information system implied sustainable development and energy efficiency had better co-operation with all the listed partners, except for Public sector clients. Co-operation with the Public sector was not influenced by almost any of the certification process items.

Furthermore, from Table 4, enterprises that found the concepts of sustainability applied to innovation systems vital for future business co-operated better with all the listed partners, except for Public sector clients. Companies for which Energy passports influenced the development of employee competence had better co-operation with most of the partners, with Suppliers of equipment, materials, components, or software ($p = 0.021$), Private sector clients ($p = 0.025$), Competitors or other enterprises from the sector ($p = 0.007$), Universities/Faculties ($p < 0.001$), Research institutes ($p = 0.039$), and Non-profit organizations ($p = 0.034$). The influence of Energy passports on the increase in revenues also resulted in better co-operation with Private sector clients ($p = 0.021$), Public sector clients ($p = 0.026$), Competitors or other enterprises from the sector ($p = 0.008$), Universities/Faculties ($p = 0.003$), Research institutes ($p = 0.012$), and Non-profit organizations ($p = 0.005$).

We additionally examined which partners construction companies found most significant when it came to co-operation. We ranked the partners according to the mean value of co-operation level relevance, and examined the differences using the Friedman test. Considering that the Friedman test is a non-parametric test, besides the mean value of co-operation level, we also present the Friedman mean rank to testify the differences. The results are presented in Table 5.

Table 4. Results of the Mann–Whitney (MW) tests for partners.

Certification Process Items			Suppliers	Private Sector Clients	Public Sector Clients	Competitors or Other Enterprises	Universities/Faculties	Research Institutes	Non-Profit Organizations
Improved co-operation with other enterprises	Yes	MW m.r.	39.49	39.86	40.83	40.42	40.67	38.66	39.81
	No		29.39	28.25	25.31	26.56	25.7	31.92	28.42
	MW sig.		$p = 0.059$	$p = 0.034$	$p = 0.005$	$p = 0.012$	$p = 0.007$	$p = 0.223$	$p = 0.029$
Enhancement of the expenditures of the enterprise	Yes	MW m.r.	39.37	42.37	39.23	38.45	42.13	37.56	41.50
	No		33.79	29.73	33.98	35.03	30.05	36.24	30.90
	MW sig.		$p = 0.231$	$p = 0.008$	$p = 0.275$	$p = 0.478$	$p = 0.012$	$p = 0.785$	$p = 0.020$
Hampering factors during certification process	Yes	MW m.r.	39.07	39.52	39.29	39.60	42.19	37.86	40.51
	No		34.03	33.38	33.72	33.27	29.57	35.77	31.97
	MW sig.		$p = 0.282$	$p = 0.200$	$p = 0.248$	$p = 0.190$	$p = 0.009$	$p = 0.666$	$p = 0.061$
Underdeveloped infrastructure network as a hampering factor	Yes	MW m.r.	38.15	38.35	39.49	38.99	39.20	39.14	41.19
	No		33.95	33.43	30.40	31.73	31.18	31.33	25.90
	MW sig.		$p = 0.416$	$p = 0.352$	$p = 0.087$	$p = 0.173$	$p = 0.134$	$p = 0.144$	$p = 0.002$
Improvement of existing facilities and/or influenced design of energy efficient facilities	Yes	MW m.r.	39.97	42.36	40.15	41.09	42.56	38.22	40.91
	No		30.94	26.06	30.56	28.65	25.65	34.50	29.02
	MW sig.		$p = 0.065$	$p = 0.001$	$p = 0.058$	$p = 0.014$	$p = 0.001$	$p = 0.463$	$p = 0.013$
Information system toward sustainable development	Yes	MW m.r.	41.15	41.60	43.60	42.34	42.30	38.89	41.41
	No		29.93	29.17	25.76	27.91	27.96	33.81	29.48
	MW sig.		$p = 0.019$	$p = 0.011$	$p < 0.001$	$p = 0.003$	$p = 0.004$	$p = 0.306$	$p = 0.010$
Concepts of sustainability applied to innovation systems are vital for future business	Yes	MW m.r.	40.52	41.55	41.27	40.42	41.09	39.18	41.30
	No		26.25	23.08	23.94	26.56	24.50	30.33	23.86
	MW sig.		$p = 0.008$	$p = 0.001$	$p = 0.002$	$p = 0.012$	$p = 0.003$	$p = 0.110$	$p = 0.001$
Development of employee competence	Yes	MW m.r.	40.38	40.37	42.51	40.13	40.22	39.11	40.88
	No		28.64	28.67	23.36	29.26	29.02	31.79	27.38
	MW sig.		$p = 0.021$	$p = 0.025$	$p < 0.001$	$p = 0.039$	$p = 0.034$	$p = 0.165$	$p = 0.007$
Increasing of own revenues in 2020 compared to 2011	Yes	MW m.r.	40.20	42.98	44.85	43.61	44.44	42.85	43.56
	No		34.36	32.06	30.53	31.55	30.86	32.18	31.59
	MW sig.		$p = 0.207$	$p = 0.021$	$p = 0.003$	$p = 0.012$	$p = 0.005$	$p = 0.026$	$p = 0.008$

Table 5. Level of co-operation with partners.

Partners	Mean	Friedman Mean Rank	Friedman Sig.
Suppliers of equipment, materials, components, or software	3.00	4.64	$p < 0.001$
Private sector clients	2.88	4.43	
Research institutes	2.74	4.07	
Competitors or other enterprises from the sector	2.71	4.04	
Public sector clients	2.66	3.84	
Universities/Faculties	2.55	3.61	
Non-profit organizations	2.42	3.38	

According to the Friedman test results, the difference in the co-operation level relevance with partners was statistically significant ($p < 0.001$). From Table 5, it can be seen that construction companies found co-operation with Suppliers of equipment, materials, components, or software most relevant, followed by Private sector clients, Research institutes, Competitors or other enterprises from the sector, and then Public sector clients. The least relevant co-operation was with Non-profit organizations. The results shown in Tables 4 and 5 are in favor of our second hypothesis that the application of energy efficiency passports has an influence on co-operation within the national innovation system.

5. Discussion

The application of energy efficiency procedures makes the public aware of energy saving, as well as environmental and sustainable development [97,98]. The number of innovative companies in the construction industry in Serbia has experienced an increase within the period 2011–2020 [16–19]. The emergence of innovative firms is of great importance to sustainable development [99]. According to the presented statistical data, the positive trend could be a logical consequence of the introduction of energy efficiency regulations.

The certification process is very significant for the future business of enterprises in the construction industry regarding environmental and innovation issues (Table 3). Our research indicated that there is a strong positive correlation between Environment and Business innovation usefulness variables. All listed certification process items showed positive trends regarding the innovative behavior of the enterprises in the construction industry within the frame of energy efficiency. The results, as mentioned above, confirm our first assumption.

Certification processes have improved co-operation between enterprises [33]. All of the companies involved in the energy certification process co-operate, while some do not have energy efficiency licensed engineers. Nevertheless, co-operation in innovation with other actors in the national innovation system is improved. Our results also extend the literature regarding the fact that the certification process accelerated the co-operation in innovation between stakeholders, emphasizing the difference in the level of co-operation, especially stakeholders involved in new technologies applied in the construction industry. Considering the fact that, in the construction industry, most innovations are related to new technologies in different parts of the construction process, the energy efficiency certification process is also very important, keeping in mind its close link with the implementation of new technologies. The most important co-operation partners for enterprises in the construction industry were partners from the business sector (Suppliers of equipment, materials, components, or software and Private sector clients); basically, partners involved in all of the innovative technological activities (Tables 4 and 5). Co-operation with Universities and Non-government institutions was identified as the least significant, but with respect and further notice of its importance for future research. Research institutes were ranked as extremely important collaboration partners. New technologies that can improve energy efficiency certification grades of the buildings are linked with new research outcomes, especially in the environmental protection aspect. Enterprises can overcome some of their "constraining peculiarities" through the process of collaboration [100]. All of the above confirm our second hypothesis.

The effective use of knowledge and new knowledge creation are secure paths to ensuring a sustainable competitive advantage [101]. The certification process influenced the development of employee competence in energy efficiency and sustainability, but also underlined the importance of innovation for these processes. This is of great importance, as innovations are knowledge-based activities. The knowledge creation process is directly linked with a firm's ability to innovate, which can lead to a sustainable competitive advantage [102,103]. In the construction industry, technological competence is very important as a managerial skill [104].

The application of energy efficiency certification processes has improved existing facilities and/or influenced the design of energy efficient facilities. Information systems can serve as tools that speed up the implementation of process energy certification towards sustainable development. On the other hand, the implementation of business process innovations is, therefore, often tied to the adoption and modification of digital technologies [69].

Obstacles affected the enterprises that were more directed towards energy efficiency slightly more. The observed companies estimated undeveloped infrastructure as the factor that hampered certification process realization the most. This was expected, as investments in the construction sector are highly capital-intensive. However, when we talk about the hampering factors for most of the companies, the certification process did not result in change.

A declining trend was only seen regarding the revenues in 2020 compared to those in 2011. Company costs in a particular period have been shown to increase after the energy efficiency certification process [105]. Such a shrinkage in revenue could be a consequence of the current global crises [106–108]. The observed companies estimated the influence of COVID-19 on the activities of the enterprise as very significant, especially concerning the building certification process [107].

There exists a relationship between sustainable development and innovation in the construction industry in Serbia. However, there is a need for strengthening its collaboration with the public and private sectors, as well as with other actors of the innovation system.

6. Conclusions

When it comes to the relationship between the national innovation system and sustainability, especially concerning sectoral approaches, there is very limited literature on the issue. Most efforts linked with innovation have focused on manufacturing, as well as some studies regarding the financial sector [5,109].

The long-term efficiency of the construction industry could rely on innovativeness [47,110], keeping in mind its linkage with new technologies, which mostly improve the innovation system within the selected sector. Sustainability-oriented innovation issues are under active research by scholars, especially in terms of energy efficiency.

Based on official statistical data from a Community Innovation Survey, which showed an increasing number of innovative enterprises in the construction industry, this empirical research was conducted.

With this study, we attempt to contribute to the analysis of the influence of energy efficiency certification processes in Serbia on sustainability-oriented innovation in the construction industry. Our research showed that the energy efficiency process has endorsed innovation and that there exists a relationship between sustainability and innovativeness in the construction industry. Through the presented research, we bring attention to energy efficiency certification processes within the frame of sustainability and innovation.

Considering the innovation concept, we underline that innovation in enterprises in the Serbian construction industry should be observed as a part of the wider picture, that is, the national innovation system. Applying energy efficiency passports has influenced co-operation among enterprises in the construction sector and other actors of the national innovation system. Some aspects of collaboration between actors have been investigated in the literature, such as that between universities and industry; however, in this research, we underline the importance of the relationships between all the actors involved in the national innovation system towards sustainability. Construction companies found co-operation to be most relevant when considering suppliers of equipment, materials, components, or software, compared to that with private sector clients, research institutes, and competitors or other enterprises from the sector. The least significant co-operation was with public sector clients, followed by non-profit organizations. The lack of co-operation in innovation between enterprises and the public sector and universities remains to be further analyzed. This can serve as a recommendation for the government, as projects in the construction industry are of great importance for sustainable infrastructure development and, as such, could bring benefits to all involved parties.

Beside co-operation, the development of employee competence is also very important for the development of sustainable innovative enterprises in the construction industry. Only the continuous professional development of employees toward sustainability importance can improve the innovation ability of the enterprise. This study showed that the professional development of employees in the construction industry includes a combination of both knowledge regarding innovation and environmental knowledge in an integrated approach towards knowledge about sustainability.

In this research, we use the term national innovation system as we conducted research with respect to the national economy. However, the concept of an innovation system is not restricted to national states. The regional innovation system dimension has been widely dealt with in the literature and can serve as a framework for analysis in some future research.

The research presented here has some practical implications. Our findings provide a useful guide for firms in the construction industry in terms of understanding and applying a comprehensive framework for observing sustainable development as a linkage between energy efficiency processes and innovation. In this way, companies in the construction industry could find the most effective mode to facilitate future innovation. We investigated aspects between innovation and sustainability in the construction industry, thus opening the door for future research to take into account the outcomes of the undertaken study for other industries.

One of the limits concerning this research is related to spatial boundaries, as the investigation process was carried out only in one country with a specific certification process, including the achievement of energy grades by the calculation of heating energy only. Cooling energy demands are not taken into consideration. Furthermore, collaboration between the actors of the national innovation system is limited in the construction industry. More precise conclusions could be achieved through the investigation of all of the innovative enterprises and their relationships with innovation actors. The starting point of this research was data from the official Community Innovation Survey (CIS) for Serbia. The CIS provided a lot of variable data, which could be incorporated into national system analyses. These data could be observed within the frame of stakeholder theory, under sectoral and regional aspects, and can be further analyzed in future research to assess the improvement in efficiency of the national innovation system towards sustainability.

The presented results may have some implications for different parties in the construction industry: stakeholders, managers, and scholars. Stakeholders and managers should recognize the importance of the energy efficiency certification process and its impact on innovation and sustainability. For scholars, this research has different implications. It is of great importance to relate innovation and sustainability in the construction industry, keeping in mind that this sector has ample opportunities to contribute to sustainability through improvements in energy efficiency performance. For scholars, it is also important to create a broader picture by visualizing data (CIS database and field collected) to work with innovation and sustainability in the construction industry, including all of the hampering factors and their influence on sustainability, especially in the context of energy efficiency. Furthermore, the presented research, in the context of the specifics of the national innovation system in Serbia, could enhance knowledge on specific national innovation systems of other CEECs, especially with respect to the construction industry, for which studies of this kind are scant, or even non-existent.

This study focused on the national innovation system in Serbia, which has experienced the same context of transition of the socio-economic paradigm as other CEECs, but according its own, specific pattern. However, this research provides evidence that sustainability-oriented innovation can be utilized in other national innovation systems. With the aim of avoiding any theoretical generalization, further research is required to provide a deeper analysis.

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Appendix A

Table A1. Survey items.

Survey Items
Environment usefulness
Reduced material use
Reduced energy use
Reduced CO_2 "footprint"
Replaced materials with less pollution substitutes
Reduced soil, water, noise, or air pollution
Recycling water and energy after use
Reduced energy use
Reduced soil, water, noise, or air pollution
Improved recycling after material use
Business innovation usefulness
New and Improved service delivery methods
New and Improved delivery, logistics, and distribution methods
Enable to introduce/improve the information system
Improved the ways of conducting administrative processes
Improved business practice related to different procedures
Improved methods of work organization and distribution of responsibilities
Enabled the introduction of a better human resource management (HRM)
Introduction of new marketing methods
Obstacles
Lack of competencies
Lack of external sources of knowledge
Lack of funds
Lack of subsidy
Lack of co-operation partners
Lack of IT resources

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