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An Exploration of Circular Economy Practices and Performance Among Romanian Producers

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Abstract: Economic growth is the mandate of the global economy and with our planet's population poised to reach 10 billion people, economists are searching for sustainable economic growth approaches that do not increase raw materials consumption nor deplete and damage our environment. This mandate is the heart of the Circular Economy (CE), a challenge to theoreticians and practitioners alike to continue global economic growth, but with fewer resources and protective methods for our environment. The European Union (EU) economies were early adopters of CE and are now demanding similar adoptions from its recently integrated members from the East. Romania is one of the laggard states in this transition, given its heritage and lack of economic sophistication. Our paper identifies the practices and performance of Romanian producers regarding the implementation of the CE principles, so future recommendations can be formulated. In surveying the Romanian firms, we applied a cluster analysis based on their level of green-oriented supply chain cooperation (GSCC) practices. The respondents were grouped into two clusters: "low green-oriented supply chain cooperation (GSCC) scorers" and "high green-oriented supply chain cooperation (GSCC) scorers'. The results suggest that cluster membership partially influence CE practices and fully influence CE-targeted performance.

Keywords: circular economy; Romanian producers; green-oriented supply chain cooperation (GSCC) practices; economic performance; clusters

1. Introduction

The concept of circular economy (CE) has been around for almost half a century. However, it failed to capture sufficient interest to become a strategic priority, despite the attractiveness of its benefits and the generosity of its desideratum. Nevertheless, in the current context of global ecological transformations and under the pressure of the recent global financial crisis, the innovative idea of regenerative design, initially launched by Lyle in the 1970s during the energy crisis and further developed under the conceptual idea of sustainability [1,2], is back in vogue. The recent incarnation of the CE centers around "new relations with goods and materials" that utilize fewer raw materials and less energy while creating additional jobs, as Stahel—one of the founding fathers of the concept—explains [3].

An overview of the CE strategies that currently exist worldwide reveals that the European Union (EU), the United States, China, and Japan developed their own CE plans [4].

At the European Union (EU) level, the conversion towards a CE represents both a commitment to the "2030 Agenda for Sustainable Development" and the opportunity to alter the member economies closer to stated EU priorities such as employment, economic growth, climate conservation, and energy efficiency [5]. In 2015 the European Commission (EC) adopted an ambitious transformative plan with profound implications for all member economies [6]. One of the key features of this plan targets industrial producers of goods that utilize substantial packaging materials in their supply chain which were traditionally wasted, generating negative implications for the environment [5,6].

The most recent approaches at EU level, advanced within the EU Research and Innovation Programme are related to "Industry 4.0"—a new production paradigm aimed at developing a more sustainable and circular economy that require appropriate policies, such that "production systems and value chains offer the opportunity to produce products more resource-efficiently and in a more sustainable fashion" [7].

The transition of a country to CE entails significant costs but also creates important benefits related to resource usage, environment, economy and society. This led many developed countries to develop early transition policies and strategies supported by appropriate financial programs [4]. From a circular business model, the Nordic countries exhibit the most advanced experience. In this respect, one of the most relevant initiatives comes from The Nordic Waste Prevention Group under the Nordic Council of Ministers that initiated a project which features examples of best practices coming from Nordic businesses as part of the Nordic circular economy and suggests, based on these examples, a range of policy recommendations in order to accelerate the development of circular economy in the Nordic region [8].

Romania, an Eastern European economy integrated in 2007 within the EU, was ill-prepared for EC transition. According to Eurostat statistics, Romania's economy is among the three economies (alongside Malta and Estonia) where economic growth has not been decoupled from pressure on the environment and natural resources, the Romanian economy is mainly dependent on production and manufacturing, economic activities requiring natural resources and adversely affecting the environment through pollution [5,9]. Further, from the perspective of fundamental macroeconomic indicators regarding efficient use of resources, Romania is the most vulnerable EU Member State on the transition to the CE [5,9]. In addition to that, certain traditional EU member states who honored their legal obligations under the 2015 CE package, claim that Romania has an unfair economical competitive advantage. Finally, the multi-level governance system required by the CE, "top-down" and "bottom-up" [10], is almost unfunctional in Romania, especially at regional level, and the influence of the private economic sector exists only at the lower levels of government [11–13]. From the business environment perspective, there are currently no examples of economic agglomerations in Romania where the CE best practices have been implemented [14] nor a proper organizational culture prepared to adopt those principles [15,16].

In the EU vision, economic actors play a key role in encouraging the transition to the CE, as the most significant barriers are microeconomic [17]. Therefore, the investigation of practices and performances of Romanian companies with production activity—regardless of size and form of ownership—is, in our opinion, critical for an understanding of the progress made by the CE in Romania. There was always going to be a discrepancy between stated intents and on the ground realities, yet a realistic approach along with a working transitional model with Romanian characteristics has to be identified. Therefore, we raised the following research questions: What are the current practices of Romanian producers regarding the CE? What is the current level of performance? Are there global best practices that can be easily adopted to aid Romania in meeting its EU commitments?

Our article begins with the global literature review pertaining to the field of CE, followed by an expansion of the research objectives stated above. Next, we describe the research methodology undertaken in our study, present our findings and close with the constraints, limitations, and future research suggestions.

2. Literature Review on the Circular Economy

2.1. General Considerations regarding the Circular Economy

The CE is defined as "an economy which is regenerative by design"; "an economic system where products and services are traded in closed loops or cycles" [18,19] or as "a way to overcome the current production and consumption model based on continuous growth and increasing resources throughput" [20]. In most classical definitions of the CE, the central theme is maintaining or increasing economic value while decreasing or maintaining the raw materials used and limiting environmental maltreatment. The ultimate goal of the CE is an increase in the quality of life for all stakeholders, achieved by eliminating waste and leakage from the traditional economic supply chains through reduction, re-usage and recycling at every step of the way, thus closing the loop and maintaining value inside.

The CE concept, along with its related theoretical models, integrates contributions from different schools of thought, established on the ancient philosophy of cycles in real-world systems. In its search for a conceptual identity, CE underwent various stages: first, the "regenerative design" stage launched by John T. Lyle; then the "performance economy" stage articulated by Walter Stahel. The "performance economy" was followed by the "re-design philosophy" enunciated by William McDonough and Michael Braungart, and then the "industrial ecology" scripted by Reid Lifset and Thomas Graedel. Finally, we have the "biomimicry" or "nature imitation" philosophy best communicated by Janine Benyus, the "blue economy" spoken of by Gunter Pauli, and the "natural capitalism" philosophy promoted by Amory Lovins, Hunter Lovins, and Paul Hawken [21]. The theoretical goal behind the above-mentioned CE theories was to supplement and in time even replace the traditional linear economy. The aim is to present a regenerative economic system that allowed for a longer life-cycle of products within an economy that operates efficiently at all levels through regenerative re-design, reduction, reuse and recycling of all materials involved, thus reducing negative externalities [18–20]. As masterfully argued by Ghisellini, Cialani and Ulgiati [20] the "holy grail" of the CE theory, namely detaching economic growth from environmental depletion, can be achieved. The transition to CE clearly represents an intentional and strategic alteration aimed at systemic transformations characterized by long-term resilience, capable of generating economic, social and environmental benefits for all [18].

Recent studies regarding CE conceptual framework highlight controversies in the CE conceptualization [22], showing that CE is an "essentially contested concept" [23,24] and signal a possible "collapse of the concept" [25], because existing CE literature is mainly connected with practical and technical aspects and "the paradigmatic potential of CE remain largely unexplored", as argued Korhonen et al. [23] or because business models, profitability and competitiveness are frequently outlined as CE enablers, as argued by Kirchherr et al. [25] and Lahti et al. [26]. Circular business is highlighted as a new CE research direction by numerous recent studies [22,24–27]. A new CE approach in relation to innovation management is needed in order to advance in CE conceptual framework and to achieve systemic changes [28,29].

A comprehensive CE framework belongs to Leader and Rashid [30] who analyze in an integrated manner the environment, resources and economic benefits in the manufacturing industry, highlighting the impact of the manufacturing industry's negative externalities on community and proposing a practical implementation strategy using a top-down and bottom-up approach. Beyond the industry or sector, very few studies analyze the transition to the CE in relation with business ownership structure. An extremely interesting study belongs to Núñez-Cacho et al. [31] who demonstrate in the Mercadona case (the food retail leader in Spain) how family business's socio-emotional values help to overcome the EC transition barriers and solve the gap between identifying negative business externalities in the community and solving it by implementing effective measures. The three dimensions model of transition to CE—community, family and business—for family business based on the theory of socio-emotional wealth, proposed by Núñez-Cacho et al. [31], anticipated a new research direction of

the circular business with particularly useful implications for less advanced countries in transition to EC, including for Romania.

The vision of the future economy, based on resource productivity, environment protection, capitalization of economic oportunities in relation to social aspects and smart waste management, can become a reality given that the paradigm of thinking about the relation between economy, society and environment will change [32].

2.2. The Macro-Economic Perspective of the Circular Economy

Considering the complexity of the transition from a linear economy towards CE, the implementation of the above-mentioned principles and theories on a global scale has been heterogenous and insubstantial. Nevertheless, upon closer inspection, there are several positive experiences that can provide a useful macro-economic blueprint highlighting the factors that positively influence the adoption and implementation of the CE principles.

The EU experience indicates that the adoption of the circular economy precepts requires an intelligent regulatory system entailing a well thought out master plan and the long-term commitment of all stakeholders such as the federal and local authorities, businesses, citizens and consumers, along with their respective knowledge and trust networks [5,33,34]. The objectives of the EU legislation regarding CE is to gradually require member states to upgrade their own legislation and converge towards a pan-European legal sphere [35]. Naturally, the legislation has to be complemented by implementation methods at the local level. Both a "top-down" and "bottom-up" approach is necessary to establish the creation of a network of support for key stakeholders by governments and responsible, intrinsic actions by these key actors at a microeconomic level [17,36,37].

Applying the precepts of the CE to the massive and dynamic economy of China is an altogether different topic. Currently, China is the world's largest CO_2 emitter and the largest steel producer among many other traditional goods. In the last four decades, many of the West's "dirty industries" migrated to China, attracted primarily by low wages but also by relaxed and non-enforced environmental policies. Unsurprisingly, China has a special place in the circular economy literature, with substantial attention and investment in both theory and practical application [38–43]. Considering the gravity of the situation and the characteristics of the Chinese economy, the principles of CE are implemented primarily through a "top-down" government mandatory approach, in stark contrast to the EU, the United States, Japan and other countries who are designing environmental and waste management policies utilizing a "bottom-up" approach [20].

The city of Dalian, a thriving Chinese manufacturing hub, is a case of a successful implementation of CE with Chinese characteristics, since it was able to conserve energy and water resources while reducing industrial emissions [44]. Other cases of Chinese success described in the literature, underscore that although the Chinese national strategy emphasizes the need to transition to CE, the implementation is still in its early stages. The preliminary conclusions from the Chinese experience is that although each sector has its particularities and preferences, an integrated, interdisciplinary macro-approach is required for the gradual improvement and transition towards CE with supply chains and industrial networks as the key to "closing the loop" [39,44–46]. Industry-specific research stresses the fact that significant improvement has only been achieved in a relatively small number of sectors such as the information technology and electronic [47–50], chemical and food [51], materials [52] and restaurants [53].

Moreover, the results achieved within the same sector highlight key success factors that tend to be heterogeneous, as is the case of "smart-water management". In the case of Taihu Lake in China, components of integrated environmental management that target institutional cooperation, public participation and the internalization of environmental externalities were identified as success factors [54], while in the case of Athens, Greece, the solution seems to come as a result of the functional integration of a packaging treatment unit and an infrastructure for information and communication

technology [55]. There are, also, comparative analyses in literature between different sectors or industries such as battery, pesticides and automotive business [56].

A key success factor identified across sectors was "cooperation with upstream and downstream supply chain partners", as indicated by Zhu, Geng and Lai [46]. According to Wagner's study [57], the sustainable performance of Europe's paper industry was generated by strategic choices, investment decisions, and management of operations. The industrial symbiosis, the transport capacity, the existence of green industrial localities, the elaboration criteria for environmental impact assessment and the implementation of environmental management systems are the success factors in planning and management of manufacturing industries in India [58]. Environmentally friendly production and packaging, participation in environmental actions, ecologic marketing, green suppliers, ecologic stock and ecology as a dimension of ecological supply chain management were identified as critical success factors for electronics manufacturing in Taiwan [59] and Thailand [48].

For other countries, such as Romania, these models are not to be copied, but rather to be studied and adapted since one of the major limitations of most of these studies is the exclusion of financial and profit performance indicators. In other words, there may be general agreement as to the benefits of CE, but we may not be willing to pay for it in terms of reduced profits and/or delayed amortization of investments [60]. Nevertheless, the transition from the linear economy towards CE requires smart regulation, tailored national and sectoral policies and instruments, but most importantly companies that undertake this process motivated by other factors than merely financial profits.

2.3. The Micro-Economic Perspective of the Circular Economy

At a firm level, the implementation of CE principles requires cooperation with suppliers and consumers within the supply chain management (SCM), the ecological design of products, clean production, the use of renewable materials and technologies and a willingness to actively participate in the secondary raw material markets among other things [6,20]. Further, firms who are pursuing the precepts of CE have to integrate ecological criteria into their supply chains and management activities that include, but are not limited to the reduction, recycling, reuse and substitution of materials [61]. Most participants in the supply chain—suppliers, manufacturers, distributors, retailers and consumers—are experiencing pressures to balance environmental concerns with economic performance [49,62,63]. These realities and pressures have constructed the "green supply chain management" (GSCM) concept, which stated as its aim "to minimize or eliminate waste including hazardous chemical, emissions, energy and solid waste along supply chain"[64]. Although still in its infancy and implemented only to a limited extent [43], the GSCM concept is increasing in importance for manufacturers willing to balance environmental with economic performance.

Fortunately, there are numerous studies that investigate the relationships of firms that practice GSCM and their financial or economic performance from various industries and both developed and developing nations. Among other facts, a key finding regarding manufacturers who practice GSCM—partially or integrally—is that their overall organizational performance increases and they are much better positioned to face the "pro-green" tendency stemming from regulators and other societal stakeholders [47–49,64–67]. As part of the GSCM initiative, the close-loop orientation (CLO) is considered one of the most successful strategic orientation since it productively mitigates the process design and economic performance of the firm with other important aspects of GSCM such as supplier selection and evaluation, environmental collaboration, internal environmental practices and green production [43,64].

Another key finding from recent studies, reveals that environmental education and awareness at the firm's level plays an important role in motivating managers to adopt the precepts of the CE in general and GSCM practices in particular [67]. Unsurprisingly, a high level of ecological education and awareness among leading manufactures in developed countries is directly correlated with the adoption of the principles of CE at the firm level. Medium size and smaller manufacturers from developed

nations are less educated and thus less willing to adopt and practice the principles of the green economy while manufactures in developing countries—regardless of their size and ownership—are less aware and less likely to implement internationally agreed environmental policies and practices even when they are the national law [68]. Certain studies revealed that a major drawback to the implementation of GSCM practices has been the perceived complexity of the process and the lack of financial incentives [49].

Looking at the responses in the manufacturing industry to the adoption of GSCM practices, the literature identifies three types of GSCM adopters in terms of their environmental, operational, and economic performance: early adopters, followers, and laggards. In the case of Chinese manufactures, studies show that legal pressure was the greatest motivator for the adoption and implementation of GSCM practices [41,69–71], but which now plays a catalyst role in their overall efforts to modernize and increase efficiency and quality [69,70]. This is supported by a comparative study undertaken by Noya et al. which highlights the advantages of moving from classic supply chain management (SCM) to a green supply chain management (GSCM), a practice that goes beyond the traditional tribute to final disposal options by focusing on efficient use of resource and waste recovery [72].

Shang et al. [59] discuss the practices of electronics companies regarding GSCM and show that the highest level of environmental performance is being achieved by a group of companies with an "ecologic marketing orientation" which is satisfying the consumers' needs while taking into account the environmental impact. Thus, if with regard to traditional SCM, Seitan [73] points out that strategic harmonization at company's level implies that "all functions within a company and all phases of the logistics chain should pursue the same purpose, one that is compatible with customers' requirements" in the case of GSCM this becomes even more obvious. The same idea is supported by Constangioara [74] regarding Romanian manufacturers who concludes that maximizing the efficiency of Romanian supply chains requires intentional effort to integrate early on, suppliers, manufacturers and clients. Also, Fonseca et al. highlight the importance of "more intense collaboration practices between companies and stronger support from supply chain agents and consumers" [4] in the case of Portuguese organizations.

The adoption by producers of CE practices implies first the ecological design of production facilities [75–78]. The process focuses on the environmental impact of manufacturing activities and centers around preventive conduct. In such an approach, closing the loop or circular production systems may even be more efficient than traditional ones [51], and oftentimes functions can be improved while reducing environmental impact [79]. The achievement of such a transformation is predicated upon the ability of the decision makers at the macro and micro-economic levels to develop and implement integrated environmental policies and strategies [80,81]. This has to be further supported at the micro-economic level through the development of an internal organizational framework that supports CE initiatives [44,82–84].

Despite all the advances and benefits of the circular economy, it is not without criticism. Zink and Geyer [85] criticized the fact that CE advocates focus too much attention on engineering to the detriment of economics, which provides a distorted picture of the results. In response, the study undertaken by Zhu et al. [46] takes into account both environmental and economic aspects in assessing CE practices and performances. These authors conclude that "both CE practices and ecological and economic performance targeted by CE are positively associated with the types of producers who have implemented the practices of the ecological supply-delivery chain at the highest level" [46].

Most studies addressing Romanian companies refer mainly to the degree of involvement of Romanian SMEs in the activities specific to CE, the difficulties and barriers encountered by Romanian SMEs in implementing CE in the EU context [86–88] and to the Romanian consumer behavior and the perceptions of circular business models [27,89,90] not necessarily referring to the practices and performance related to the transition to CE.

In conclusion, the review of the literature supports the necessity and the opportunity to explore the practices and performances of CE among Romanian producers.

3. Research Methodology

The overall objective of our research study is to identify the practices and performances of Romanian producers regarding the implementation of the CE principles in order to formulate recommendations aimed at contributing to the fulfilment of Romania's commitments to EC. Our specific objectives were to identify: (1) the practices pertaining to the collaboration of manufacturers with their suppliers and customers regarding the green supply chain; (2) internal activities and practices related to the eco-design of products and ecological management; (3) the level of ecological and economic performance accomplished as a result of the adoption of CE principles.

Addressing a topic such as the practices and performance of Romanian producers regarding circular economy represents a difficult task as it tackles a field that is less explored in this context. Most studies in the extant literature investigate the Chinese producers, presenting, therefore, their context and specificities. However, we consider that most of the actions undertaken by the Romanian producers' can be included in the conceptual framework developed by Zhu, Geng and Lai [46], therefore our choice for this framework appears natural, of course, with the necessary adjustments.

Based on the literature review outlined thus far and considering the above-mentioned research objectives we proposed the following hypotheses:

H1: *There is a positive correlation between the implementation of the CE practices and higher levels of GSCC practices among Romanian producers.*

H2: *There is a positive correlation between CE targeted performance and the implementation of GSCC practices at higher levels.*

3.1. Research Variables and Instruments

There were three variables included in this study. The first, green-oriented supply chain cooperation (GSCC), assesses the level of integrating environmental concern of a producer into its supply chain by engaging both upstream partners (suppliers) through green purchasing practices (GPP) and downstream partners (clients) through cooperation with clients (CC) to create environmental-friendly products, processes and foster "loop-closure".

The second variable is comprised of the three major components of the CE, namely, (a) ecological product design (ECO) where the producer manages the product design process with an environmental-oriented approach; (b) internal environmental management (IEM) where the internal commitment to environmental issues is measured by appraising the tools and processes which foster a circular approach, and (c) practices related to return on investment (IR).

The third variable we included in our study was CE targeted performance and was composed of the two major dimensions namely, the ecological performance and the economic performance. This, in turn, would indicate the performance improvements Romanian producers would be expecting from the implementation of CE practices.

Our research design followed the literature outlined above, mainly the research efforts of Zhu, Gheng and Lai who developed an excellent framework composed of 16 items which assess a manufacturer's orientation towards environmental collaboration within its LSC, 19 items for assessing CE practices, and 11 items for assessing CE ecological and economic performance among Chinese producers [46]. In order to reach the goals of this research and to verify the research hypotheses, a selective quantitative research was used with a questionnaire as a tool. Beginning with their framework [46] and cross-referencing it with Romanian macroeconomic data, we developed the list of items for our questionnaire. The items next underwent the evaluation of five specialists to ensure their validity and suitability for the Romanian context and to confirm ease of understanding by potential respondents. Following this process, we selected 10 items to measure the implementation

of green-oriented supply chain cooperation (GSCC) practices by Romanian manufacturers. Out of the 10, 5 items were intended to measure the environmental orientation in the relationship with their suppliers (green purchasing—GP) and 5 items were intended to measure the relationship with their customers. For the measurement of CE practices, we utilized 5 items to assess ecologic product design (ECO), 5 items to assess the implementation of internal environmental management (IEM) practices and 5 items for investment recovery practices (IR). For the CE internal performance measurement, we employed 5 items to measure ecologic performance and 5 items to measure economic performance. All questions were arranged in a survey containing 3 parts: first, an eligibility item was incorporated to ensure only respondents with production activities participate in the survey. The second part of the questionnaire included the items assessing GSCC, CE practices and CE-targeted performance. The 25 items measuring GSCC and CE practices were designed to collect data on a 5-point scale measuring the frequency of implementation of the practices with 1 = never; 2 = sometimes 3 = so and so, 4 = often, 5 = always). The 10 items regarding CE-targeted performance were operationalized also using a 5-point scale measuring the extent to which performance has been achieved in the last year where 1 = not at all, 2 = small degree, 3 = moderated degree, 4 = high degree, 5 = very high degree. The third part of the questionnaire was designed to collect data at the organizational level regarding industry, turnover, number of employees, form of ownership and individual data regarding gender, age, and the position held in the company.

3.2. Data Collection

The final questionnaire was distributed via email using Qualtrics, an online research platform, to a database of 27,000 Romanian companies using the contact addresses provided by the Trade Registry of Romania during the months of October through December 2017. 377 respondents started the survey, 260 completed it with 98 respondents meeting the eligibility criteria of being engaged in manufacturing activities. The modest response rate may be attributed to the novelty of the topic in the Romanian economy or by the complexity of the questionnaire. Another possible explanation may be the quality of the database used which contains contact information provided by the official Trade Registry and which may not be updated. The profile of our respondents is summarized in Table 1. and it shows representation from seven types of producers' groups with a high interest in ecological issues, since they complete our questionnaire.

Table 1. The profile of the Romanian respondents.

Type of Business	Number	Percent
Groups of producers		
Metallurgy, metallic and non-metallic constructions	15	15.31%
Woodworking, furniture manufacturing	7	7.14%
Electrical, electronic, printing	18	18.37%
Agriculture and food industry	13	13.27%
Textiles, leather	11	11.22%
Chemicals, pharmaceuticals, rubber, plastics, paper	17	17.35%
Motor vehicle, machinery and equipment	17	17.35%
Total	98	100.00%
Ownership structure		
Private-owned	93	94.90%
State-owned	5	5.10%
Total	98	100.00%
Number of employees		
Under 249	66	67.35%
Over 249	32	32.65%
Total	98	100.00%

The fact that our sample of 98 respondents includes representatives from most of the industries with impact on circular economy in Romania constitutes an argument to support the relevance of our study.

At the same time, the 98 respondents forming our sample represent a true reflection of the structure of Romanian producers in regard to criteria such as "ownership structure" and "number of employees".

4. Results

The collected data was processed using IBM SPSS software for a comprehensive analysis. We first performed a correlation matrix to verify the association and correlation among variables. Then, we obtained the metric properties of the main scales utilized by our research, through the completion of statistical analysis such as Alpha Cronbach and Factor Analysis. We further applied a cluster analysis based on the implemented level of ESCC practices to determine the number and the types of clusters in which to group producers. Finally, we tested the two research hypotheses using independent samples *t* tests.

4.1. The Results of Statistical Analysis

The results of the correlation analysis indicate that there are six large size Pearson correlation coefficients (r > 0.5), twelve medium size Person correlation coefficients (r > 0.3), and only three small size Pearson correlation coefficients (r < 0.3) according to Cohen [91]. The correlation matrix of the main variables is presented in Table 2.

Table 2. Correlation matrix.

		Green Purcha-Sing	Customer Cooperation	Eco Design	Internal Environ-Mental	Investment Recovery	Environ-Mental Perfor-Mance	Economic Perfor-Mance
Green Purchasing	Pearson Correlation							
	Sig. (2-tailed)							
Customer cooperation	Pearson Correlation	**0.631** **						
	Sig. (2-tailed)	0.000						
Eco Design	Pearson Correlation	**0.443** **	**0.584** **					
	Sig. (2-tailed)	0.000	0.000					
Internal Environmental	Pearson Correlation	**0.568** **	**0.451** **	**0.425** **				
	Sig. (2-tailed)	0.000	0.000	0.000				
Investment Recovery	Pearson Correlation	**0.295** **	**0.341** **	**0.394** **	**0.368** **			
	Sig. (2-tailed)	0.003	0.001	0.000	0.000			
Environmental Performance	Pearson Correlation	**0.420** **	**0.528** **	**0.588** **	**0.387** **	**0.267** **		
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.008		
Economic performance	Pearson Correlation	**0.456** **	**0.476** **	**0.443** **	**0.338** **	**0.202** *	**0.659** **	
	Sig. (2-tailed)	0.000	0.000	0.000	0.001	0.047	0.000	

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).

In order to test the reliability of the factors comprising GSCC practices, CE practices and CE-targeted performance among Romanian producers, we performed an Alpha Cronbach test for each of the scales individually, followed by a factor analysis for each factor. The Cronbach's alpha values for the two factors containing GSCC practices are 0.83 for green purchasing (GP), 0.727 for customer cooperation (CC) and a total item correlation between 0.61–0.75 for GP and 0.46–0.65 for CC. For the three factors encompassing CE practices, eco-design (ECO) has a Cronbach's alpha value of 0.838 and a total item correlation in the range of 0.6–0.86. Internal environmental management (IEM) has a Cronbach's alpha value of 0.87 and a total item correlation of between 0.68 and 0.89 while investment recovery (IR) has a Cronbach's alpha value of 0.86 with a total item correlation interval of 0.49–0.88. The Cronbach's alpha values for the two factors of CE-targeted performance are 0.882 for

environmental performance and 0.835 for economic performance with a total item correlation interval of between 0.66–0.87 in the case of environmental performance and 0.63–0.90 for economic performance. The recorded values of Cronbach's alpha (>0.70) and those of total item correlation coefficients (>0.40) indicate a good internal consistency of the factors in the ESCC practices, CE practices and CE-targeted performance. Only in the case of CC was recorded a value of 0.727, which indicates an acceptable internal consistency [70,92,93]. The Alpha Cronbach coefficients are presented in Table 3 together with model fit indicators such as χ^2, (together with the degrees of freedom and p value), and RMSEA and RCLOSE value. These results suggest that, according to RMSEA, the models are slightly beyond the conventional 0.05 value limit for a good model fit.

Table 3. Reliability analysis values.

Factor	Scale	Alpha Cronbach	Total Item Correlation Interval	Model Fit Indices				
				χ^2	DF	*p*	RMSEA	PCLOSE
ESCC practices				40.73	32	0.138	0.53	0.429
	Green Purchasing	0.830 (5 items)	0.61–0.75					
	Customer Cooperation	0.727 (5 items)	0.46–0.65					
CE practices				39.30	29	0.096	0.061	0.335
	Eco-design	0.838 (5 items)	0.60–0.86					
	Internal environmental management	0.870 (5 items)	0.68–0.89					
	Investment recovery	0.860 (5 items)	0.49–0.88					
CE targeted performance				28.27	22	0.164	0.055	0.412
	Environmental performance	0.882 (5 items)	0.66–0.87					
	Economic performance	0.835 (4 items) *	0.63–0.90					

* In case of 'economic performance' scale one item was dropped because it had a low loading for the main construct (total item correlation was 0.34). So, the scale now consists of 4 items. All the other scales, from Table 2, consist of 5 items.

4.2. Producers Clustering according to GSCC Practices Preferences

In order to better test our stated hypothesis, we performed a cluster analysis to determine the numbers and the types of clusters to group our respondents into. Based upon the above-mentioned findings, we grouped our respondents according to their level of GSCC percepts implementation into clusters. Using the SPSS software, we effected a Two Step Cluster Analysis, which is a recent, exploratory procedure designed to identify natural clusters in a data set. This procedure can reveal conditions such as categorical and continuous variables mixed in the same procedure, choice of automatic number of cluster selection or scalability and the possibility of constructing a predictor profile among other things. We applied the two-step cluster analysis on the data gathered from 'Green purchasing' (scale 1–5) and 'Customer cooperation' (scale 1–5) from our sample of 98 respondents. We also used optimal number of clusters, log-likelihood distance measure Akaike's Information Criterion (AIC). The analysis revealed 2 natural clusters, with a respectable cluster quality. Further analyses using specific fixed option with 3 or 4 clusters indicated that cluster quality would decrease with every additional cluster. Furthermore, an analysis with 3 or 4 clusters revealed that the relationship between two cluster predictors is linear and positively related and does not change the overall conclusions. We thus opted for the automatic results which generated best cluster quality. The most important predictors for the cluster connection were: green purchasing (1.0) and customer cooperation (0.52). The first cluster comprises of 51% of the respondents and had a lower than average median for both predictors, while the second cluster comprised 49% of the respondents and had a higher than

average median for both predictors (see Figure 1). We labeled the first cluster "low scorers on GSCC practices" while the second cluster "high scorers on GSCC practices".

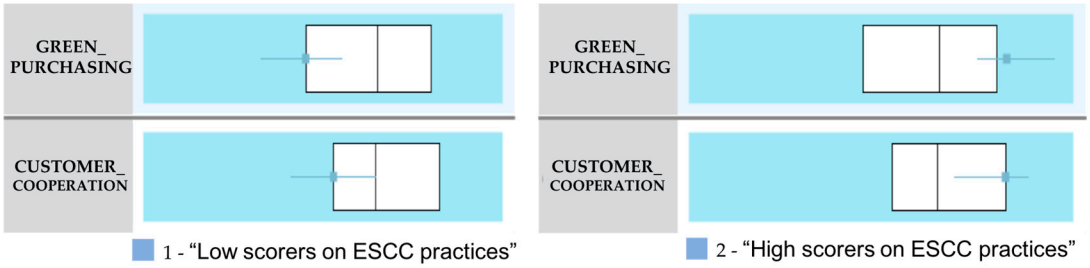

Figure 1. Cluster comparison according to the two predictors.

4.3. Hypotheses Testing

Next, we tested our two hypotheses "there is a positive correlation among the implementation of CE practices and higher levels of GSCC practices among Romanian producers" (H1) and "There is a positive correlation among CE-targeted performance and the implementation of GSCC practices at higher levels" (H2). We used the independent *t* test with the new multigroup variable based on the above-mentioned clusters. This analysis would indicate a positive or a negative influence on the CE practices and/or on the CE-targeted performance among Romanian producers. The characteristics of the sample are presented in Table 4. The results reveal significant differences in the scores for cluster 1 and cluster 2 with regards to eco-design, internal environment, environmental performance and economic performance (see Table 4).

Table 4. Mean, standard deviation, *t* and *p* values for the comparison of clusters 1 and 2 according to the distinctive variables.

Variable	M & SD		*t* & *p* Value
	Low scorers on GSCC practices (CLUSTER 1)	High scorers on GSCC practices (CLUSTER 2)	$t = -5.347$, $p = 0.000$
CE practices			
Eco design	M = 19.76, SD = 3.31	M = 22.97, SD = 2.58	$t = -5.347$, $p = 0.000$
Internal environment	M = 16.70, SD = 6.03	M = 21.83, SD = 3.43	$t = -5.199$, $p = 0.000$
Investment recovery	M = 19.22, SD = 4.50	M = 20.79, SD = 4.77	$t = -1.676$, $p = 0.097$
CE targeted performance			
Environmental performance	M = 19.10, SD = 3.58	M = 22.35, SD = 2.86	$t = -4.956$, $p = 0.000$
Economic performance	M = 14.00, SD = 3.08	M = 17.54, SD = 2.79	$t = -5.954$, $p = 0.000$

Note: M = mean, SD = standard deviation, *t* = *t* test, *p* value = significance level.

The results suggest that the type of cluster a producer belongs to partially influence their CE practices and fully influence their CE-targeted performance. We uncovered border significance for investment recovery, which means that the frequency of GSCC practices a producer uses is not associated with investment recovery practices. Therefore, based upon the above-mentioned evidence we can conclude that hypothesis 1 (H1) "there is a positive correlation between the implementation of CE practices and higher levels of GSCC practices among Romanian producers" is partially confirmed, while hypothesis 2 (H2) "there is a positive correlation between CE targeted performance and the implementation of GSCC practices at higher levels" is fully confirmed.

5. Conclusions and Further Research

The results of our research reveal that based upon their practices and performances regarding the transition to CE, the Romanian producers can be grouped into two clusters. The first cluster "Low scorers on GSCC practices" is comprised of 51% of the respondents, while the second

cluster, "High scorers on GSCC practices" is comprised of 49% of the respondents. The most important predictors for the cluster membership are "green purchasing" and "customer cooperation". The significant differences between the two clusters stem from the eco-design and internal environment, two of the three component variables of the circular economy practices. Regarding the third major component, "investment recovery practices", our analysis does not reveal significant variance between the two clusters. In regard to the "CE-targeted performance" variable, the two clusters show significant differences for both environmental and economic performance. As a result, we can conclude that the type of cluster a producer belongs to partly influences their CE practices and fully influences their CE-targeted performance. As already mentioned in our introduction, the precepts of the CE have yet to become mainstream even in the developed economies. From a theoretical standpoint, the burden of proof is still upon the shoulders of CE proponents who have yet to demonstrate financial sustainability and speedier development cycles for the underdeveloped regions of the world. The major counterargument to the CE coming from the developing world is an accusation of hypocrisy. The West has developed its economies over the past three centuries with disregard to the environment and thus achieved an enviable standard of prosperity, and when it is "The Rest's" turn, it imposes ecological limitations. This counterargument reveals the lack of knowledge and education and it is perhaps the major impetus for further research into the possibilities and potential of the CE. Without adequate theoretical tools, the traditional, linear economic development model will be the only one available for developing economies—such as Romania—to embrace for themselves.

The results of the study indicate that, in the case of Romanian producers, the practices related to "green purchasing" and "customer cooperation" significantly determine the level of economic and ecologic performance. These results are similar to other studies concerning producers from EU [4,51,72,75,79] among which, the case of Spanish pork producers presents the greatest similarity [72]. The differences between Romanian producers and those from other European Union countries, as indicated by our research, are related to the polarization of Romanian producers at the two extremes—low and high GSCC, which reflects the low degree of economic cooperation and networking. This result can be explained by the operational gaps that can be found in the supply chain of most industries in Romania, the economic agents' lack of trust in collaborative mechanisms, the scarcity of best practices and governance models regarding networks of companies that can lead to bottom-up clustering and make green-oriented supply chain cooperation (GSCC) possible. Adoption of a new style of governance that pursues cooperation and networking (network governance), improvement of specialization along value chain through motivating regional policies, networks of companies leading to bottom-up clustering and focus on innovative management and learning processes in order to capitalize endogenous potential—are some recommendations resulted from this research that can facilitate the Romanian producers' transition to CE in the context of integration into the European model. In the absence of concrete measures, Romanian producers will face difficulties in covering the transition costs imposed by EU legislation and ultimately will be excluded from the European market by the competitive pressure.

The present research connects with the theoretical literature and is trying to fill a gap regarding Romanian producers. As we presented in the literature review, there were no studies addressing the relationship between the implementation of the CE practices and higher levels of GSCC practices among Romanian producers and Romanian producers CE targeted performance in relation with GSCC practices were not previously studied in other papers. The novelty of this study lies in using the cluster analysis in order to identify the practices and performances of Romanian producers regarding the implementation of the CE principles. In our opinion, the cluster analysis chosen as the research method is innovative in relation to existing literature. As mentioned in the results section, based on the practices and performance related to the transition to CE, Romanian producers can be grouped into two clusters with significant differences for both components, environmental performance and economic performance. Even if our research has its limitations based on the representativeness of a sample of 98 respondents and the heterogeneity of industries of the Romanian respondents, the present

analysis could be easily extended by sending the questionnaire to a broader sample of producers covering each industry. Furthermore, as managerial implications are concerned, our study can help producers select the most appropriate set of circular actions regarding components "green purchasing" and "customer cooperation" as prerequisites for achieving performance. Nevertheless, this aspect requires further investigation.

Naturally, further research studies in the Romanian context regarding the implementation of the circular economy practices and compliance with EU regulation have to include a larger sample of the business community, including family business [31]. Second, the industries and sectors from where the data is collected have to be expanded to include all domains pertinent to the circular economy, and, in particular, the manufacturing industry [30] and construction industry [94]. Thirdly, for an in-depth analysis, more clusters would have to be formed to evaluate how different variables affect different groups. Finally, these types of studies ought to have a longitudinal dimension so progress can be monitored over longer periods of time and the necessary corrections can be made.

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