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Green Procurement in Romanian Construction Projects. A Cluster Analysis of the Barriers and Enablers to Green Procurement in Construction Projects from the Bucharest-Ilfov Region of Romania

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Received: 24 September 2019; Accepted: 5 November 2019; Published: 7 November 2019

Abstract: The research presented in this paper aimed at identifying the most significant green procurement barriers and enablers for construction projects in the Bucharest-Ilfov region and grouping them into clusters. For this purpose, 14 barriers and 14 enablers were selected on the basis of the literature review and a questionnaire-based survey was carried out with members of the construction projects' teams from the analyzed region. The cluster analysis resulted in eight clusters for barriers and seven clusters for enablers. In the case of barriers, the most significant cluster was the one that included the barrier regarding technical and technological difficulties related to the use of green building materials. Another significant barrier was the increase of project execution costs. Enablers from the most significant cluster had higher energy efficiency and use of green building materials as a competitive advantage. Another significant enabler identified was regarding the pressure to implement environmental protection policies/legislation. To explain and detail the results of the cluster analysis, semi-structured interviews were carried out with experts involved in projects. They indicated, in most cases, the same barriers and enablers as those obtained from the cluster analysis.

Keywords: green; procurement; construction; projects; cluster; analysis; barriers; enablers

1. Introduction

Construction projects are considered, throughout their life cycle, as some of the biggest sources of environmental problems, from the consumption of non-renewable resources and the impact on biodiversity to the effects on global warming [1]. In the European Union, buildings have become one of the most important elements of energy efficiency policies, as about 40% of the energy consumption of society comes from the energy consumption of buildings [2]. In Romania, the energy consumption of the residential and non-residential building sector represents about 45% of total energy consumption. At the national level, there is a concern for the implementation of Directive 2010/31/ EU on the energy performance of buildings and of Directive 2012/27/EU on energy efficiency. In the European Union, the completion and exploitation of construction projects involve half of the total extracted materials and one third of water consumption [3,4]. The construction sector generates one third of the total waste at the European Union (EU) level [3]. In developing countries, residential construction projects are responsible for increasing CO_2 consumption [5].

Due to the major impact on construction projects on the environment in the European Union, there are concerns about their environmental performance and the development of a system of specific indicators, largely related to the acquisition and use of resources [6]. Green procurement has been

identified as one of the most efficient solutions for increasing the environmental performance of construction projects. Previous research has shown that the use of energy efficient materials and solutions in the rehabilitation of buildings can lead to savings of almost 25% in residential energy consumption [2].

In Romania, the context of the implementation of green procurement includes both factors that could favor this process and factors that may disadvantage it. The need for the implementation of the European directives in the field of energy efficiency, including Directive (EU) 2018/844 [7], has led to the existence of numerous national and European programs that finance projects in this field, both at the national level and at the level of the Bucharest-Ilfov region. At the national level, the technical directorate of the Ministry of Regional Development and Public Administration has elaborated a long-term strategy on the renovation of buildings, which approached in an integrated way the renovation of the national park of buildings from the perspective of energy efficiency and seismic risk [8]. Renovation of residential and non-residential buildings in Romania in order to increase energy efficiency and reduce seismic risk creates an additional demand for new construction works using green building materials according to the new design codes. The financing of the construction projects in the field of energy efficiency is realized from European funds through the Regional Operational Program (with priority axes specially dedicated to energy efficiency, axes 3 and 4) and from national funds through the National Program of Local Development [9]. Reducing the seismic risk of buildings is a constant concern at both national and local levels. The City Hall of Bucharest has a special investment program, financed through the local budget, for projects for the rehabilitation of residential and non-residential buildings that are in the first seismic risk class (buildings most exposed to seismic risk).

According to the good practice guide of the Ministry of Regional Development and Public Administration in order to reach the optimal levels, in terms of costs, of the minimum energy performance requirements of the various categories of buildings from the point of view of energy consumption, the existing real estate fund still has the potential to significantly to be brought to high standards in terms of energy performance, thus highlighting the importance of developing an ambitious strategy for renovating residential buildings in Romania [10]. The same practice guide provides for significant reductions in the operating costs of new or non-residential buildings or that have been thermally rehabilitated compared to the operating costs in the case of non-residential constructions. However, the calculations made for the implementation of the good practice guide for reaching the optimal levels, in terms of costs, of the minimum energy performance requirements of the various categories of buildings show that the investment costs for implementing the energy efficiency measures are higher than in the case of previously applied solutions in the construction of residential and non-residential buildings.

Green building materials have started to be included in the offer of the manufacturers of building materials in Romania, but their use is still at low levels because of prices, which are generally higher than for the classic construction solutions and the result of the tendency of consumers to prefer constructive solutions considered safer. Thus, although in Romania there is a historical tradition of constructions made of wood, consumers prefer the classic solutions of reinforced concrete structures as they consider them safer. On the other hand, new generations of consumers are more concerned with environmental issues and require construction companies to differentiate themselves using green building materials (including construction using recyclable materials). Through the Green House Program, the Romanian state wants to encourage the use of organic and natural insulating materials in order to reduce the energy consumption of buildings. The Green Mortgage Program, launched by the Romanian Council for Green Buildings, is a program through which the participating banks offer a unique mortgage product of the buildings, offering them a reduction in the interest rate to minimize the risk of non-payment of the mortgage.

The Romanian Council for Green Buildings considers that relatively easy-to-use green building materials in the execution of projects, are, in Romania: ecological cements with a carbon footprint reduced by 40%; concrete reinforced with natural or artificial fibers; lightweight concrete with

aggregates; traditional construction technologies that undergo revolutionary transformations and have exceptional green potential, such as land-based construction techniques used in office, tourist or commercial buildings; building materials from the space age, which enter today's practice, from the aerogel (the easiest solid, with exceptional performances in insulation) to the electrochromic and thermo-chromic windows; building materials with recycled content, such as non-woven geotextiles and polyester wool insulation; and products from recycled plastic bottles. Romanian construction companies also encounter a number of technical problems when they want to use green building materials in construction works. The equipment and machines they use are specific to the classical construction solutions and the switch to the use of new solutions, based on green materials, requires the assimilation of new technologies that cannot be acquired in the short term in the absence of financial resources.

In the literature there are countless approaches and definitions of the concept of green procurement and an evolution in time of this concept [11]. In 2000 Nagel considered that the term green procurement was associated with keywords such as"eco-labels, the avoidance of environmentally hazardous substances, energy use, the use of recycled materials, the mass, the re-usability of some parts, the recyclability" [12]. In 2001, green procurements were considered as "the set of purchasing policies held, actions taken, and relationships formed in response to concerns associated with the natural environment. These concerns relate to the acquisition of raw materials, including supplier selection, evaluation and development; suppliers' operations; inbound distribution; packaging; recycling; reuse; resource reduction; and final disposal of the firm's products" [13]. In 2011, green procurement was considered as an "integration of environmental considerations into purchasing policies, programs, and actions" [14]. Green procurement introduces specific criteria for environmental performance into common procurement mechanisms [15]. More recent approaches define green procurement as "the procurement of products or services that have a reduced environmental impact compared with other products or services that serve the same purpose, or products that meet certain predefined environmental criteria" [16].

Switching from common procurement processes to green procurement on the organization or construction project level, although assumed as an intention is not always easy. It involves a series of technical obstacles, the redefinition of relations with stakeholders, innovative approaches to the design and the possibility of increasing the cost of construction works. All of these can be potential barriers to green procurements on the organization or project level. Also, the requirements of the organization regarding the environmental performance and the existing legislation can act as enablers of green procurement. Therefore, there are a number of previous researches conducted in different countries on the barriers that may exist in the process of adopting green procurement in the particular case of construction projects.

The most important sources of barriers to the adoption and implementation of green procurement within projects are government policies, the characteristics of materials and products used in construction projects, the attitude towards adopting and implementing green procurement on the organization or project level, the construction market, the real estate market, and the building materials market [17].

In the field of construction, the adoption and implementation of green procurement on the project or organization level are related to specific government policies [18]. The existence or absence of these specific policies can be considered as enablers or barriers to green procurement adoption [19]. Governments can use their purchasing power to encourage the adoption of green procurement in the public sector. In the US and the European Union environmentally preferable procurement guidelines have been developed in the public sector [20]. Starting from the practice of the European Union and in Romania, specific procurement guides have been included in the law of public procurement.

Several previous studies consider that the most important barrier at the organization level for adopting green procurement practices is the increase in the product, service, and work costs [21–26]. In the case of construction projects, changing the specifications of the materials, products, and technologies used requires additional costs which may have the effect of increasing the execution costs.

The attitude of the organization or project team matters in terms of adopting and implementing green procurement. A positive attitude of the organization towards environmental issues and the existence of specific organization strategies/policies/responsibilities will encourage managers to adopt green procurement [27]. If construction companies have no specific policies/responsibilities regarding environmental issues, the managers, especially at the operational level, will be less oriented towards adopting green procurement. The implementation of green procurement in construction projects implies an interdisciplinary approach and the involvement of several departments within the participating companies in their realization [28]. The favorable attitude of management comes from the fact that the organizations are interested in sustainable competitiveness [29]. The adoption and implementation of green procurement is, from an organizational perspective, part of the process of sustainable competitiveness.

The number of potential barriers to green procurement adoption differs in previous research. Shen et al. [17] synthesized 13 typical barriers that can appear in real estate projects, finding that most real estate developers in the analyzed area have no experience or little experience in the field of green procurement. The most significant barriers to adopting and implementing green procurement in real estate projects are lack of attractiveness of green building materials to the consumer, lack of incentives from the government, technical concerns with using green building materials, unavailability of green building materials in the local market, and cost increase [17]. Wong et al. [30] analyzed 35 green procurement enablers in construction projects that they grouped into 10 categories: green principles and techniques for reducing the impact on the environment; efforts or initiatives taken by industry or society; requirements assumed by company managers; collaboration between stakeholders; establishing databases for green procurement; the existence of regulations and standards adopted by the government in the field of green procurement; green design; life-cycle and green technologies adoption; and support from middle level managers involved in the construction projects. In the same study, a number of recommendations were made regarding green procurement at various stages of the life cycle of construction projects.

Other specialists have created a preliminary model of green procurement for building projects based on three key issues that influence the organization's green orientation: green policies and guidelines; environmental evaluation; and the use of green products [31]. The construction of this model starts from the premise that green oriented procurement influences a project's green performance [31]. The research carried out by Apolloni et al. [24] based on a systematic review of the studies published on the topic of green procurement (which included 86 previously published articles), showed that they come from four areas: production, operations, and supply chain management; sustainability, environment, and quality; general management; and marketing. The authors of the study showed that the implementation of green procurement in the private sector has both barriers and enablers (named by author drivers). These may come from within or outside the organization. The most important types of barriers coming from within the organization were considered the cost (with 14 articles published on this topic) and lack of legitimacy. The most significant types of barriers outside the organization are regulation, poor supplier commitment, and industry specific barriers [24]. The research carried out on the topic of green procurement drivers (enablers) quantitatively exceeds those regarding the barriers that may arise in the path of adopting green procurement at the project and/or organizational level. The most important internal drivers of green procurement are organizational in nature. The most significant types of green procurement drivers are considered customers, competition, and society [24]. The literature not only includes research conducted on the topic of barriers and enablers but also on the topic of green procurement performance or the implications of green procurement on the performance of projects or organizations in the field of construction [24,31]. In the literature, studies are focused on either green procurement barriers or green procurement enablers. Relatively few studies have been concerned with both barriers and green procurement enablers, even if they used a common, undifferentiated grouping of barriers and green procurement enablers. The analysis of the previously published studies revealed that there are no previous studies and researches related to green procurement in Romanian

construction projects, not even on green procurement in other areas of Romania, although the public procurement legislation contains specific provisions and criteria for green procurements. The lack of studies and research on green procurement in Romanian construction projects and the focus of previous researches were the starting point in carrying out this research.

2. Materials and Methods. Research Methodology

Since so far, no studies and research on green procurements in Romanian construction projects have been carried out, the research presented in this article had the following objectives:

- identification of the most important barriers and enablers for green procurements in Romanian construction projects;
- grouping the most significant barriers and enablers regarding green procurements in Romanian construction projects by cluster analysis of the existing data at the level of a development region;
- identification of recommendations for overcoming the existing barriers to adopting green procurement and for generalizing the positive effects of green procurement enablers.

To achieve the research objectives, a research methodology was developed that includes the steps presented in Figure 1.

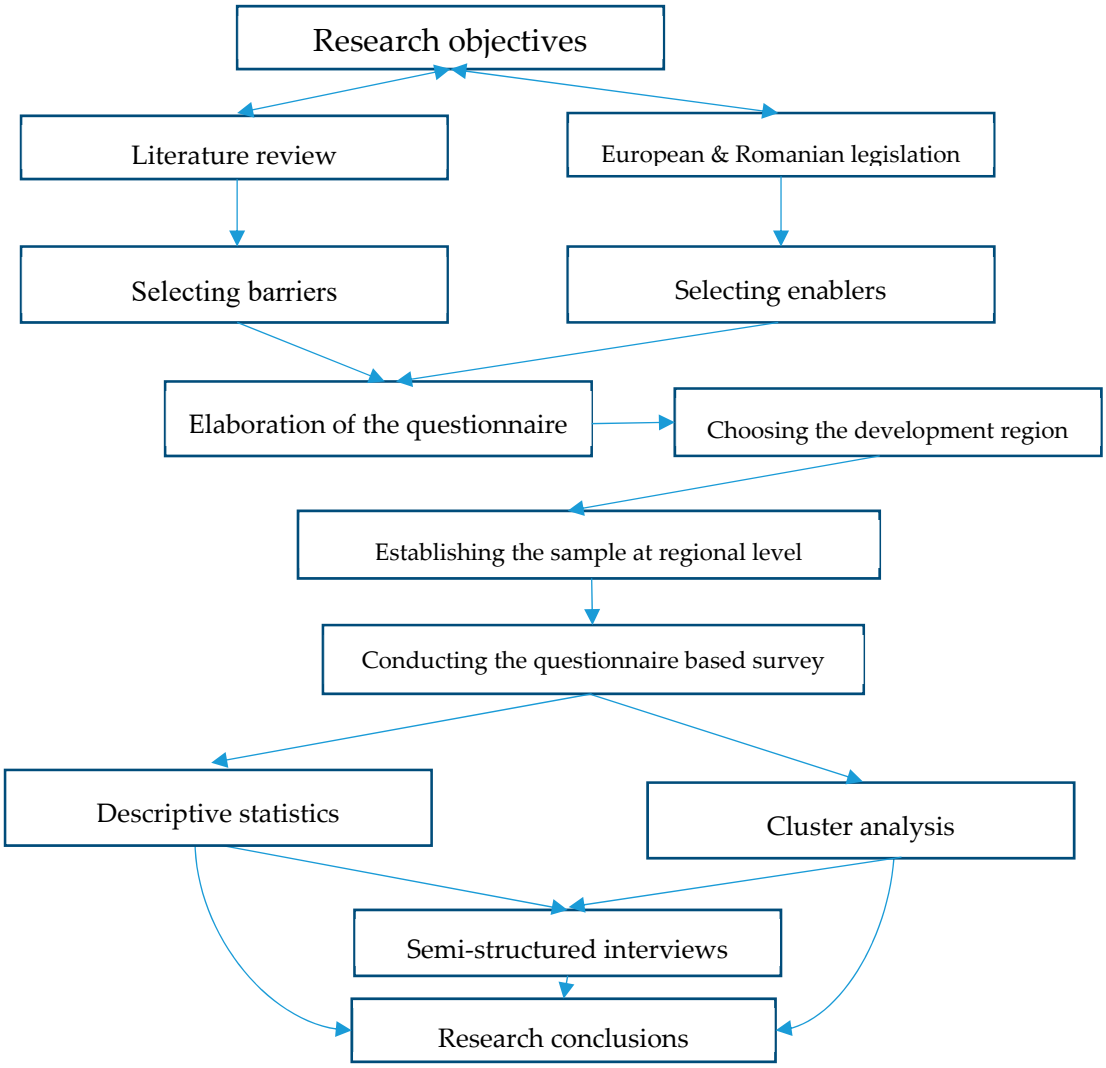

Figure 1. Research methodology.

The three objectives of the above mentioned research were established taking into account the results recorded by the studies published previously on the topic of green procurements in construction projects but also by the provisions of the Romanian legislation and of the European Union in the field of green procurement.

The review of the specialized literature aimed at defining the concept of green procurement as well as barriers and enablers identified by previous studies both in the field of construction projects and in other fields. Based on the specialized literature, the first series of barriers and enablers were identified that may influence the adoption and implementation of green procurement within the Romanian construction projects.

Analysis of Romanian and European legislation included laws on green public procurement [32,33], European and Romanian legislation on public procurement [34,35], and legislation on green public procurement criteria in the European Union [36,37]. The analysis of the Romanian and European legislation allowed for the identification of new barriers and enablers but also the confirmation of barriers and enablers identified as a result of the review of previously published studies and research.

The selection of potential barriers in terms of green procurement in construction projects was made based on barriers already identified by the results of previous researches and on the study of Romanian and European legislation in the field of green procurement. Initially, 21 potential barriers were identified, and 14 barriers were selected considering that only these were specific to construction projects. The fourteen barriers specific to construction projects are presented in Table 1.

The selection of potential enablers was performed in the same way as for green procurement barriers. Initially 19 potential enablers were selected, of which 14 were considered to be specific to the construction sector. The 14 enablers that can enhance the use of green procurements in the case of construction projects are presented in Table 2.

Some of the enablers were selected from the literature and others by comparative analysis of the literature and of the European and/or Romanian legislation. Among the enablers identified in both the literature review and the Romanian and European legislation were: E2—higher energy efficiency in the exploitation stage of construction projects; E3—pressure to implement environmental protection policies/legislation in the field of construction; E5—reduction of construction waste; E6—establishment of standards, such as evaluation criteria, green specification, and suppliers' ISO (International Organization for Standardization) 14000 certifications; and E10—design of construction products for reuse, recycling, recovery of material, and component parts.

In the literature there are numerous studies on higher energy efficiency in the exploitation stage of construction projects [43,59] but they are already present in Romanian and European legislation directives on energy efficiency at the European level, as well as national legislation on public procurement and green procurement [2–5,32,33]. Pressure to implement environmental protection policies/legislation in the field of construction is an enabler selected as a result of the national and European legislative framework that imposes precise terms of application in the construction sector [32–35] but is also an enabler mentioned in several studies and researches in the literature [44–46]. The documents elaborated by the European Commission and the European legislation create the necessary framework for the establishment of standards (E6) and design of construction products for reuse, recycling, and recovery of materials (E10). The enablers E6 and E10 are also mentioned in the research carried out by authors in the literature [3,30,35–37,50].

The questionnaire was elaborated taking into account the need to know certain details about the respondents and to know the opinions of the respondents about barriers and enablers. Therefore, the questionnaire had two essential parts:

- the first part had details about the respondents of the questionnaire and the analyzed projects (the position of the respondents in the project team or in the company, the type of project in which the respondents are involved, the professional experience of the respondents);
- the second part comprised barriers and enablers for green procurement in construction projects (14 barriers and 14 enablers) and respondents' opinions on the significance of barriers/enablers.

Table 1. Potential barriers specific to green procurement in construction projects. [1]

Barrier Code	Barrier	References
B1	Lack of understanding of how to incorporate green thinking into buying	[17,24,38]
B2	Increase of project execution costs due to the higher price of green building materials	[21–26]
B3	Technical and technological difficulties regarding the use of green building materials	[16,24,39]
B4	Lack of expertise and knowledge regarding the use of green building materials and technologies	[11,24]
B5	The lack of strategic options regarding the environment in the organization's strategy	[21,40]
B6	Unclear definition of environmental responsibilities within the organization or its departments	[27,28,41]
B7	Unpleasant experiences regarding the purchase and use of green building materials	[24,39]
B8	Low interest of the management in the organization on environmental issues	[24,27,28]
B9	Low interest of the clients in construction projects for environmental issues	[13,17]
B10	Reduced attractiveness of green building materials for clients of construction projects	[22,26]
B11	The additional operational risks involved in green procurement and green building materials, such as incompatibility with other materials/construction elements used during the execution phase of projects	[31,37,39]
B12	Reduced information on the construction market regarding the possibilities of using green building materials	[11,24]
B13	Low supply of green building materials/solutions in the local market	[15,33,42]
B14	Lack of supplier awareness	[18,21,24]

[1] Source: authors, based on the mentioned references.

The significance level was measured using a 5 point scale: 1 = neglectable, 2 = not important, 3 = common; 4 = important; 5 = extremely important. This 5 point Likert scale is considered an effective method for observing respondents' views on barriers [17,19] but also on enablers.

The choice of the Bucharest-Ilfov development region was made taking into account the following criteria: it is the most dynamic development region of the construction sector; is the development region where the largest construction projects are carried out, especially in the residential area; is the development region in which the most important construction, design, and most important manufacturers and importers of construction materials and products have their headquarters.

The establishment of the sample at the regional level was made starting from the set of projects for which construction permits were issued at the regional level. These were corroborated with data regarding the determining phases of the projects in progress from the State Inspectorate for Constructions, both at the central and Bucharest-Ilfov region level.

After identifying the actual number of projects in progress, 110 questionnaires were sent by email or directly to the managers of the companies involved in them with the request to complete them or to send them to the subordinate personnel for completion. In total, 92 replies were received, of which only 84 were complete, which corresponds to a response rate of 76.36%. The resulting sample is representative for the important construction projects carried out at the regional level.

Table 2. Green procurement enablers in construction projects.[1]

Enablers Code	Enablers	References
E1	Incentive policies from policymakers	[17,24]
E2	Higher energy efficiency in the exploitation stage of construction projects	[2–5,32,33,43]
E3	Pressure to implement environmental protection policies/legislation in the field of construction	[32,33,44–46]
E4	Internal pressures of senior management of organizations over project managers regarding the use of green procurement to reduce environmental related risks	[47,48]
E5	Reduction of construction waste	[4,24,36,37,49]
E6	Establishment of standards, such as evaluation criteria, green specification, and suppliers' ISO (International Organization for Standardization) 14000 certifications	[3,30,35,50]
E7	Cooperation between designers and other parties in the construction supply chain	[12,23,43]
E8	Use of green building materials as a competitive advantage of differentiation on the local market of constructions	[14,51]
E9	Life cycle cost reduction by using green procurement	[6,44,52]
E10	Design of construction products for reuse, recycling, recovery of material, and component parts	[6,24,30,36,37]
E11	The suppliers' willingness to participate in green supply chain initiatives	[23,53,54]
E12	Pressure from competitors and awareness of global trends	[41,55–57]
E13	The accessibility of products made from recycled or reused materials	[4,40,50,58]
E14	Improvement of the environmental image of the company or projects	[13,26]

[1] Source: authors, based on the mentioned references.

Conducting the survey based on the questionnaire generated the necessary data for descriptive statistics (typology of respondents and projects analyzed, frequency of responses for barriers and enablers).

The hierarchical cluster analysis was chosen because it is a method of grouping a set of objects in a way that objects in the same cluster are similar to each other and objects in different clusters are as dissimilar as possible [60].

By using the hierarchical cluster analysis green procurement enablers or barriers can be grouped with a dual perspective: their contribution to the implementation of green procurement within the construction projects and the differences of opinion between the respondents regarding the barriers or enablers [17].

Hierarchical cluster analysis starts from the assumption that objects, in our case barriers or enablers, are more similar if their clustering distance is smaller. By using cluster analysis each barrier or enabler is integrated step by step on the basis of cluster distance and in the end the dendrogram is obtained [61,62].

The use of the hierarchical cluster method for analyzing green procurement barriers and enablers is detailed below. Each barrier Bi (i = 1,2,3 ..., M) and enabler Ei (i = 1,2,3 ..., M) is characterized by two

variables: relative importance value (RIV_i) and standard deviation value (SDV_i). The two variables can be determined using the following formulas [17]:

$$RIV_i = \frac{\sum_{j()=1}^{N} xj}{N} \quad (1)$$

where:

RIV_i—relative importance value;

x_j—the score given to the barrier B_i or enabler E_i by the respondent (j = 1,2,3 … N);

N—number of respondents.

$$SDV_i = \sqrt{\frac{\sum_{j=1}^{N}\left(x_j - RIV_i\right)^2}{N}} \quad (2)$$

where:

SDV_i—standard deviation value;

x_j—the score given to the barrier B_i or enabler E_i by the respondent (j = 1,2,3...N);

RIV_i—relative importance value;

N—number of respondents.

In the research conducted, the relative importance value and standard deviation value equal the weight values. To make sure the two variables are equally important a standardization process is conducted. The standardization method used in this research to convert RIV_i and SDV_i to $Z\ (RIV_i)$ and $Z\ (SDV_i)$ is the one proposed by Kaufman and Rousseeuw [63] using the following formulas:

$$Z(RIV_i) = \frac{RIV_i - \mu_{RIV}}{\frac{1}{M}\sum_{i=1}^{M}\left|RIV_i - \mu_{RIV}\right|} \quad (3)$$

$$Z(SDV_i) = \frac{SDV_i - \mu_{RIV}}{\frac{1}{M}\sum_{i=1}^{M}\left|SDV_i - \mu_{RIV}\right|} \quad (4)$$

where:

N—the total number of barriers or enablers.

$$\mu_{RIV} = \frac{1}{M}\sum_{i=1}^{M} RIV_i \quad (5)$$

$$\mu_{SDV} = \frac{1}{M}\sum_{i=1}^{M} SDV_i \quad (6)$$

Euclidean distance was used to measure the cluster distance between pairs of barriers or between pairs of enablers. To determine the Euclidean distance between pairs of barriers or between pairs of enablers (e and f) the formula used was:

$$ED\ (e,f) = \sqrt{\left(Z(RIV_e) - Z\left(RIV_f\right)\right)^2 + \left(Z(SDV_e) - Z\left(SDV_f\right)\right)^2} \quad (7)$$

By using the Euclidean distance between the pairs of barriers those pairs of barriers with the shortest distance were grouped and clusters were formed that contain more than one barrier.

To measure the distance between the pairs of clusters R and Q, group average linkage was used with the following formula:

$$CD(R,Q) = \frac{1}{|R||Q|} \sum_{\substack{e \epsilon R \\ f \epsilon q}}^{2} ED(e,f) \quad (8)$$

where | R | and | Q | represent the number of barriers in clusters R and Q.

The optimal number of clusters was determined using the silhouette index [60]. For each barrier or enabler, the silhouette index was determined using the following formula:

$$Silhouette\ index = \sum_{i=1}^{M} \frac{b_i - a_i}{\max(b_i, a_i)} \quad (9)$$

where:

a_i—the average distance between the B_i barrier and other barriers in the same cluster or between the E_i enabler and others in the same cluster;

b_i—the average distance between the barrier B_i and the other barriers in the nearest neighbor cluster or between the enabler E_i and the other barriers in the nearest neighbor cluster.

The average silhouette coefficient of a cluster (or of a number of clusters) was calculated as the average silhouette coefficients of the barriers or enablers in that cluster or group of clusters. The optimal number of clusters is the one for which the silhouette index is the highest.

The semi-structured interviews were conducted in order to explain in more detail the results of the cluster analysis and to reveal a series of potential measures that can be taken to overcome the barriers that may arise in the implementation of green procurement in the construction projects from the analyzed region and in general from Romania.

The semi-structured interviews were conducted with the participation of four subjects:

- a researcher from the national institute of research in constructions (code I_1);
- a member of the management of the association of manufacturers of building materials (code I_2);
- a member of the management of an association specialized in environmental protection (code I_3);
- an engineer member of the technical expert body in Romania (code I_4).

The choice of these four subjects took into account the fact that they represent four categories of key stakeholders involved in construction projects. These stakeholders can decisively influence the implementation of green procurement in the construction sector.

These stakeholders are represented in various phases of the project's realization, so their opinions about green procurement are the most endorsed opinions other than those of the construction companies (which were the object of the cluster analysis).

The four subjects of the semi-structured interviews had four questions to answer:

- What is your perspective on clusters of barriers and enablers of green procurement in construction projects? Are the barriers and enablers indicated by the results of the questionnaire most relevant?
- What do you consider to be the measures that should be taken to overcome or remove the most significant barriers?
- Which stakeholders involved in the construction projects should be responsible for the most significant barriers to be overcome or removed?
- How should action be taken to increase the influence of green procurement enablers compared to the current level in construction projects?

Based on the results of the cluster analysis and the semi-structured interviews, the research conclusions were formulated. The research was followed by a mixed quantitative and qualitative

approach, through cluster analysis and semi-structured interviews. The mixed approach was chosen so that, based on the results of the cluster analysis, the interviewed experts will be able to provide qualitative information necessary to identify measures to accelerate the process of implementing green procurement within the construction projects in the Bucharest-Ilfov region.

3. Results

The research was conducted using the survey based on the questionnaire, which received 84 complete answers. The profile of the respondents according to the position occupied within the project teams is presented in Table 3.

Table 3. The position of the respondents within the project teams.

No.	Position of the Respondents	Number of Respondents [1]	Percentage [2]
1	Project manager	24	28.57
2	Site manager	15	17.86
3	Engineer	12	14.29
4	Economic responsible	12	14.28
5	Procurement responsible	21	25.00
	Total	84	100.00

[1,2] Own calculations based on survey data.

Most respondents to the survey based on the questionnaire were either persons directly involved in the procurement process or persons who approved the procurement or are involved in substantiating the procurement process (project managers, economically responsible). Less than one third of the respondents to the questionnaire are among those who are indirectly involved in the procurement process.

The professional experience of the respondents participating in the survey based on the questionnaire regarding green procurement barriers and enablers was significant. More than half of the respondents have more than 15 years of professional experience, placing themselves in decision positions within the project teams, including procurements made. A minority in the sample, under one third of the total respondents, is staff with very low experience (under five years) or relatively small (between 5 and 10 years). The structure of the respondents to the survey based on the questionnaire regarding green procurement barriers and enablers according to their professional experience is presented in Table 4.

Table 4. The structure of the sample according to the professional experience of the respondents.

No.	The Professional Experience of the Respondents	Number [1]	Percentage [2]
1	Under 5 years	7	8.33
2	Between 5 and 10 years	11	13.10
3	Between 11 and 15 years	23	27.38
4	Between 16 and 20 years	25	29.76
5	Over 20 years	18	21.43
	Total	84	100.00

[1,2] Own calculations based on survey data.

The typology of the projects in which the survey respondents are involved is presented in Table 5. The structure of the respondents reflects the most important types of projects carried out in the Bucharest-Ilfov region when the survey was conducted, as well as the availability to answer the members of the teams involved in their realization.

Table 5. Structure of the sample according to the type of projects in which the respondents are involved.

No.	Type of Projects	Number [1]	Percentage [2]
1	Residential buildings	32	38.10
2	Non-residential buildings	14	16.67
3	Construction of roads	9	10.71
4	Construction of railways	2	2.38
5	Construction of bridges	1	1.19
6	Electrical, plumbing, and other construction installation activities	7	8.33
7	Utility projects	11	13.10
8	Demolition	8	9.52
	Total	**84**	**100.00**

[1,2] Own calculations based on survey data.

Most of the respondents to the survey based on the green procurement barriers and enablers are involved as managers or execution personnel in residential or non-residential construction projects. This sample structure is normal as it reflects the share of residential and non-residential projects in all the construction projects carried out in the Bucharest-Ilfov region of Romania.

The structure of the answers regarding the level of significance of the specific green procurement barriers in the construction projects in the Bucharest-Ilfov region is presented in Table 6.

Table 6. Number of responses to the level of significance of barriers.[1]

Barrier Code	Level of Significance				
	1	**2**	**3**	**4**	**5**
B1	15	53	11	3	2
B2	0	3	6	37	38
B3	0	3	7	35	39
B4	3	12	32	32	5
B5	1	30	40	10	3
B6	3	8	33	36	4
B7	3	32	39	6	4
B8	2	28	40	11	3
B9	3	11	35	30	5
B10	19	50	6	6	3
B11	1	5	11	39	28
B12	3	9	32	37	3
B13	3	39	33	8	1
B14	22	52	5	3	2

[1] Own calculations based on survey data.

The barriers that may occur in the implementation of green procurement in the construction projects in the analyzed region, appreciated by respondents as important or extremely important, are the increase of project execution costs due to the higher price of green building materials and technical and technological difficulties regarding the use of green building materials.

By applying the mentioned calculation relationships in the research methodology (calculation relationships 1–4) we obtained significant values of green procurement barriers. These are presented in Table 7.

The most significant barriers to green procurement in construction projects, from the perspective of relative importance value, are the barriers B2—the increase of project execution costs due to the higher price of green building materials, B3—technical and technological difficulties regarding the use of green building materials, and B11—the additional operational risks involved in green procurement and green building materials. The barriers with the most significant differences of opinion between

the respondents are those regarding reduced attractiveness of green building materials for clients of construction projects and lack of expertise and knowledge regarding the use of green building materials and technologies.

Table 7. Significance values of green procurement barriers.[1]

Barrier Code	RIV	SDV	Z(RIV)	Z(SDV)
B1	2.0476	0.7544	−1.6016	−1.5445
B2	4.3095	0.7556	1.9545	−1.5224
B3	4.3095	0.7711	1.9545	−1.2156
B4	3.2857	0.9073	0.3449	1.4623
B5	2.8095	0.7940	−0.4037	−0.7666
B6	3.3571	0.8542	0.4572	0.4176
B7	2.7143	0.8391	−0.5535	0.1212
B8	2.8214	0.8188	−0.3850	−0.2774
B9	3.2738	0.8911	0.3262	1.1445
B10	2.0952	0.9464	−1.5267	2.2325
B11	4.0476	0.8985	1.5428	1.2894
B12	3.3333	0.8498	0.4198	0.3325
B13	2.5833	0.7592	−0.7594	−1.4506
B14	1.9405	0.8216	−1.7701	−0.2230

[1] Own calculations based on survey data.

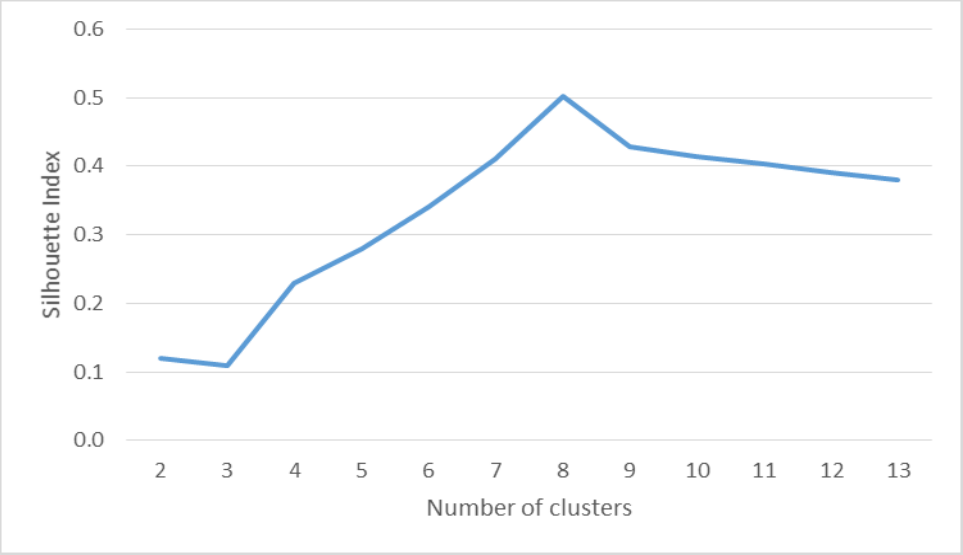

Figure 2. The results of the silhouette index for determining the optimal number of clusters including green procurement barriers.

Regarding the barriers, the optimal number of clusters is eight, because for eight clusters the value of the silhouette index is the highest (Figure 2).

Cluster membership for green procurement barriers in construction projects is presented in Table 8.

The first cluster comprises five barriers (B1, B8, B11, B12, and B13), which are most barriers of all clusters. This cluster has an average level of RIV and SDV, which denotes an average relative importance given by the respondents to the set of barriers in the composition of the cluster and the existence of differences of opinion between the respondents but which are below the level registered in other clusters (clusters 2, 4, 6, 7, and 8).

Table 8. Cluster membership for green procurement barriers in construction projects.

Barrier Code	Barrier	Cluster Number [1]
B1	Lack of understanding of how to incorporate green thinking into buying	1
B2	Increase in project execution costs due to the higher price of green building materials	2
B3	Technical and technological difficulties regarding the use of green building materials	3
B4	Lack of expertise and knowledge regarding the use of green building materials and technologies	4
B5	The lack of strategic options regarding the environment in the organization's strategy	5
B6	Unclear definition of environmental responsibilities within the organization or its departments	6
B7	Unpleasant experiences regarding the purchase and use of green building materials	7
B8	Low interest of the management in the organization of environmental issues	1
B9	Low interest of the clients in construction projects for environmental issues	4
B10	Reduced attractiveness of green building materials for clients of construction projects	2
B11	The additional operational risks involved in green procurement and green building materials, such as incompatibility with other materials/construction elements used during the execution phase of projects	1
B12	Reduced information on the construction market regarding the possibilities of using green building materials	1
B13	Low supply of green building materials/solutions in the local market	1
B14	Lack of supplier awareness	8

[1] Results obtained from the cluster analysis of the data on the green procurement barriers from the questionnaire-based survey.

The second cluster comprises two barriers: B2 and B10. Compared to the first cluster, this cluster has a higher level of relative importance given by the respondents to the set of barriers within the cluster as it includes the barrier B2 which is the increase of project execution costs due to the higher price of green building materials. For this barrier, SDV has a reduced value (compared to other barriers) which also indicates the existence of lower differences of opinion of the respondents.

The third cluster comprises a single barrier (B3) and is perceived by the respondents as the most important cluster from the RIV perspective, with the smallest differences of opinion between the respondents from the SDV value perspective. B3 represents, along with B2 in the second cluster, the most important barriers perceived by respondents regarding green procurement in construction projects in the analyzed region.

The fourth cluster comprises two barriers (B4 and B9) and is more important in the perception of respondents compared to the first two clusters but less important than the third cluster. The differences of opinion between the respondents regarding the importance of the barriers are significant in the case of the fourth cluster.

The other four clusters (clusters 4, 6, 7, and 8) comprise only one barrier, respectively barriers B5, B6, B7, and B14. Cluster 6, which includes B6, is the most important of these last four clusters, but is less important in the perception of respondents than cluster 3. The dendrogram resulting from the cluster analysis of the barriers that may occur in the case of green procurement in construction projects in the region analyzed is shown in Figure 3.

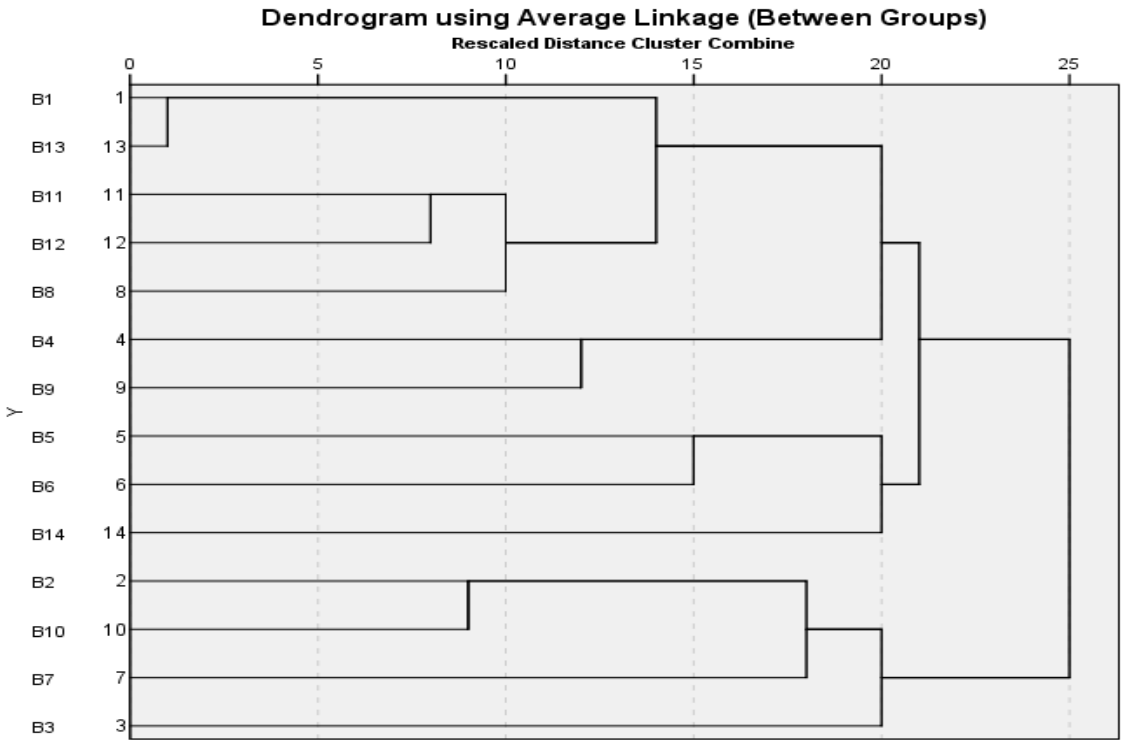

Figure 3. Dendrogram resulting from cluster analysis of green procurement barriers.

The structure of the answers regarding the significance level of the specific green procurement enablers in construction projects in the Bucharest-Ilfov region is presented in Table 9.

The most important enablers for green procurement in the construction projects in the Bucharest-Ilfov region, according to the respondents' opinions, are higher energy efficiency in the exploitation stage of construction projects and pressure to implement environmental protection policies/legislation in the field of construction. Using the calculation relationships mentioned in the research methodology (calculation relationships 1–4), significant values of green procurement enablers were obtained. These are shown in Table 10.

The most significant enablers regarding green procurements in construction projects in the Bucharest-Ilfov region, from the perspective of relative importance value, are E2, higher energy efficiency in the exploitation stage of construction projects, and E3, pressure to implement environmental protection policies/legislation in the field of construction. These are followed, from the perspective of relative importance value, by enablers E6 and E5.The optimal number of clusters for green procurement enablers is seven clusters because for this cluster number the silhouette index has the highest value (Figure 4).

Table 9. Number of responses to the level of significance of enablers.[1]

Enabler Code	Level of Significance				
	1	**2**	**3**	**4**	**5**
E1	16	49	14	5	0
E2	0	3	6	37	38
E3	0	1	3	39	41
E4	3	3	40	36	2
E5	3	3	40	36	2
E6	0	4	36	40	4
E7	0	37	34	10	3
E8	2	29	46	5	2
E9	3	31	43	4	3
E10	3	6	43	26	6
E11	26	45	8	3	2
E12	2	42	31	5	4
E13	10	39	27	7	1
E14	30	41	8	2	3

[1] Own calculations based on survey data.

Table 10. Significance values of green procurement enablers.[1]

Enabler Code	RIV	SDV	Z(RIV)	Z(SDV)
E1	2.0952	0.7656	–1.3115	–0.2951
E2	4.3095	0.7556	2.0367	–0.4557
E3	4.4286	0.6227	2.2168	–2.5767
E4	3.4643	0.8084	0.7586	0.3877
E5	3.3690	0.7525	0.6146	–0.5052
E6	3.5238	0.6633	0.8486	–1.9292
E7	2.7500	0.7999	–0.3215	0.2527
E8	2.7143	0.7167	–0.3755	–1.0766
E9	2.6786	0.7740	–0.4295	–0.1614
E10	3.3095	0.8448	0.5246	0.9694
E11	1.9286	0.8699	–1.5636	1.3705
E12	2.6071	0.8312	–0.5375	0.7520
E13	2.4048	0.8468	–0.8435	1.0015
E14	1.8929	0.9260	–1.6176	2.2662

[1] Own calculations based on survey data.

Figure 4. The results of the silhouette index for determining the optimal number of clusters including green procurement enablers.

The cluster membership for green procurement enablers in construction projects in the Bucharest-Ilfov region is presented in Table 11.

Table 11. Cluster membership for green procurement enablers in construction projects.

Enabler Code	Enablers	Cluster Number [1]
E1	Incentive policies from the policymakers	1
E2	Higher energy efficiency in the exploitation stage of construction projects	2
E3	Pressure to implement environmental protection policies/legislation in the field of construction	1
E4	Internal pressures of senior management of organizations over project managers regarding the use of green procurement to reduce environmental related risks	3
E5	Reduction of construction waste	4
E6	Establishment of standards, such as evaluation criteria, green specification, and suppliers' ISO 14,000 certification	3
E7	Cooperation between designers and other parties in the construction supply chain	5
E8	Use of green building materials as a competitive advantage of differentiation on the local market of constructions	2
E9	Life cycle cost reduction by using green procurement	6
E10	Design of construction products for reuse, recycling, recovery of material, and component parts	4
E11	The suppliers' willingness to participate in green supply chain initiatives	4
E12	Pressure from competitors and awareness of global trends	1
E13	The accessibility of products made from recycled or reused materials	5
E14	Improvement of environmental image of the company or projects	7

[1] Results obtained from the cluster analysis of the data on the green procurement barriers from the questionnaire-based survey.

The first cluster is made up of three enablers (E1, E3, and E12) and is the third cluster from the RIV average perspective, which shows that respondents consider the barriers in this cluster to be relatively important. The SDV value is among the lowest compared to the other clusters which shows the existence of relatively small differences of opinion between the respondents regarding the importance of green procurements enablers from this cluster for the construction projects in the analyzed region. The first cluster also includes the E3 enabler, the most important from the RIV perspective.

The second cluster consists of two enablers, E2 and E8. This cluster has the highest level of relative importance given by the respondents to the enablers' assembly in the cluster's composition as it includes E2, higher energy efficiency barrier in the exploitation stage of construction projects. For this cluster, SDV has the lowest value (compared to all other clusters) which also indicates the existence of smaller differences of opinion of the respondents regarding the green procurement enablers in this cluster.

The third cluster comprises two enablers, E4 and E6. This cluster is second in terms of the relative importance given by the respondents to the enablers' assembly in the cluster. The mean value of the SDV shows the existence of greater differences of opinion of the respondents regarding green procurement enablers as compared to the second cluster. The fourth cluster comprises three enablers

E5, E10, and E11, with an average value of RIV and SDV compared to the other clusters, which shows a relative average importance given by the respondents and the existence of relatively significant differences of opinion. Cluster five consists of two enablers (E7 and E13) and is the second to last in terms of the relative importance given by the respondents. In this cluster, the differences of opinion of the respondents regarding the enablers are the smallest compared to all the other clusters analyzed.

The last two clusters (clusters 6 and 7) contain a single enabler: E9 in cluster 6 and E14 in cluster 7. Cluster 6 has relative importance given by respondents close to the average and differences of opinion between respondents also close to the average of the other clusters. Cluster 7 has the lowest relative importance in the opinion of the respondents and the biggest differences of opinion between the respondents. The dendrogram resulting from the cluster analysis of the enablers that may occur in the case of green procurement in construction projects in the region of Bucharest-Ilfov is shown in Figure 5.

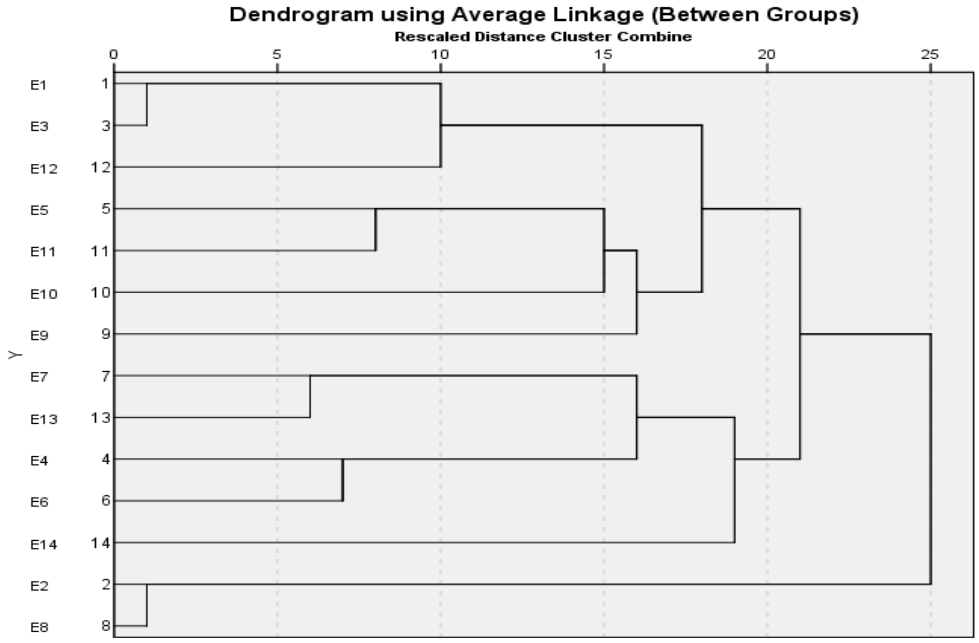

Figure 5. Dendrogram resulting from cluster analysis of green procurement enablers.

In order to detail and explain some of the results of the cluster analysis, semi-structured interviews with four experts from outside the construction companies involved in carrying out the construction projects were used, according to the research methodology: research, design, and engineering service providers; material suppliers; consultants in environmental issues (obtaining the environmental permit and analyzing environmental problems in the feasibility phase of construction projects); and suppliers of technical expertise during the course of the projects.

The first subject of the semi-structured interviews (I_1) came from the research-development area and had a similar perspective with the respondents of the questionnaire on the most significant cluster and the most significant barrier regarding green procurement in the construction projects in the analyzed region. The first expert interviewed (I_1) considered that "the third cluster and the B3 barrier, technical and technological difficulties regarding the use of green building materials, represents the most important obstacle regarding green procurement not only for the Bucharest-Ilfov region but also for all the other regions of Romania." According to the subject I_1, the technical difficulties have, in Romania, two major causes: "lack of interest for updating the technical standards and regulations with elements regarding the use of green building materials and the extent of the investments necessary for the changes of technical and technological nature at the level of the construction companies." Subject I_1, from the perspective of the two above mentioned causes, stated two measures that would lead to

overcoming the barriers regarding green procurement in the construction projects in the Bucharest-Ilfov region and in other regions of Romania:

- a program at the national level to review the technical standards and regulations that have as central elements the concepts of green buildings, green materials, and construction technologies;
- additional investments at the stakeholder level involved in the realization of construction projects so that the additional technical difficulties generated by the use of green materials can be overcome.

In the opinion of the first expert interviewed the most important stakeholder responsible for overcoming the B3 barrier is the Technical Directorate within the Regional Ministry and the Public Administration, which through the technical regulation service, has the role of triggering factors of the revision of the standards, norms, and technical regulations at the national level in the field of constructions.

The expert I_1 considers that, regarding the results of the cluster analysis for green procurement enablers, the second cluster consisting of the two enablers E2 and E8, is the most important (according to the opinions of the respondents participating in the survey based on the questionnaire). Also, the first subject interviewed considered the E3 enabler the most important from the RIV perspective. In order to amplify the action of the two main enablers (E2 and E3), subject I_1 made two proposals: increasing the value of the national programs' budgets in the field of increasing the energy efficiency of the buildings and elaborating timelines for the implementation of environmental protection policies/legislation in the field of construction, especially at the level of construction companies.

The second subject interviewed (I_2) also considers that "cluster 3 which includes the B3 barrier represents the most important obstacle regarding green procurement in construction projects."

The expert I_2 considers the B2 barrier as an "increase of project execution costs due to the higher price of green building materials" as significant as the B3 barrier in terms of green procurement in construction projects both in the analyzed region and in other regions of Romania. Subject I_2 considered that the measures to stimulate the demand for green materials and green buildings are the ones that can lead to overcoming the barrier B2. In his opinion, the cost reduction can only be achieved if the procurement prices of the green materials are reduced, and as a representative of the producers he argues that they can reduce the prices only as a result of the increased demand and the volume of production.

Subject I_2 considers that the most important stakeholders for overcoming the barriers B3 and B2 are the manufacturers of construction materials and construction companies, because they are the key points on the green procurement technology in construction projects.

Expert I_2 appreciated that the second cluster, consisting of the two enablers E2 and E8, is the most important in the case of the results of the cluster analysis for green procurement in the construction projects in Romania. The second surveyed expert also considered that a very important enabler is E9, life cycle cost reduction by using green procurement. In order to increase the influence of enablers E2, E8, and E9, regarding green procurements in the construction projects the second interviewed subject considered that the manufacturers of materials should include the offers and technical instructions aspects regarding energy efficiency, the differentiation from the competitive point of view using green materials, and the perspective of the life cycle cost analysis in the procurement of construction materials and products.

The third subject interviewed (I_3) agreed with the results of the cluster analysis on the green procurement barriers, respectively with cluster 3 and the B3 barrier as the most significant, but stated that, in his opinion, it was as close in the significance as the B8 barrier—low interest of the management of the organization on environmental issues. He explained that the B8 barrier is a consequence of the fact that Romanian construction companies are focused on current operational aspects (the execution of the projects in which they are involved) and the value of the penalties for environmental problems is insignificant in relation to the value of the projects. The main measures proposed to overcome the barriers B3 and B8 by expert I_3 were to intensify the control on the sites carried out by

the National Environmental Guard and increase the value of penalties for the environmental problems of construction companies and/or construction projects.

In the conception of subject I_3, the main stakeholders responsible for the barriers to be overcome or removed are the Ministry of the Environment, the National Environmental Guard, and the construction companies, which should comply with the requirements of environmental protection legislation.

The most important enablers in the opinion of the third expert are E2 and E8 from the second cluster, which seems to confirm the results from the questionnaire analysis, but also the E3 enabler. In order to increase the influence of the three enablers, the third expert interviewed considered that the most appropriate measures are to amplify the scope of national programs on energy efficiency and to increase the participation of non-governmental organizations in the field of environmental protection in the analysis of the technical-economic documentation for the construction projects under public debate.

The fourth expert (I_4) interviewed considered that cluster 3 which includes the B3 barrier was the most significant regarding green procurement barriers, specifying that in his opinion the B2 barrier is as significant as the B3. The most important measures to overcome barriers B2 and B3 in the opinion of expert I_4 are those that consider the orientation of the solutions from the technical expertise carried out in the sense of using technologies, design variants, and green materials. That is why the most important stakeholders for removing green procurement barriers are design firms, technical experts, green material producers, and construction companies. The fourth expert appreciated that the E2 and E8 enablers of the second cluster are the most important, adding to them the E3 enabler. The most important measures to increase the influence of these enablers, according to expert I_4, are to increase the funds allocated for energy efficiency and the inclusion of criteria regarding environmental protection as a factor of differentiation between the bidders in the scoring system related to the public procurement of construction works.

4. Discussion

The research conducted on green procurement barriers and enablers started from the results of previous studies existing in the literature [17,24,30] as well as from the fact that there were no previous studies on this topic in Romania. This research has the advantage of being one of the few studies that refers to both the barriers that arise regarding green procurement in construction projects and the potential enablers.

The results of the research regarding the green procurement barriers in the construction projects in the Bucharest-Ilfov region present some common elements with other studies previously conducted [17]. Such an element is represented by the B2 barrier—Increase of project execution costs due to the higher price of green building materials. The increase in acquisition costs as a result of green procurement is also mentioned in other existing studies in the literature, without them referring exclusively to the construction sector [24]. The four interviewed subjects confirmed the results of the research conducted on the green procurement barriers and confirmed the respondents' opinions on the questionnaire-based survey, also considering that the most significant cluster is cluster 3 formed by the B3 barrier. However, the four subjects also indicated other barriers that they consider significant in terms of green procurement in the construction projects in the Bucharest-Ilfov region (primarily the B2 barrier).

The results of the cluster analysis regarding green procurement enablers in the construction projects in the Bucharest-Ilfov region also present a series of elements common to other studies previously conducted. Enablers E2 and E8 from the cluster perceived by the respondents as the most significant, but also the E3 enabler are mentioned in other studies existing in the literature [26], even if not with the same level of significance. The interviewed subjects appreciated the same cluster consisting of E2 and E8 enablers as very important from the green procurement perspective in the construction projects.

In contrast to the results of other research, the respondents involved in the construction projects in the Bucharest-Ilfov region are almost exclusively focused on the technical and economic aspects of

operational nature regarding green procurement: the technical and technological difficulties involved in green procurement, the increase of the procurement costs of green materials, increasing energy efficiency. The only exception from this component of the cluster that includes the most important enablers is the E8 enabler which reveals the competitive advantage that the respondents to the survey based on questionnaire seem to recognize as an effect of green procurement in the construction projects in the analyzed region.

Future directions of the research are related to the extension of the sample at the national level and to the particularization of the barriers and green procurement enablers on the execution phases of the construction projects, because this research on the execution phase of the construction projects in a single region of Romania.

5. Conclusions

The research presented in this article aimed to identify the most important barriers and enablers regarding green procurement in the case of construction projects in the Bucharest-Ilfov region of Romania. Considering the main objectives of the research, 14 barriers and 14 enablers were selected as a result of the review of the specialized literature and the analysis of the current legislation. Taking into account the main elements that characterized the respondents, the 14 barriers, and the 14 enablers, a questionnaire-based survey was conducted in the Bucharest-Ilfov region.

Using the data from the survey based on the questionnaire, a cluster analysis was performed, which resulted in eight clusters including green procurements barriers and seven clusters that included green procurement enablers for construction projects undertaken in Romania. The optimal number of clusters for barriers and enablers was determined as a result of the silhouette index calculation. The most important cluster from the perspective of the significance of the barriers for the respondents involved in the realization of the construction projects in the Bucharest-Ilfov region is the third cluster comprising a single B3 technical barrier and technical difficulties regarding the use of green building materials. Another important barrier from the respondents' perspective is the B2 barrier—increase of project execution costs due to the higher price of green building materials—from the composition of the second cluster.

The choice of the cluster that includes the B3 barrier regarding the technical difficulties regarding the use of green building materials becomes even more significant in the current context of the Romanian construction sector, where there are relatively few large construction companies that can assume the high investment costs that involves the assimilation of new construction technologies based on green building materials. The only companies that can overcome this technological barrier without problems are multinational companies in the field of construction and production of construction materials. An additional explanation of the consideration of the B2 barrier—increase of project execution costs due to the higher price of green building materials—as very important comes from the cost standards developed for public investment projects and the good practice guide for reaching optimal levels; the point of view of costs of the minimum energy performance requirements of the various categories of buildings confirms this. The survey respondents are involved in projects financed from local budgets, they use the cost standards and know the level of execution costs of the construction projects that involve green building materials and solutions.

The most significant cluster in terms of green procurement enablers is the second cluster consisting of two enablers: E2—higher energy efficiency in the exploitation stage of construction projects; and E8—use of green building materials as a competitive advantage of differentiation on the local construction market. According to the perception of the respondents in the survey based on questionnaire E3—pressure to implement environmental protection policies/legislation in the field of construction—belonging to the first cluster has a significance as big as the E2 enabler regarding green procurement in the construction projects in the analyzed region.

The choice of the cluster that includes E2—higher energy efficiency in the exploitation stage of construction projects—is even more evident if we refer to the context of the construction sector in

Romania and the Bucharest-Ilfov region. The existence of specific studies of the Ministry of Regional Development and Public Administration such as the good practice guide for achieving optimal levels, in terms of costs, of the minimum energy performance requirements of the different categories of buildings has an important role in the perception of the respondents on higher energy efficiency in the exploitation stage of construction projects. The existence of national and European programs (the axes of the Regional Operational Program, the National Program of Local Development) to finance the projects for the energy efficiency of buildings has transformed higher energy efficiency in the exploitation stage of construction projects into a major theme for all stakeholders in the construction sector. Also, the consumption trends of new generations require the construction companies to differentiate themselves by using green building materials, especially those coming from recyclable materials.

To explain and detail some of the results obtained from the cluster analysis, semi-structured interviews were used with experts from outside the construction companies in the Bucharest-Ilfov region but who are stakeholders directly or indirectly involved in the construction projects. Four experts from the following fields were interviewed: research and development in construction, production of construction materials, environmental protection, and technical expertise. The four experts confirmed in most cases the results of the cluster analysis: the most important cluster that includes the barriers is cluster 3 which includes the B3 barrier (but also indicating the B2 barrier as being of great importance); the most important cluster in terms of green procurement enablers is the second cluster comprising enablers E2 and E8. Just as important as the E2 enabler was the E3 enabler by some of the interviewed subjects.

In the semi-structured interviews, the mentioned subjects listed a number of measures that should be taken in order to eliminate the barriers or increase the influence of green procurement enablers: increasing the value of the national programs' budgets in the field of increasing the energy efficiency of buildings; developing schedules for implementing environmental protection policies/legislation in the field of construction; measures to stimulate demand for green materials; increasing the value of penalties for environmental problems of construction companies and/or construction projects.

Another important result of the semi-structured interviews is the nomination of key stakeholders regarding the elimination of barriers and increasing the influence of enablers; these included the Technical Directorate within the Ministry of Development and Public Administration, material producers, designers, the Environmental Guard, and construction companies. Most of the interviewed experts indicated that the most significant barriers and the most significant enablers from the composition of the analyzed clusters in the case of the Bucharest-Ilfov region are equally important in the case of construction projects in the other regions of Romania. This is a first direction for further research in the future by extending the sample to the national level. The second direction is the analysis of the barriers and enablers specific to the phases of the life cycle of construction projects.

The research carried out presents, in comparison with other previous researches on the same subject, the following advantages: it is one of the few studies that refers both to the barriers that appear regarding green procurement in construction projects and to potential enablers; it uses experts in the field of construction but outside the construction companies involved in the execution of the projects for the confirmation and explanation of results of the cluster analysis; and it includes a series of measures to eliminate the most significant barriers and to increase the influence of green procurement enablers, specifying the responsible stakeholders (in the view of the interviewed subjects).

Author Contributions: C.-P.S. performed the literature review, the questionnaire, the cluster analysis, and wrote the article. C.N. carried out the analysis of the legislation and the survey based on the questionnaire. M.V. conducted the semi-structured interviews.

Funding: This research was funded by the Romanian Ministry of Innovation and Research, grant PFE24/16.10.2018, "Increasing research capacity in the economic field through the development of transdisciplinary research infrastructures (CERTRAN)."

Conflicts of Interest: The authors declare no conflicts of interest.

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