

Article

The Effects of Strategic Procurement 4.0 Performance on Organizational Competitiveness in the Circular Economy

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Abstract: *Background:* This study aims to identify how and if strategic procurement 4.0 performance influences competitiveness under circular economy conditions. In this regard, to achieve the aim of the study, we examine the moderating and mediating effects of strategic procurement 4.0 performance. In addition, the paper explores the role of procurement 4.0 in the circular economy and its impact on organizational competitiveness, with a focus on the mediating factors in the relationship between manager attitudes and competitiveness, making a significant contribution to the emerging research in this field. *Methods:* The results of a two-way moderated multiple regression analysis showed that there is an effect that intensifies the relationship between the variables being studied. Mediating effects were tested using Smart PLS-4 and the results showed significant mediating effects of strategy for procurement 4.0 and planning for procurement 4.0. *Results:* The study found that organizations with high strategic procurement 4.0 performance and high circular economy openness have the highest level of competitiveness. However, low levels of circular economy openness result in similar competitiveness levels regardless of low or average strategic procurement 4.0 performance. *Conclusions:* We found that strategic procurement 4.0, aligned with sustainability goals and incorporating digital technologies, leads to increased competitiveness in the context of the circular economy, as demonstrated in the Romanian business environment. Moreover, our study highlights the importance of strategic training in procurement 4.0, the need for a three-level approach in procurement strategy, planning, and performance review, and the significance of considering non-financial aspects in competitiveness and innovation within the context of a circular economy.

Keywords: moderating effect; mediating effect; competitiveness; procurement; strategy



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1. Introduction

In the current context, procurement plays a strategic role in the production system, and is closely linked to the company's financial policy while transforming from a cost center to a profit center. Especially in companies that produce goods, procurement has direct implications on the competitiveness of the company, the flow, the quality of raw materials that directly influence the quality of the product offered on the market, and production costs. Procurement is a central element of the company's strategy through its ability to determine integration policy upstream or downstream, influence financial policy, and contribute to the development of relationships with suppliers [1].

An increasing number of companies are seeing opportunities in the complicated contexts in which they are caught, and many are thinking of the circular economy as an opportunity for a new and improved business model. This is because such a business model has the potential to reduce the overuse of depletable natural resources, but also to reduce the volume of waste generated as a result of economic activities [2].

The Ellen MacArthur Foundation is an important organization that supports the idea of circularity by discussing how sustainable development goals can be achieved through the application of the principles of circular economy [3]. Most studies view the concept

of circular economy as especially important due to international efforts at the macro and microeconomic levels to focus on elements of sustainability [4].

Technology remains a crucial element in the successful transition to a circular economy model. These include technologies based on the Internet of Things such as RFID (radio frequency identification), GPS (global positioning system), robots, and driverless vehicles, all of which can enable uninterrupted flows, whether we are talking about information or logistical issues. All of these factors have exciting potential to contribute decisively to operational management in accordance with the benefits and principles [5].

It is in the so-called fourth industrial revolution, called Industry 4.0 for short, where procurement activity cannot be a simple manual process, but rather an automated process with the help of digital technologies. Automating such a process will save time and resources [6], which converges with the development of the ability to operate according to the principles of the circular economy [7].

Given its potential to boost productivity, save expenses, and enhance performance in businesses, procurement 4.0—the integration of digital technology into procurement processes—is a pertinent and relevant study problem. Firms are under growing pressure to be more efficient, cost-effective, and sustainable in today's quickly evolving business environment. Procurement 4.0 may be a critical tool in helping organizations achieve these objectives. Moreover, as the globe faces environmental and ecological concerns, the shift to a circular economy is becoming more significant for enterprises. To decrease environmental impact, boost competitiveness, and identify and execute sustainable procurement methods, enterprises must play a key role in the transition to a circular economy. Therefore, it is important to analyze how procurement 4.0 will affect firms' capacity to compete and move toward a circular economy. Finally, this study may help firms improve their procurement procedures and become more sustainable, cost-effective, and competitive by offering useful insights and suggestions. Examining how procurement 4.0 will affect competitiveness and the shift to a circular economy will help firms better understand how to use technology to accomplish their objectives and stay ahead of the competition.

The term procurement 4.0 is a relative novelty and therefore we consider that it requires further investigation, especially in the strategic context of the organization. This study builds on previous research [8,9] and presents a framework that examines the crucial strategic components of procurement 4.0 and their impact on an organization's competitiveness within the framework of the circular economy. The study adopts a dual viewpoint.

We want to understand the direct influences of manager attitudes towards the circular economy on organizational competitiveness. From a different angle, the study aims to explore the indirect effects by examining how the performance of strategic procurement 4.0 acts as a moderating factor in the relationship between a manager's attitudes towards the circular economy and the organization's competitiveness. Going further, indirect effects will be assessed through mediation analysis. We consider that the aspects we study through this research are important; they make a significant contribution to the previously established literature, and procurement 4.0 interconnections at the strategic level and at the performance level of the company in a context of the circular economy are highlighted. Thus, we propose the following research questions.

RQ1. Are organizations that are more open to the circular economy more competitive?

RQ2. Does the effect of openness to the circular economy, understood as manager's attitudes towards the circular economy, increase if the organization uses procurement 4.0 as a strategic tool for performance?

RQ3. Are there mediating factors in the relationship between the manager's attitude toward circular economy and organizational competitiveness?

Therefore, our study highlights a number of managerial levers and strategic areas through which managers can directly interact to influence the level of competitiveness of the company in the context of the need to move to the circular economy. Before implementing Procurement 4.0, this action will come as a consequence of certain strategic thinking, thus it is not always clear which are the strategic elements that contribute to achieving superior

performance in the new context of the circular economy. As an emerging research pool, our empirical study contributes to the extension of knowledge about the dynamics of procurement 4.0. The significance of the paper lies in its contribution to the emerging research pool on procurement 4.0 and its role in the context of the circular economy. This paper proposes a framework that considers the strategic elements of procurement 4.0 and its influence on organizational competitiveness in the circular economy. Through the examination of direct and indirect effects of manager attitudes towards the circular economy, the study sheds light on the managerial levers and strategic areas that managers can interact with to influence the competitiveness of the company. This information can be of excellent value to organizations that are considering the transition to a circular economy model. The novelty of the paper lies in its examination of the mediating factors in the relationship between manager attitudes towards the circular economy and organizational competitiveness. This study is one of the first to investigate the interconnections between procurement 4.0 and the circular economy at the strategic level and performance level of the company. Furthermore, the paper provides empirical evidence on the impact of procurement 4.0 on organizational competitiveness, which can serve as a valuable resource for managers and organizations in their decision-making processes. Overall, the findings of this study can contribute to the development of more effective strategies for companies seeking to transition to a circular economy model.

Furthermore, we continue with the literature review in the next section while determining our research hypotheses and the conceptual approach of the research. Going further, we present the research methods, followed by the results obtained, discussions on the implications of the results, and conclusions.

2. Research Background and Hypotheses

Procurement 4.0 refers to the integration of digital technologies in procurement processes for increased efficiency and performance. The circular economy is a system where waste and pollution are reduced, and resources are conserved through closed-loop supply chains. Competitiveness refers to an organization's ability to compete in the market and offer goods and services at lower costs or higher quality. Strategic procurement 4.0 performance has a positive impact on competitiveness and the transition to a circular economy by allowing organizations to prioritize sustainability and improve supply chain performance. The transition to a circular economy can be facilitated by a combination of technological advancements, such as procurement 4.0, and changes in organizational practices and culture. Procurement plays a critical role in the transition to a circular economy by helping organizations implement sustainable practices and improve competitiveness.

2.1. Procurement 4.0

Procurement activity should not be confused with other specific activities in the supply chain and with term logistics. Procurement involves the identification, buying, and management of the necessary materials, services, or products from suppliers for an organization to operate and grow. Procurement aims to control cost, make resources available in an efficient manner, deal with risk, and collect and disseminate information through the organization in order to support decision-making. In contrast, we have logistics. The transportation of raw materials or finished goods along the supply chain is the main role of logistics [10]. We believe that this confusion stems from some definitions of the word. Therefore, logistics indicates the planning, execution, and control of the procurement and use of raw materials, personnel, and other resources to achieve the objectives of the activity [11]. According to other definitions, logistics can also refer to the activity of sales and marketing [12]. The author of Ref. [13] describe logistics as the detailed organization and implementation of a complex operation, which can be purchasing or selling. Originally from French *logistique*, according to Larousse, logistics refers to the set of methods and means used to organize a department or a company, and includes the actions of handling, transport, and packaging, sometimes procurement as well [14]. We consider procurement

relations to be characterized by the fact that they are exchange relations between companies that involve the sharing of profits and have effects on the entire activity of the company, which are in turn influenced by the power relations held on the market by the actors involved. Most of the time, partners have opposite interests, and the role of procurement activity is to harmonize these interests.

Given fluctuations in the supply of raw materials, in terms of quality or quantity, procurement must take advantage of all the opportunities that arise to find solutions to resolve a crisis [15]. Material insurance can also directly influence the quality and characteristics of the final product offered for sale, for example, by choosing the raw materials that will participate in the production process.

The company's general strategy will include a strategy in the field of procurement that will reduce threats, exploit opportunities, eliminate weaknesses, emphasize strengths, make material insurance decisions in full knowledge of their impact on the company and customers, as well as under the conditions of the most favorable supply possibilities [16]. We add that in the construction of the value chain of an organization, procurement refers to the function of purchasing the input elements actually used within the chain and not to the input elements supplied as such. As with all value chain activities, procurement uses "technology", such as working procedures with suppliers, qualification rules, and information systems. Therefore, improving procurement practices can have a pronounced effect on the cost and quality of inputs, as well as on other activities associated with the reception and use of these items, and the relationship between the firm and its suppliers.

Traditional procurement strategies focus on a "buy-make-dispose" approach, aligned with the current linear economy agenda. However, the principles of the circular economy are becoming more important every day, affecting the well-established way of working in procurement. To meet the challenges of the circular economy, partnering with designers and developers is essential to have materials that can be reused, repaired, and remade [17], which will involve strategic suppliers who can deliver and manage these supply chains over time. Thus, a new mindset will be needed for the procurement activity, as well as new performance measurement systems, new skills, and competencies.

Operating in circular economy conditions requires procurement to allow a vital role, which requires selecting suppliers, establishing long-term partnerships with suppliers, selecting environmentally certified suppliers, and integrating processes to engage in ecological practices together with suppliers. These are all prerequisites that support an organization's sustainability goals with the help of strategic suppliers [18]. Uncertainty and complexity are the key words when it comes to product recovery and/or recycling. Thus, the effectiveness of a company that implements these practices heavily relies on how the company effectively manages its supply and relevant logistics processes. More attention must be paid to ensuring the provision of IT and technical resources that contribute to a rapid and efficient flow of supply. Therefore, based on the study of the existing literature, it is important to maintain a state of competitiveness of the organization, given the need to move to a circular economy, as well as the role of supply in this context.

Starting from these aspects and adding the need and opportunity to digitize activities [19], we can see how the interdependence between digitization and procurement is a growing topic of interest. The term 'Procurement 4.0', which in principle denotes the application of specific techniques from 'Industry 4.0', is a novelty element, as it could be identified in very few works [9]. We consider this term to be of utmost importance in the context of the digital age and an obvious necessary integration with other business processes within organizations. Furthermore, the literature has shown us over time how enterprise resource planning (ERP) solutions have created various implementation difficulties, and as a result, organizations have focused more on managing supplier relationships to succeed in implementing such solutions [9]. Some authors [20,21] have suggested that ERP solutions facilitate information transfer in real time to integrate all activities in the organization, which may be useful in adopting procurement 4.0 systems. However, the constraints of such an approach have not been studied thoroughly; in addition to the rather prohibitive

costs, companies need to consider procedures, capabilities, and knowledge to successfully implement such an approach. Thus, although the authors mentioned above have taken important steps in showing how the procurement function is particularly important, the literature could benefit from more research in this regard in order to produce empirical evidence in different contexts and approaches.

2.2. Circular Economy

Climate change, a well-known phenomenon in which the Earth's temperature fluctuates significantly based on the amount of carbon dioxide in the atmosphere [22], has become increasingly prevalent and serious in recent years, as evidenced by the frequent reports of natural disasters. The current environmental crisis is just as significant as the COVID-19 pandemic. In light of this reality, leaders, civil society, heads of state, and other relevant stakeholders must acknowledge the need for new strategies and practices that support and advance sustainable development. In this context, the circular economy provides a promising solution to the global environmental challenge that the world is facing.

A survey conducted by Flash Eurobarometer 388 on "European attitudes to waste management and resource efficiency" found that most respondents believe that more efficient resource use could lead to improved quality of life (86%), economic growth (80%), and employment opportunities (78%) in their country [23]. In recent times, the circular economy has become a widely debated topic within the EU [24].

The circular economy refers to a sustainable production and consumption system aimed at maximizing the use of recyclable materials through repeated production, use, and reuse, and extending their lifespan as much as possible [25]. The concept of circular economy was first introduced in an economic model by Pearce and Turner [26]. The authors argued that the linear economy is not concerned with recycling, thus harming the functionality of the environment–economy dyad. The authors of Ref. [27] highlight that the circular economy encompasses the three "Rs": reducing waste and materials, reusing products or their components, and recycling. Thus, the circularity concept in the economy has been known to respond to the pursuit of sustainability based on sustainable growth amid the increasing pressure that production and consumption place on the planet's resources and environment. A circular economy operates on a continuous production system where resources and waste are continually reused. When a product reaches the end of its life cycle, efforts are made to keep its materials in circulation for as long as possible.

However, implementing a circular economy faces certain challenges. According to the authors of [28], changing the linear economic model that has become prevalent since the Industrial Revolution is a complex and demanding task that entails transforming current production and consumption practices. This transformation can be perceived as a threat by some stakeholders and a chance by others.

The literature highlights in [29] that it is desirable for procurement 4.0 to be connected to the circular economy because it involves the use of specific Industry 4.0 technologies and can become part of the implementation of digital technologies that contribute to achieving sustainability goals.

The literature taught us that the circular economy [30] and procurement 4.0 are two research topics in an emerging dynamic that require significant contributions to increase the level of knowledge [9,31].

2.3. Competitiveness

Competitiveness involves competition between economic agents or even between states. States compete for resources, labor, influence, etc., and firms compete for suppliers, customers, and all the resources necessary for the efficient and effective conduct of their business [32]. However, it should be noted that the conduct of business activities under competitive conditions is closely related to the level of competitiveness of the economy as a whole, and vice versa.

Although it is a complex term, considered by some authors almost impossible to precisely define, competitiveness can be the ability of a company to compete with other companies and their products/services [33]. Microeconomic competition between companies is often considered to be a beneficial element for their long-term development because the existence of competitors will be a good source of motivation in order to maintain a certain state of competitiveness. For this, companies are constantly looking for useful sources to maintain a certain level of competitiveness. Therefore, companies seek to obtain and maintain competitive advantages. These competitive advantages are very varied in terms of how they are obtained [34].

The literature provides some insight into ways to obtain competitive advantage. Adding value to organizations and therefore to customers, cost control, and differentiation, and strategically following certain market niches while considering cooperation, globalization, and innovation are just a few of the elements of the path a company can address to attain competitive advantage [35].

Therefore, in the context of achieving and maintaining a reasonable degree of competitiveness for the organization while facing uncertainty in the external environment of the company, we argue for reconsidering the strategic role of the procurement function for a better strategic fit, while reflecting on the interdependencies between the level of competitiveness of the company and the elements of internal and external environment that influence this level.

2.4. Strategic Procurement 4.0 Performance and Its Indirect Effects

The performance of strategic procurement 4.0 refers to the strategic level of preparation of the organization for the implementation of procurement 4.0 to achieve better performance. This term is based on three elements: strategy for procurement 4.0, planning for procurement 4.0, and review of procurement 4.0 performance [9].

The strategy for procurement 4.0 involves especially long-term managerial decisions. Under the particularities of the circular economy, we can address discussions on a strategy that involves both elements of competitive strategy and partnership strategy to conduct material remanufacturing and recycling processes [36]. However, we must not neglect the fact that the procurement 4.0 strategy is based on the company's corporate strategy, which will decide how important procurement is in the organizational context. Therefore, strategic fit is very important because the strategic level of the organization will influence the attitude and thinking of both buyers and suppliers, thus facilitating the highlighting of the utility of procurement 4.0 at the organizational level [8,9], and will also influence the place and role of procurement in the organization.

Procurement 4.0 planning involves the existence of a process of securing material resources, and in the context of the circular economy, it will mean optimizing the use of resources to ensure the lowest possible consumption [37]. When using Industry 4.0 specific technologies that can be used mainly to ensure real-time data transfer, procurement managers need transparency regarding the volume of supply and demand [9]. The planning of acquisitions is influenced by a number of variables, one of the most important of which is supporting management through strategic objectives [38]. Therefore, we consider procurement 4.0 planning an important element that reveals how strategically prepared the organization is for the implementation of procurement 4.0 [9].

Review of procurement 4.0 performance was shown to have significant effects on customer satisfaction in terms of remanufacturing and recycling [9]. Periodic evaluations of procurement 4.0 performance benefit more than just the procurement activity itself because the information obtained can be useful for both sales and production [39]. We also believe that the organization's procurement strategy must benefit from a well-developed evaluation system to constantly streamline processes and delivery times, which makes it a crucial element for measuring strategic procurement 4.0 performance.

From the point of view of the indirect effects of strategic procurement 4.0 performance, we consider that the level of performance of strategic procurement 4.0 can both strengthen

and weaken the relationship between the managerial level of openness for transitioning to a circular economy business model and the competitiveness of the company. When they are better prepared, the organization seeks to set strategic goals that place procurement in a critical place; therefore, it is more likely to design and support effective procurement strategies that will not circumvent the necessary dimensions of sustainability and alignment with the principles of the circular economy [40]. Substantiating this strategy using data collected from competitors, customers, suppliers, partners, and other stakeholders involved will mean greater chances of reducing energy consumption and resources, as well as reducing supply times [41,42].

Although there are some studies that provide theoretical support for the relationship between the openness of managers towards transitioning to circular economy, strategic procurement 4.0 performance, and competitiveness of the organization, there is still a lack of empirical evidence that supports these relationships. Further empirical research is needed to test and validate these relationships. Moreover, Industry 4.0 technologies play an extensive role in the implementation of procurement 4.0 and the transition to a circular economy. More research is needed to investigate how these technologies can support the relationships between the openness of managers towards transitioning to circular economy, strategic procurement 4.0 performance, and competitiveness of the organization. Based on these research gaps, the research issues addressed in this paper refer to the direct and indirect interactions between the openness shown by the managerial attitude regarding the circular economy, the performance of the 4.0 strategic procurement, and the company's competitiveness. The literature sets the background of the research and, following its analysis, we therefore hypothesize:

H1. *The openness of managers towards transitioning to circular economy has a direct positive effect on the competitiveness of the organization.*

H2. *As the value of strategic procurement 4.0 performance increases, the effect between the openness of managers towards transitioning to circular economy and the competitiveness of the organization also increase.*

H3. *The openness of managers towards transitioning to circular economy has a significant effect on (a) strategy for procurement 4.0, (b) planning for procurement 4.0, and (c) review of procurement 4.0 performance.*

H4. *The link between the openness of managers toward transitioning to circular economy and the competitiveness of the organization is mediated by (a) strategy for procurement 4.0, (b) planning for procurement 4.0, and (c) review of procurement 4.0 performance.*

3. Research Methodology

For testing the research hypotheses, we have used the two-way moderated regression analysis and Partial Least Square Structural Equation Modelling. To apply those statistical instruments, we have also used two different computer software, IBM SPSS 26 and Smart PLS-4 version 4.0.8.4 software. The added value of the methodology used in the study is the combination of two statistical instruments, namely the two-way moderated regression analysis and Partial Least Square Structural Equation Modelling, to test the research hypotheses. The use of these statistical instruments allowed us to examine the moderating effect of strategic procurement 4.0 performance on the relationship between competitiveness of organizations and the managerial attitude towards the transition to the circular economy, as well as to examine mediating effects. Furthermore, the study used a rigorous process in the operationalization of the constructs and the development of the research variables, which were based on a review of the literature and discussions with practitioners and academics.

Figure 1 illustrates the conceptual framework and demonstrates the approach to empirical testing.

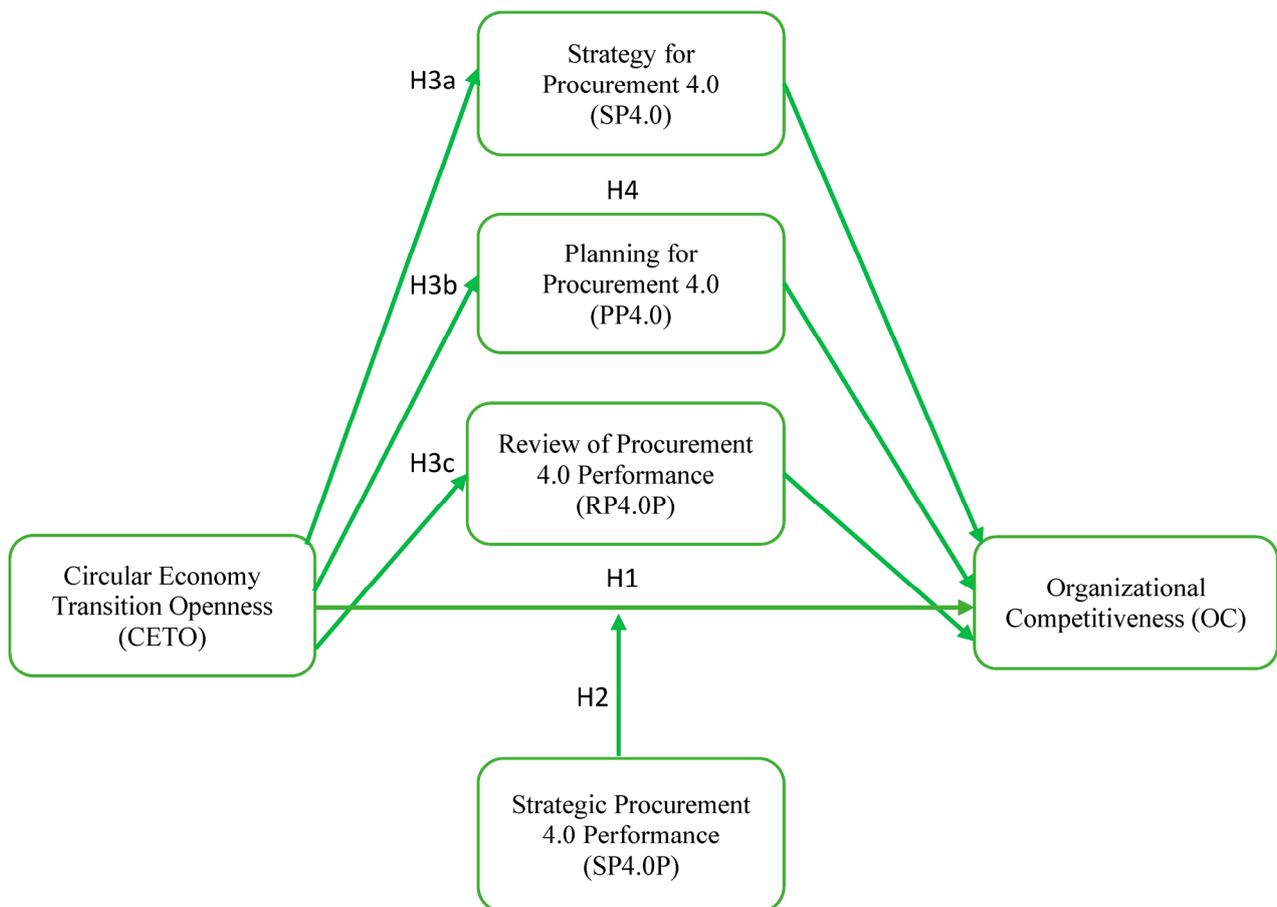


Figure 1. Conceptual Framework.

3.1. Study Participants, Method, and Data Collection

Our research aimed to test whether strategic procurement 4.0 performance has a moderating effect on the link between competitiveness of organizations and the managerial attitude considering the transition to circular economy. In contrast, we also examined mediating effects. Our research target translated into the statistical population of the study, which was large companies currently active in Romania. We consider companies to be large in size by having more than EUR 50 million in annual turnover and having over 250 employees; the European Commission [43] is the source for defining a company in such a way. We chose large companies because we can argue that their available resources and potential may increase the chance of strategically thinking and implementing innovative procurement processes and circular economy principles. The survey we used was conducted online via email and built using Google Forms. We found this method to be dependable for conducting this analysis.

Thus, within the target group, which included 466 companies, we have managed to collect 85 responses which we further analyzed to test our hypotheses. This made the response rate 18.24%. We consider this response rate to be considered acceptable because we used the convenience sampling technique. Furthermore, the COVID-19 pandemic, the characteristics of the business environment in Romania, and the availability of managers from large companies also contributed to the response rate. In addition, if we refer to other supply chain studies, some reported a response rate of 7.15% [44]. Going further, although the sample is relatively small, it can be considered representative as a result of the distribution of companies in different fields of activity. When using PLS-SEM, the arrows pointing to the variables will decide the necessary sample size. Usually, the recommendation is that the sample size be ten times bigger than the number of arrows. In

our case, we have six arrows pointing at variables in the conceptual model; therefore, a good sample size would be sixty. We managed to collect 85 responses through our survey; therefore, we can consider that we have met the expectation of sample size.

We consider the methods used to test the hypotheses to be appropriate because they allow us to examine the complex relationships between the variables of interest, such as the openness of managers towards transitioning to circular economy, the competitiveness of the organization, and strategic procurement 4.0 performance. Advanced statistical methods that enable the evaluation of moderated and mediated connections include two-way moderated regression analysis and Partial Least Square Structural Equation Modelling (PLS-SEM). These techniques are appropriate for evaluating the indirect relationships between the variables because they can reveal if a third variable (moderation) influences one variable's effect on another, or whether one variable's effect is passed via another (mediation). With the aid of IBM SPSS 26 and Smart PLS-4 version 4.0.8.4 software, we can conduct the statistical analysis with efficiency and dependability. These commonly used software programs have strong capabilities for performing data analysis and testing hypotheses. In conclusion, the employment of two-way moderated regression analysis, PLS-SEM, IBM SPSS, and Smart PLS-4 gives a solid framework for studying the intricate interactions between the research's key variables and testing the hypotheses.

3.2. Research Variables

Regarding the operationalization of the constructs and the development of the research variables, we adopted a rigorous process. Therefore, the items of the questionnaire from which the research variables resulted were based on a review of the literature. Furthermore, various discussions we have had with practitioners and academics helped us determine some of the research variables. Concerning the measurement of our variables, we relied on the literature because we used scales that proved to be reliable in similar studies. Therefore, our items measured the agreement of respondents with the research statements in the questionnaire. This was accomplished by using a five-point Likert scale (where, 1 = "strongly disagree" and 5 = "strongly agree") in the case of all the variables we have used.

Table A1 contains the explanations of the research variables we used, their full name abbreviation, and their description and references, as can be seen in Appendix A.

4. Statistical Analysis and Results

Furthermore, eighty-five large companies were analyzed in terms of the level of strategic procurement 4.0 performance, the level of openness of managers towards transitioning to the circular economy, and the competitiveness of these organizations. Strategic procurement 4.0 performance is a construct that is the result of incorporating three other constructs, as follows: strategy for procurement 4.0, planning for procurement 4.0, and review of procurement 4.0 performance [9]. The descriptive statistics for the variables that we used are presented in Table 1.

Table 1. Descriptive statistics for SPP4.0, CETO, OC, SP4.0, PP4.0, and RP4.0P.

	N	Range	Min	Max	Mean	Standard Deviation	Coefficient of Variation	Skewness	Kurtosis
SPP4.0	85	1.30	2.80	4.10	3.40	0.480	0.231	0.292	−1.456
CETO	85	3.00	1.00	4.00	3.00	1.055	1.113	−1.191	−0.106
OC	85	1.40	2.60	4.00	3.50	0.558	0.312	−0.643	−1.330
SP4.0	85	3.33	1.50	4.83	3.18	0.708	0.502	0.458	−0.180
PP4.0	85	3.50	1.25	4.75	2.99	0.614	0.378	−0.132	0.328
RP4.0P	85	4.00	1.00	5.00	3.19	0.930	0.865	0.315	−0.390
Valid N (listwise)	85								

Research data were statistically analyzed, and during this process, we assessed the convergent and discriminant validity. Cronbach's Alpha coefficient was assessed with the aim of testing internal consistency of the scales we have used. This was necessary mainly

because our variables resulted from several items. The accepted threshold for Cronbach's Alpha is 0.7 [45]. The results showed the reliability of the scales used. A coefficient of 0.711 was obtained for the strategic procurement 4.0 performance scale, 0.764 for the circular economy transition openness scale, and 0.890 for the competitiveness scale, as measured by Cronbach's coefficient. Following this, Cronbach coefficients of 0.865, 0.796, and 0.901 were calculated for strategy for procurement 4.0, planning for procurement 4.0, and review of procurement 4.0 performance, respectively.

To test the moderating effects proposed by our research, we used multiple regression. Therefore, the two-way moderated multiple regression implies the satisfaction of a set of assumptions regarding the research data. First, the data must be normally distributed. A kurtosis of less than 9 and a skewness of less than 2 represent an indication of normal distribution [46]. Although skewness and kurtosis are considered good indicators for normal distribution, we also used the Shapiro–Wilk test. All *p*-values for this test were found to be above the threshold of 0.05, creating the conditions to reject the null hypothesis of data not being distributed significantly differently from being normally distributed. Therefore, the normal distribution of the data can be assumed [47,48].

To test the mediating effects of selected constructs on organizational competitiveness as defined by our study, we used a measurement model described in our conceptual framework. Therefore, the aforementioned measurement model was examined for convergent and discriminant validity. Composite reliability (CR) was also considered. The Cronbach alpha coefficients that we have mentioned in an earlier stage were the first indicators to demonstrate that the quality criteria were met. Furthermore, we can support the previous statement by reporting that the factor loadings, CR, and average variance extracted (AVE) resulted in the recovery of values above the recommended thresholds of 0.7 for Cronbach's alpha, factor loadings, and CR, and 0.5 for AVE (see Table 2). Fornell and Larcker's criterion was employed to assess discriminant validity. The results showed that the model has external consistency. Before reporting results, which met the basic quality criteria for the model we have employed, some of the initial items were removed from the model because the loading was below the recommended threshold, thus improving both CR and AVE. In addition, we will report the results only for the factors we have kept in the model.

Table 2. Convergent validity, reliability, and item loadings.

Constructs	Items	Loadings	VIF	Cronbach's Alpha	CR	AVE
Strategy for procurement 4.0 (SP4.0)	SP4.04	0.769	1.093	0.865	0.890	0.679
	SP4.05	0.851	1.101			
	SP4.06	0.873	1.046			
	SP4.07	0.752	1.169			
	SP4.08	0.897	1.047			
	SP4.09	0.855	1.141			
Planning for procurement 4.0 (PP4.0)	PP4.01	0.902	1.174	0.796	0.724	0.507
	PP4.02	0.946	1.054			
	PP4.03	0.886	1.171			
	PP4.06	0.857	1.130			
Review of procurement 4.0 performance (RP4.0P)	RP4.0P1	0.893	1.043	0.901	0.889	0.628
	RP4.0P2	0.871	1.032			
	RP4.0P3	0.789	1.034			
Circular economy transition openness (CETO)	CETO1	0.844	1.006	0.764	0.778	0.531
	CETO2	0.863	1.021			
Organizational competitiveness (OC)	OC1	0.759	1.067	0.890	0.883	0.774
	OC2	0.716	1.111			
	OC4	0.825	1.058			
	OC5	0.809	1.101			
	OC7	0.760	1.161			
	OC8	0.746	1.172			
	OC10	0.843	1.036			
	OC12	0.878	1.090			
OC15	0.854	1.034				

Hence, we have shown that basic qualitative criteria have been met. The coefficients of determination helped to evaluate direct and indirect relationships. The corresponding results are presented further in the analysis.

4.1. Moderating Effect

The influence of managers’ openness to circular economy transition on the organizational competitiveness was tested using a two-way moderated multiple linear regression. In this study, the moderating impact of strategic procurement 4.0 performance on this relationship was analyzed. To perform this test, we multiplied the independent variable (CETO) by the moderator (SP4.0P) to ensure that we can avoid high multicollinearity with the interaction term [49]. As a result, the F for the ANOVA was significant and the adjusted R square has increased by 43.1%, thus significantly increasing the predictive power of our model. Table 3 summarizes the findings and shows that the adjusted R square for Model 1 was 0.460. This result means that 46.0% of the OC variance can be predicted from CETO and SP4.0P. Cohen [50] assesses the relationship as being moderately strong. As for Model 2, the adjusted R square is 0.901, which indicates that 90.1% of the variance in OC is predictable from CETO and SP4.0P. According to [50], this is a strong relationship. We can see a substantial change in R square by adding the moderator variable represented by the interaction effect CETO_by_SP4.0P.

Table 3. Direct and moderated relationships (H1 and H2).

Model	R	R ²	R ² Adjusted	SE	Change Statistics				
					R ² Change	F Change	df1	df2	p-Value (F Change)
1	0.688 ^a	0.473	0.460	0.41011	0.473	36.830	2	82	0.000
2	0.951 ^b	0.904	0.901	0.17584	0.431	365.053	1	81	0.000
a. Predictors: (Constant), SP4.0P, CETO									
b. Predictors: (constant), SP4.0P, CETO, CETO_by_SP4.0P									
Variable			Estimated Coefficient	Standard Robust Error		p-Value			
CETO_by_SP4.0P			4.33	0.227		0.000			

As for the bootstrapped 95% confidence interval for the slope to predict OC from CETO_by_SP4.0P, it ranged from 3.88 to 4.78. Thus, it can be asserted that if the moderator variable increases with one unit, OC will also increase by about 3.88 to 4.78 points. Furthermore, both models showed a statistically significant F test at 5% level of significance, which is a good indicator that both the independent variables and the moderator variable justify the variation in OC. CETO and SP4.0P have the ability to describe and predict possible changes that may appear regarding OC. The results from the two-way moderated multiple linear regression analysis indicate positive relationships between the variables. In contrast, changes in OC can also be attributed to the interaction effect played by the moderator variable because it increased the predictive power of our model, relieving its potential to moderate the effect between variables.

We further propose to examine the moderation effect through a graphical analysis. Similar to mediation, hierarchical regression can be a solution to testing and verifying the moderating effect of variables. For this purpose, we used IBM SPSS software to center the variables and create the interaction effect. PROCESS v4.0 developed by Andrew F. Hayes in SPSS [51] was used for the centering and interaction terms. Interaction points were plotted for a better interpretation of the interaction. When examining Figure 2, an enhancing effect is revealed, so that as CETO and SP4.0P increased, the competitiveness of the company also increased at all levels. Therefore, the results emphasized that organizations with managers who have a strong openness to transitioning to the circular economy and prominent levels of strategic procurement 4.0 performance showed the highest competitiveness. Moreover, at low circular economy openness, we noticed similar competitiveness levels both at low and average strategic procurement 4.0 performance.

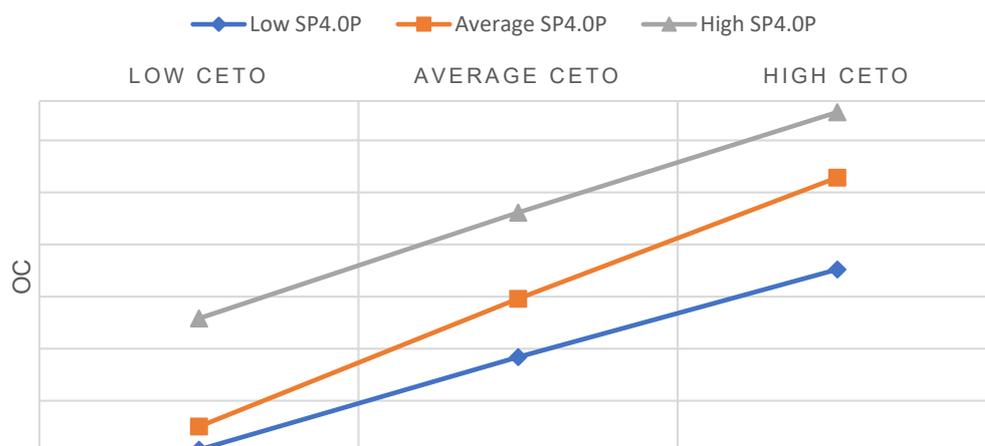


Figure 2. Graphic representation of the interaction effect.

Consequently, we can state that hypotheses H1 and H2 are supported by the research results.

4.2. Mediating Effect

To further test our research hypotheses, we evaluated the structural model through all direct and indirect effects that represented interest to our research approach. The assessment consisted of the path coefficients and their corresponding t values, as well as the level of statistical significance. As we can see presented in Table 4, the result for the direct and mediated relationships reveals that apart from $CETO \rightarrow RP4.0P \rightarrow OC$ ($\beta = 0.027, t = 1.949, p = 0.051$), all the relationships were positive and significant. These results show that H3 is supported, while H4 is just partially supported by the mediator role of SP4.0 ($\beta = 0.266, t = 2.128, p = 0.033$) and PP4.0 ($\beta = 0.146, t = 2.910, p = 0.004$).

Table 4. Direct and mediated relationships (H3 and H4).

	β	t	p-Values
H3a: CETO -> SP4.0	0.163	2.299	0.022
H3b: CETO -> PP4.0	0.218	2.284	0.022
H3c: CETO -> RP4.0P	0.165	2.634	0.008
H4a: CETO -> SP4.0 -> OC	0.266	2.128	0.033
H4b: CETO -> PP4.0 -> OC	0.146	2.910	0.004
H4c: CETO -> RP4.0P -> OC	0.027	1.949	0.051

5. Discussion

To test the hypotheses that organizational competitiveness may be the result of the influence of ecological and strategic factors at the level of the procurement function—more specifically, if strategic procurement 4.0 performance moderates the effects between managers’ openness towards transitioning to the circular economy and organizational competitiveness—we conducted a moderated multiple regression analysis. The results we obtained have supported both the first and second hypotheses. Based on the results, it can be concluded that the openness of the organization towards transitioning to the circular economy has a significant impact on its competitiveness (H1). Additionally, the level of performance of strategic procurement 4.0 has a positive effect on the relationship between the openness of managers to the circular economy and the competitiveness of the organization (H2). Furthermore, our PLS-SEM analysis revealed that the strategy referring to procurement 4.0, planning for procurement 4.0, and reviewing procurement 4.0 performance are all influenced by the openness of managers towards transitioning to circular economy, thus supporting H3. Lastly, the results from the mediation analysis showed that only procurement 4.0 and the planning for procurement 4.0 serve as effective

mediators in the relationship between the openness of managers towards transitioning to the circular economy and the competitiveness of the organization. Thus, only partial support was found for hypothesis H4.

The results of the study confirm that the openness of managers to specific practices of the circular economy plays a supporting role in improving both environmental and financial performance [42] as part of maintaining a favorable level of competitiveness. Sustainability goals necessary for contemporary organizations can be achieved through practices specific to the circular economy [52]. The findings of the study suggest that organizations with managers who have a strong inclination towards adopting the principles of the circular economy—and thus to its specific practices—not only support the achievement of sustainability goals, but also attain benefits in terms of higher performance. This fact has been previously reported by [29], as the adoption of circular economy principles is believed to improve production efficiency while leading to significantly higher financial performance. The moderating role of strategic procurement 4.0 performance suggests the important influences of some industry 4.0 digital elements, which are specific and are believed to enhance performance in the context of the circular economy [53]. Authors such as Bag et al. [9] indicated that organizational strategies involving procurement 4.0 have a positive relationship with the intention of customers to improve their business processes, which potentially increases organizational competitiveness, and thus is in line with part of our results.

Although the strategy is meant to bridge the gap between the internal environment and the external environment of a company, strategic procurement 4.0 performance will use specific and digital procurement knowledge to enhance the company's performance and its market-related gains in a circular economy context. As suggested by [54], our study also shows how the competitiveness of the organization increases under circular economy practices as well as under the conditions of long-term thinking and strategic thinking regarding the procurement 4.0 function.

The key findings of our article focus on how the competitiveness of the organization is influenced by some degree of managerial openness toward transitioning to circular economy practices in terms of knowledge, but also in terms of the intention to adopt them and the performance of procurement 4.0 under the organizational strategy. Therefore, we notice how the strategic thinking of managers influences the performance of the organization with respect to the procurement function under circular economy conditions.

6. Conclusions

As for the procurement function, it ceased to be just a support activity of manufacturing organizations quite a while ago. Instead, today's managers engage in a strategic procurement view and seek to align this activity with sustainability goals while including digital technologies. Our study brings evidence from the context of the Romanian business environment, which is still on the verge of moving closer to digitizing activities in order to be more efficient and to reduce resource consumption and help recycle while supporting Europe's efforts in the circular economy. Therefore, we managed to demonstrate that organizations that are strategically prepared to implement procurement 4.0 are also those that have a higher level of competitiveness in the context of the circular economy. This is because the openness of managers to the circular economy has proven to be an element that also positively influences the competitiveness of the organization, and this influence is enhanced by the level of strategic procurement 4.0 performance.

6.1. Managerial Implications

Some managerial implications are derived from this study. First, it is not enough for the manager to be open to the principles of the circular economy. Of course, for increased performance under current economic conditions, it is necessary for managers to know the principles of the circular economy and to show an open attitude towards them. This highlights the importance of managers having a positive attitude towards circular economy

practices and being knowledgeable about them in order to drive competitive advantage. However, in the context of digitalization and procurement 4.0, the level of strategic training of the organization is the one that has a decisive influence on the achievement of superior performance. Therefore, strategic thinking becomes critical.

Second, strategic thinking regarding procurement 4.0 works on three levels: procurement 4.0 strategy, procurement 4.0 planning, and procurement 4.0 performance review, meaning long-term as well as short-term vision; constant evaluation brings a continuous improvement of the system. This implies that organizations should focus on not only having a positive attitude towards circular economy practices, but also on implementing and effectively utilizing strategic procurement 4.0 in order to maximize the benefits of these practices.

Third, the competitiveness of the organization does not only refer to financial performance, but also to the capacity for innovation, know-how, and level of cooperation. Based on the findings of this study, it can be concluded that there is a need for greater understanding of the benefits of procurement 4.0. This is because procurement 4.0 offers advantages such as increased supply chain collaboration, the use of hard data in decision-making, and improved employee skills, which are all essential in the context of a circular economy and achieving a company's sustainability goals.

Finally, our findings offer useful information to managers and organizations trying to boost their competitiveness in the context of the circular economy. To develop a competitive advantage, businesses should focus their attention on adopting a pro-circular economy mindset, driving strategic procurement 4.0 into reality, and coordinating their procurement strategies with broader sustainability objectives.

6.2. Research Limits and Future Directions

Even though the study succeeded in integrating the potential impact of the performance of strategic procurement 4.0 on competitiveness in a circular economy context, there are several other dimensions of procurement 4.0 and the circular economy that need to be studied as well. Additionally, the study focused exclusively on large Romanian companies. However, companies operating in other countries, especially outside the European Union, could provide more insight because their environments, both internal and external, could be different. Although we assumed that in big companies, the level of development both at the strategic level and at the amount of capacity, expertise, and time and resources required to effectively execute and implement a procurement 4.0 process in a circular economy setting is substantially greater, future research can focus on the differences between companies depending on their size, and in different contexts and countries, in order to deepen our understanding of the importance of strategic procurement 4.0 performance and circular economy managerial openness and its impact on competitiveness in a more general framework.

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Appendix A

Table A1. Dependent and independent research variables.

Variable and Abbreviation	Indicator	Description	References
Strategic procurement 4.0 performance—SPP4.0—[Strategy for Procurement 4.0 (SP4.0); Planning for Procurement 4.0 (PP4.0); Review of Procurement 4.0 Performance (RP4.0P)]	SP4.01	To what extent does the procurement department encourage important suppliers to sign a yearly contract for strategic products.	[9,55]
	SP4.02	The extent to which the procurement department shares technical knowledge about products with key suppliers.	[9,55]
	SP4.03	The extent to which the procurement department invites suppliers to make technical contributions in the initial stages of product development.	[9,55]
	SP4.04	The extent to which the organization treats suppliers, such as the company's customers.	[9,55]
	SP4.05	To what extent is big data exploited for procurement decisions?	[8,9]
	SP4.06	The extent to which the Internet of Things has enabled the development of smart supply infrastructure.	[8,9]
	SP4.07	The degree to which clarity and accountability inside the supply chain system will improve customer relationships and trust in the long run.	[8,9]
	SP4.08	The extent to which suppliers within the organization are already included in the digital transformation process.	[8,9]
	SP4.09	The extent to which purchasing agents may operate with complete remote access thanks to mobile applications, cloud solutions, and cloud-based ERP systems.	[8,9]
	PP4.01	The extent to which the procurement department plans for short, medium, and long-term procurement using I4.0 technologies.	[9,56]
	PP4.02	The extent to which the procurement department uses I4.0 systems to plan procurement actions.	[9,57]
	PP4.03	To what extent does the procurement department use the ERP package for daily operations?	[9,57]
	PP4.04	The extent to which the procurement department uses predictive analytics tools to accelerate planning processes.	[8,9]
	PP4.05	The extent to which the procurement department uses artificial intelligence to make procurement planning decisions.	[8,9]
	PP4.06	The degree to which the company evaluates procurement in meetings.	[8,9]
	Circular Economy Transition Openness—CETO	RP4.0P1	To what extent does management review the performance of procurement (e.g., budget vs. actual expenses, supplier cost, and the addition of new suppliers) at the monthly meeting of the executive committee.
RP4.0P2		The extent to which the IT team closely monitors and reviews cybersecurity in electronic procurement systems.	[9,58]
RP4.0P3		The degree to which the company gradually moves to a digital performance management system.	[9,58]
Organizational Competitiveness—OC	CETO1	The extent to which the firm adheres to the concepts of the circular economy.	[60]
	CETO2	The extent to which the organization intends to find ways to shift from a "linear economy" to a "circular economy".	[61]
	OC1	Economic and financial success in accordance with the company's goals.	[62,63]
	OC2	Compared to five years ago, the economic and financial performance has seen an improvement.	[62,63]
	OC3	Financial and economic success in comparison to competitors.	[62,63]
	OC4	Depending on the company's aims, assessed competitiveness.	[62,63]
	OC5	In comparison to five years ago, perceived competitiveness has increased.	[62,63]
	OC6	Assessed competitiveness in comparison to the primary rivals.	[62,63]
	OC7	The degree to which the organization's expertise and abilities are applied creatively.	[64]
	OC8	The extent to which the corporate structure encourages innovation in order to create new items for a higher market presence as well as in emerging markets.	[64]
	OC9	The level to which innovative components generated previously within other companies have been fully adopted.	[64]
	OC10	To what extent has the firm conducted R&D activities?	[64]
	OC11	The degree to which the organization has partnered with other organizations in carrying out research and development activities.	[64]
	OC12	The degree to which the company views ethics to be crucial in interactions with stakeholders (clients, vendors, funders, etc.), as well as a high level of trust, collaboration, and knowledge transfer.	[64]
	OC13	The level of a company's involvement in partnerships and collaborations with other companies.	[64]
	OC14	To what degree are cooperation relationships promoting the attraction and collaborative use of similar assets?	[64]
OC15	The measure to which the organization hires intermediaries in order to obtain access to specific markets.	[64]	
OC16	The extent to which the organization strives to achieve a healthy balance between third-party and internal interests by establishing a competitive edge in order to generate new opportunities or eliminate threats.	[64]	

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